Technological Change in an International Industrial System

Leif Linnskog

Mälardalen University

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TECHNOLOGICAL CHANGE IN AN INTERNATIONAL INDUSTRIAL SYSTEM

Leif Linnskog

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Abstract

Industrial systems resist change, more often, because heavy production facilities and industrial constructions are expensive and have long economic lives, but also because people tend to defend ingrained conceptions of how things are and how activities ought to be performed. Starting out from the question: “How does technological change come about in an international, industrial system?” the thesis investigates the interplay between technological, social, and economic factors. Empirically the work is located to the steel and metals industries and covers business exchange within and between several economic entities performing international business operations.

It is shown that technological change is driven by strategic intention, but that it also occurs as a result of chance or “necessity”, or follows on everyday enterprise operations. In an attempt to realize strategic intentions actors involve in games of negotiation while referring to different power bases. Backed by organizational role (hierarchic level/managerial position), personal “luminosity” (charisma/leadership), or control over critical resources (that other actors are interested in) various arguments are put to the test on “the arena for negotiations and change”. While involving in negotiations actors may relate to existing business and/or social relations for support or they may take advantage of full-blown coalitions.

Constrained by the games of negotiation, which unfold in an institutional environment, the process of technological change adopts evidently evolutionary characteristics, and it follows implicitly that the single actor has at its disposal only limited possibilities to determine the process outcome. Technological change as an evolutionary process consists of three underlying sub-processes, viz. innovation, interaction, and institutionalization, it is argued.

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PREFACE

By completion of this thesis a long and winding journey has finally come to an end.

At the time I commenced my postgraduate studies in the mid 1990s I was still employed by the Avesta Sheffield group as a product manager for special grades, and by then I had already spent about ten years in the stainless steel industry. I was organized in the marketing department of a production unit of the group and my role as a product manager made me frequently involve in customer-orientated technological matters – not the least technological change – in an international business environment. I used to have 80 - 100 working days abroad annually.

The professional environment of mine had a strong orientation towards exchange framed by business relationships and this circumstance triggered my curiosity and made me return to the university in the early 1990s for further academic studies at master’s level, an endeavor that was later extended into postgraduate studies. Support from the Avesta Sheffield group management and particularly from the marketing director of the group at that time, Hans-Jacob Waern, but also from the plant manager Lennart Paijkull of Unit Cold Rolled¹, made it possible for me to attend postgraduate courses at Uppsala University, Stockholm University (Stockholm Center for Organizational Research), and University of Umeå (Marketing Technology Center) during the latter part of the 1990s.

Combining a strictly result-orientated professional life with markedly philosophical considerations typical for university studies was somewhat confusing to me in the beginning, and today I am inclined to confess that my early attempts to write up a thesis suffered from strong prescriptive propensity, a writing style that is usually not particularly successful in academic writing. At a later stage in the process of personal development maybe I got too keen on theory while forgetting about the interesting experiences of mine that I had gained through business practice. Now, in the final phase of writing up a thesis for the doctorate, I hope I have succeeded in striking a reasonable balance between theory and practice. The empirical part of the work is developed based on my own experiences completed with interview data and information gathered by the study of a large number of authentic documents.

In early 2006 I was accepted for postgraduate studies at Mälardalen University with Professor Ulf Johanson as main supervisor and Professor Peter Söderbaum as assistant supervisor. Already in the autumn of 2003 I had presented my scattered writing for Peter, who showed an honest interest in it and encouraged me to go on. Also Professor Esbjörn Segelod was kind enough to underpin my further writing. This was actually a turning point in my endeavor for the doctorate. Peter’s interest without I had probably never bothered to go on with the project, and I have really appreciated his support and

¹ The business unit in which I was employed.
appropriate commenting throughout the writing process. Later Ulf’s competent tutoring has been most helpful for the completion of this thesis work. I have listened to and obeyed most of his insightful comments and proposals. However, it is important to underline that any inconsistencies or flaws occurring in the material are entirely my own responsibility.

A few people close to me have followed my struggle through the years. I dedicate my work to my mother Britta, who never got the opportunity to see and read the final version of the thesis, to my wife Margareta, who always supported me and particularly so at times when conditions were tough, and, last but not least, to my children Robert and Linda, who are both most proud of their father’s achievement (and have promised to read the book from the beginning to the last page).

Sometimes I have wondered what I would have done had I not written a doctoral thesis as the project has consumed thousands of hours. Maybe I had refurbished our house somewhat more frequently, or I had built a holiday cottage for us, or I had invested in a pleasure-boat. Or maybe I had put all my energy on improving my musical skills. As a matter of fact in connection with my final seminar session in September last year I bought myself a soprano saxophone, and now, when the thesis work has finally been completed, I know perfectly well what I will do ….

Eskilstuna in May, 2007.
Leif Linnskog
ABSTRACT

Industrial systems resist change, more often, because heavy production facilities and industrial constructions are expensive and have long economic lives, but also because people tend to defend ingrained conceptions of how things are and how activities ought to be performed. Starting out from the question: “How does technological change come about in an international, industrial system?” the thesis investigates the interplay between technological, social, and economic factors. Empirically the work is located to the steel and metals industries and covers business exchange within and between several economic entities performing international business operations.

It is shown that technological change is driven by strategic intention, but that it also occurs as a result of chance or “necessity”, or follows on everyday enterprise operations. In an attempt to realize strategic intentions actors involve in games of negotiation while referring to different power bases. Backed by organizational role (hierarchic level/managerial position), personal “luminosity” (charisma/leadership), or control over critical resources (that other actors are interested in) various arguments are put to the test on “the arena for negotiations and change”. While involving in negotiations actors may relate to existing business and/or social relations for support or they may take advantage of full-blown coalitions.

Constrained by the games of negotiation, which unfold in an institutional environment, the process of technological change adopts evidently evolutionary characteristics, and it follows implicitly that the single actor has at its disposal only limited possibilities to determine the process outcome. Technological change as an evolutionary process consists of three underlying sub-processes, viz. innovation, interaction, and institutionalization, it is argued.
SAMMANFATTNING

Industriella system är vanligtvis trögföränderliga som en följd av att tunga maskin- och anläggningsinvesteringar har lång ekonomisk livslängd, men även på grund av att människor ofta försvarar invanda föreställningar om hur saker och ting är och hur aktiviteter ska eller bör utföras. I avhandlingen studeras samspelet mellan teknologiska, sociala och ekonomiska faktorer utifrån frågeställningen "Hur kommer teknologisk förändring till stånd i ett internationellt, industriellt system?" Den empiriska miljön är förlagd till stål- och metallindustrin och omfattar affärsutbyte såväl inom som mellan ett flertal ekonomiska enheter i företag med internationell verksamhet.

Avhandlingen visar att strategiska avsikter och beslut har en avgörande inverkan på teknologiska förändringar men att sådana förändringar inte sällan även uppstår på grund av tillfälligheter eller "nödvändigheter" eller som en konsekvens av företags löpande affärsverksamhet. I sin strävan att förverkliga strategiska avsikter refererar olika aktörer till olika maktbaser och deltar därigenom i ett förhandlingsspel där den enskilde aktören inte sällan söker stöd för sin sak i upparbetade affärs- och/eller sociala relationer eller genom att ingå regelrätta koalitioner. I sammanhanget prövas argument som backas upp av organisatorisk roll (hierarkisk position/eventuell chefsbefattning), personlig ”lyskraft” (karisma/ledarskap), eller kontroll över kritiska resurser (som andra är intresserade av).

Den teknologiska förändringsprocessen får inom ramen för detta förhandlingsspel, som sker i en institutionell miljö, en tydlig evolutionär karaktär där den enskilde aktören har uppenbart begränsade möjligheter att bestämma utfallet, och denna evolutionära process visas bestå av tre underliggande delprocesser, nämligen innovation, interaktion och institutionalisering.
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1 STUDY APPROACH

Some general considerations about technological change in a socio-economic context introduce the reader into the research subject. An introductory case leads up to the research problem and the aim of thesis. A few fundamental assumptions determine the outward boundary of the theoretical framework, which combines business network theory and institutional organization theory. The process of change is conceptualized and technological change is positioned in relation to other change sub-processes. A discussion on methodology follows, and an outline of the thesis structure completes the chapter.

1.1 Introduction

This monograph deals with the occurrence of technological change in an international industrial system, and it is argued that existing theory leaves open unexplained voids in relation to technological change as it appears in the business process. Basically the shortcoming has to do with choice of perspective. Choosing a theoretical perspective is choosing a particular way to view a phenomenon, and any such choice implies that some aspects of the phenomenon are rendered focal interest, whereas other aspects are sent off to the periphery or are entirely disregarded. However, irrespective of which is the perspective chosen, some general questions may be raised in relation to the phenomenon of technological change. One may wonder what it is that is changing, but one may also ponder over possible sources of technological change. Can certain change drivers and inhibitors of change be identified? Is the emergence of technological change tied to certain places, or is it viable to talk about technology that is traveling through an industrial system? This kind of questions may serve as mind openers in connection with a study of technological change.

1.2 Technological change in a socio-economic context – some general considerations

People in contemporary society encounter a large amount of technologies in their lives. Some technologies make life easier for the individual human being, whereas other technologies provide constraints or raise barriers. New technology is commonly developed in order to improve the conditions of life for various users, and it is clear that the outcome of technological change is more often judged positive. However, sometimes technological change brings with it negative effects. Such negative effects may hit those that the new technology is meant for, but also other parties, not to forget the physical environment.

Technological change is a process, starting as somebody is discovering an opportunity to improve existing technology, or to develop new technology expected to bring with it
some kind of advantage, if realized. Hence, a prospect concerning technological change is directly connected to an expectation of potential advantages, an expectation that is born at the same moment as the discovery is made. In today’s high-technological society a major part of technological development is made within and between business organizations, but also universities, authorities and other actors in various ways contribute to the development process. Technological change closely relates to the allocation and orientation of resources as well as to the coordination and control of activities. Complex structures emerge; structures that are reaching beyond the legal boundaries of organizations, and those structures are continuously subject to change.

It is not a given that serious proposals concerning improvement of existing technology or development of new technology are always realized. Usually it doesn’t suffice that the originator of an idea is confident about it. For realization to occur resources have to be allocated and activities have to be performed, and that in turn, demands that other actors – individuals, groups, or organizations – support the idea and contribute to its realization. It is reasonable to assume that others’ choice to support a potential project is grounded, to a certain extent, in scientific and/or technological considerations. Some projects may be rejected already at first inspection, as they are judged entirely unrealistic – maybe natural law is setting the limit. Other proposals may have been closely investigated in the past and were found less interesting due to technical difficulties. Even if it is reasonable to suppose that the decision whether to support or reject an idea commonly refers to scientific or technological considerations it is contended that also other considerations may impact upon the outcome. It is not a given that an idea about technological change will be realized just because it is judged feasible on technological grounds.

The considerations that will finally determine whether to invest in a new idea are contained in the answers to the following two comprehensive questions: What is the probability that the idea will turn out profitable? Can we/do we want to support the idea? The one question does not exclude the other. Perhaps we hold a positive stance towards an idea because we believe it will generate profit, or we decide to support it for other reasons. Scientific and technological considerations will certainly influence our decision but the final choice will be made on financial and/or social grounds. Expectations of economic success are an important decisive element in business. A proposal about technological change that is expected to generate high economic yield has a good chance to receive sufficient support. Friendship or a high level of trust in a social relation is another factor that may decide whether a new idea will be supported or not. In a close social relation characterized by trust and affinity the involvement in the relation as such may motivate one party to support the other party’s idea about change. Important contextual actors having strong confidence in a person proposing a change project of questionable quality may still decide to support the project because they trust the person.
The discussion aims at showing that technological change is not a freestanding phenomenon. On the contrary, it is assumed that technological change is embedded in the socio-economic context in which it evolves. Granovetter (1985) argues that economic activities are closely related to the social structures in which they appear, i.e. that economic activities are embedded in social structure. Veblen (1914) maintains that technological change is modified and constrained by social beliefs and structure. The apprehension that technological change controls cultural, political and economic change has been denoted ‘technological determinism’. A modified version of the concept, viz. ‘technological interactionism’, conceives of technological and social change as mutually influential (Outhwaite & Bottomore, 1998). Thus, the idea that the process of technological change influences the socio-economic structure is supported in the literature, but the opposite is also rendered support, i.e. that the socio-economic structure impacts upon the process of technological change.

Although the sources of change may often be traceable to individuals, groups or other actors aiming at making certain change come about, it seems that change that influences the actors now and then evolves out of their reach. It might be sometimes that they are even unaware of realized change although it influences their operating conditions in various ways. As change processes commonly involve several actors, and as the activities performed by the actors are commonly dispersed in space and time, tracing the appropriate sources of change is often difficult. And sometimes it is even impossible. “Not knowing” introduces a certain amount of chance in the process of change and when chance is around the process of change appears to be evolutionary rather than anything else.

1.3 Introductory case: Product development and utilization in an industrial system

Product development, the theme of the introductory case, represents a certain kind of technological change frequently occurring in business. A Swedish stainless steel manufacturer makes up the supply side, whereas a company specializing in the manufacturing of plate heat exchangers constitutes the demand side of the case. Other actors, identified or contextually anticipated, complete the setting.

1.3.1 Presenting the introductory case

In the early 1970s, a young student graduated from the department of metallurgy at the Royal School of Technology in Sweden. During his years at school he had become

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1 A plate heat exchanger is a technical system transferring heat from one medium to another, most commonly from one liquid to another or from one gas to another but sometimes also from a liquid to a gas or reverse. Heat exchangers are used in various industrial processes.
interested in steel grade composition and particularly in the development of advanced grades designed to resist wet corrosion attack in environments containing high concentration of halogens\(^1\). Ordinary seawater\(^2\) is such an environment and seawater becomes particularly aggressive at elevated temperatures. When still at school the young fellow designed a promising steel grade formula destined for service in this type of environment, and, as seawater applications make up an important use area, the new grade was supposed to have a large business potential. Avesta Jernverk AB, a company specializing in the development and production of stainless steel, employed the young graduate for work in their R&D department where he, together with some qualified colleagues, experts on metallurgy and corrosion technology, developed the new formula into a commercial steel grade\(^3\) intended for service primarily in marine environments. The plate heat exchanger (PHE) application was early meant to be an appropriate use area for the new grade, and a large manufacturer in the field, a regular user of other Avesta grades, was soon involved as partner in a development project aiming at exploiting the new grade. A full-scale test was prepared addressing desalination plants onboard on vessels. \(^4\) Could the new grade be successfully used, substantial cost savings would result as currently the application was drawing on an expensive nickel-base alloy\(^5\).

The project proceeded and information related to issues such as manufacturing, service conditions and corrosion problems was exchanged between the actors involved. Laboratory tests confirmed that the new grade was suitable for the application and everything looked promising. Sheets of stainless steel were produced along standard production procedures, and out of the sheets heat exchangers were manufactured, but not without difficulty, as the new grade was much tougher than grades previously used by the PHE manufacturer. Finally, the exchangers were built into desalination plants for service onboard on vessels. Just a short time in service was enough to show that the new steel did not come up to expectations. At ordinary process temperature the material could not resist the aggressiveness of the seawater. Inspection revealed the occurrence of severe corrosion attacks on the steel surface. A few sheets were even penetrated. Laboratory tests had approved the grade for the application but on-site testing saw the grade fail. Why did it fail? Attempts made to restore the project came to nothing as no serious investigation addressing the reason for material failure was carried out. The new technology aiming at more efficient desalination of seawater did not materialize as the new grade was never approved for the application.

\(^1\) Fluorine, chlorine, bromine, iodine and astatine together make up the group of halogens.
\(^2\) Seawater contains a high level of sodium chloride. At elevated temperature also brackish water is aggressive.
\(^3\) The steel grade was patented in most industrialized countries around the world.
\(^4\) A desalination plant converts seawater or brackish water into fresh water.
\(^5\) In general, under demanding service conditions nickel-base alloys resist corrosion better than stainless steels, but as the nickel price is much higher than that of iron (the base metal of stainless steel) nickel-base alloys are usually much more expensive than stainless steel grades.
Epilogue:
Although the new grade did not reach success during the early days – as has been described straightforwardly in the case – nowadays it is frequently used in plate heat exchangers operating in different corrosive environments, among those seawater. Several other applications also benefit from the grade and it is widely appreciated for its outstanding performance when exposed to difficult service conditions.

1.3.2 Discussing the introductory case
The development, manufacturing and utilization of products are central to any industrial operation. The empirical case serves as an illustration. It tells about the development and commercialization of a new steel grade, a process starting with an idea ending up in a new product involving new technology. The change process involves several actors in different roles relating to each other in various ways. Downstream we find the customer and the customer’s customer and if starting at “the bottom” there is a chain of suppliers upstream. At each horizontal level we anticipate some kind of competition. Had Avesta’s new stainless grade been approved for use in desalination plants onboard on vessels, sales of nickel-base alloys for the application had suffered, no doubt, as the price difference between the two materials is substantial. Getting access to the new grade would have been a crucial issue for PHE manufacturers, and those manufacturers who had been lucky enough to secure reliable supply had got a competitive edge in the field. And the patent holder of the new steel grade, i.e. Avesta, would have been the one deciding whom to render access to the new material. Now, as the case reveals, the new grade did not qualify for the actual application. The nickel-base solution was challenged but it survived the challenge.

Certainly more interesting than the competitive aspect of the case is that of cooperation. A product development project is established between Avesta and the PHE manufacturer with an aim of developing the new grade for the desalination application. Technological information is exchanged, the steel is specified for PHE manufacturing, and the PHE manufacturer adjusts its working tools for the task. The PHE manufacturer also makes the necessary arrangements with sea transporters for full-scale testing onboard. A lot of information is exchanged and many activities are performed in the various interface areas between the companies. Within the Avesta system it seems that established procedures and routines largely guide activity performance within and between the units concerned. An explanation to the quality discrepancy between the laboratory samples and the as-mill produced material subject to full-scale testing is not seriously searched for. It seems that the activities of the R&D unit as regards product development, and the process development work carried through in the various manufacturing units, are not properly coordinated. It is common knowledge that producing a new steel grade in a steel mill is not just deciding about how much of the various alloying elements to feed into the furnace, but also to decide about how to run the various process technologies of the mill, i.e. the smelting
procedures, slag treatment, the various casting arrangements, etc., as each steel composition is bound closely to its own constraining parameters. Downstream hot rolling and cold rolling procedures are also affected. The notable discrepancy in performance between the laboratory samples and the as-mill produced material makes probable that the manufacturing processes in the various mills have not been appropriately tuned to meet the specification of the new grade. Furthermore, as the project was abandoned halfway through maybe the marketing people, who certainly saw the commercial potential of the project, were unable to impact upon the upcoming problem situation. Perhaps they didn’t possess the necessary influential power, or they were never invited to have a voice in the matter.

Elaborating on the empirical case leaves many questions unanswered. Why didn’t the project end up in success? What went wrong? Were there communication problems? What about the availability of technological competence and capability? What about manufacturing procedures, were they adjusted to fit the new grade? Was there something wrong with the full-scale testing; more aggressive parameters than specified; inappropriate logging of service conditions? Was interest in the new grade lacking? Etc.?

The initial project failed, but the new grade did not. Instead it gradually developed into a commercial steel of very good reputation known for its splendid performance when used in heavy service environments. The technological change that was originally strived for never materialized but the new steel found a slightly different route to the user. Unfortunately there is not enough data available to uncover that route in detail.

1.4 Research problem and aim of thesis

1.4.1 Problem background

The introductory case shows that technological change appearing in an industrial context is not necessarily a straightforward activity controlled by one single actor only. It is probably more common that such activities involve more than one firm and often also more than one unit within the firms involved. In the introductory case forces operating inside the focal firm, i.e. Avesta, influence the development and commercialization of the new steel grade, but it is clear that also external actors, and perhaps even the exchange process itself, impact upon the progress of technological change. The PHE manufacturer, for example, adds both to the technological development and to the commercialization of the new grade by developing his cold-working skills. It is also most probable that the full-scale test had never come about without the involvement of the PHE manufacturer. Unfortunately the negative result of the test did not trigger the necessary problem solving activities within the Avesta
system and the project did not end up in success. As a result the business remained in the hands of the nickel-base feedstock suppliers.

The case description indicates that technological change may appear as an integrated part of the business process, and that the phenomenon may concern both intra- and inter-organizational matters, i.e. that it transcends firm boundaries. This view of technological change contradicts the conventional view of the phenomenon where technological change is studied primarily from an intra-organizational perspective. It is not argued, though, that the “fruits of technology” have nothing to do with the customer in e.g. managerial economics. Certainly they have. It is just that the process of technology development is not supposed to involve the customer. It is rather supposed to be a hierarchically controlled process including three main phases: (1) exploring customer needs, (2) developing new technology to fit customer needs, and (3) satisfying customer needs by exploiting the new technology. Such a view is lacking a realistic assumption about the customer. The customer is considered to be a “faceless creature” best “treated” at an aggregate level, i.e. by identifying homogenous market segments, each such segment to be treated in a univocal way while relying on the logic of stimulus-organism-response. A different view of the customer builds on the assumption that the customer is an active part involved in interaction with the supplier on equal terms. Adding the latter assumption opens for the study of technological change in a dual perspective considering both intra- and inter-organizational aspects.

The introductory case does not forward any detailed information about the process through which the new steel grade is molded into physical shape but its route from “conceptual” technology to physical product seems fairly bumpy. As a matter of fact, it never reaches the destination originally sought for. However, through its various product “incarnations” the new grade reaches other ends, ends that, according to the epilogue description, involve a lot of success. In reality the process of ‘developing technological change’, the focal issue of the introductory case, seems at times to be a fairly complex phenomenon. A central problem relating to the issue is how to understand the word ‘developing”? Should it mean innovating, imitating, adapting, transferring, transforming, or what? At the one extreme ‘developing technological change’ may be considered a pure, intra-organizational R & D process (research and development) driven by qualified and devoted researchers and engineers assigned the task of continuously feeding the company with new, brilliant product and process solutions. At the other extreme ‘developing technological change’ may concern external supply of the latest technology available to secure that the firm doesn’t fall behind its competitors. Both extremes frequently appear in business, no doubt, at least in forms that come close to those described, and the forms described can be related to the classic inquiry whether to make or to buy (Coase, 1937; Williamsson, 1975) although the choice may well involve also other than strict economic considerations. As the introductory case indicates technology may be subject to change as it moves through an industrial system from one place to another. Various forces may impinge
upon its content and shape. Constraints and opportunities appearing along the road may impact upon the direction and thus the final destination of the journey. The initial idea or piece of technology may go through various stages of change as it travels through the system. If appreciating the view of technology as a phenomenon that is molded by many forces as it moves through space and time, it might be more feasible to talk about ‘technological evolution’ than about ‘technological development’, as the former to a greater extent than the latter apprehends the influence of unpredictable and unforeseeable factors.

To summarize, an organization may provide for technological change (1) by creating technology in-house (for internal use and for sale), (2) by acquiring “ready-to-use” technology from external sources, and (3) by participating in evolutionary processes of technological change where ideas and concepts are molded and elaborated by several actors until new or modified technologies finally appear. ‘Technological evolution’ is about technological ideas and concepts passing by while involving various intra- and inter-organizational forces and sources shaping their reification into manifest technologies. Technological change may take on the form of evolution to a larger or lesser extent, but it is hard to think of any industry-related process of technological change that entirely escapes the evolutionary component. In-house development of technology is frequently affected by ideas, support and validation emanating from external sources. External supply of “ready-to-use” technology is proven, more often, not to be fully “ready-to-use” in a specific company context. Acquisitions of the kind usually need more or less extensive external support to function properly, or the technology acquired has to be modified in-house to better meet a particular task.

1.4.2 Research problem and aim of thesis specified

Literature on entrepreneurship commonly elaborates technology development while emphasizing creation and innovation. Organization theory focuses on intra-organizational processes while refraining from elaborating processes of technological change appearing in the interface between organizations. Theory on business relationships and networks largely ignores intra-organizational processes while maintaining that technological development emerges as two or more firms involve in interaction with one another. All three approaches deal with technological change but all three miss out on an integrative perspective. Assuming technological change to be an evolutionary process is appreciating that activities such as creation, innovation, imitation, adaptation, transformation, and exchange are making up the process, which implies technological change is supposed to emanate from various sources, to transcend organizational boundaries, and to closely relate to the business process. The discussion converges into the research question of the thesis.
Research question:
How does technological change come about in an international, industrial system?

The question implicitly involves several inquiries, inquiries such as “what is technology” and “what is technological change”? It also addresses the issue of “what is an industrial system”? Furthermore, the involvement of ‘change’ points at a dynamic approach and a process perspective. For illustrative purposes some sub-questions may be developed:

Which inter-organizational sources and processes influence the development of technological change in an industrial system?
Which intra-organizational sources and processes influence the development of technological change in an industrial system?
How do inter-organizational sources and processes impact upon the way technology evolves inside an organization?
How do intra-organizational sources and processes impact upon the way technological change evolves between organizations?
Which conflicts and crises arise as the process of technological change unfolds?
How does the handling of those conflicts and crises influence the process of technological change?

Aim of thesis
To explore and describe how technological change comes about in an international, industrial system by investigating intra- and interorganizational sources and processes that organize technological change.

Both the research question and the aim of thesis involve the formulation “an international, industrial system”, which may be thought of as problematic as it opens for different interpretations. One may ask which international, industrial system it is all about. The formulation would be rendered either the meaning “in any international, industrial system”, or the meaning “in one particular international, industrial system” (viz. the one that is approached in this thesis work), or a meaning positioned somewhere between those two extremes. It is basically a matter of judging “how far” (within which region or domain) the findings developed can be attributed validity. The issue concerns the external validity of the thesis work and is further discussed in paragraph 1.7.5 below.¹

1.5 Theory scope

Science is divided into various scientific fields. Research activities within a particular field commonly adhere to certain accepted theory traditions, a circumstance directing researchers’ attention to particular areas of study while at the same time constraining their scope of investigation. It is normal, for instance, that organization theorists approach phenomena occurring inside organizations along the traditions of organization theory, whereas theorists belonging to other fields, e.g. marketing or industrial organization economics, identify phenomena out of their particular area of interest while striving to contribute to the development and refinement of their stock of knowledge.

1.5.1 Two approaches to business studies

Traditional literature on the firm and the market has its origin in classical and neoclassical economics both employing a rational/analytic approach. Along this tradition ‘managerial economics’ (ME) and ‘industrial organization economics’ (IO) are prominent offshoots of our days. The firm is supposed to be an instrumental organization with a hierarchical structure where operations are directed from the top. The employees of the firm are looked upon as production resources, which are semi-permanently tied to the company by way of contracts. Customers are “face-less” creatures clustered into segments. They react on stimuli. While attempting to satisfy customers the firm aims at surpassing competitors. As suppliers and customers meet in the market, history doesn’t matter. In this vein of thought, technological change is an instrumental process based on rational grounds. It shows up in normative management processes prescribing how change is better manipulated and controlled for the reach of anticipated results in a most efficient way. In neoclassical economics technology given in the form of production functions is largely reduced to a physical phenomenon, and technological change is a matter of strategic decision-making, where one-way forces are supposed to fully control the change process. Studies in the vein of managerial economics are aiming at detecting causal relations without paying much attention to context. When technological change is studied the purpose is usually normative. It might concern the development of a prescriptive model, or the analysis of data collected along a limited number of variables brought in from an existing causal model. The approach emphasizes the “parts” rather than the “whole”.1

Another view of business that will be emphasized here shows companies that engage in exchange with each other again and again, while orientating their resources and activities towards those counterparts with whom they interact. Such companies are supposed to interconnect into larger systems, systems that may be studied at different levels of aggregation. At a high level of aggregation (the macro level), all appropriate

1 Some additional information about theories in the tradition of economics is forwarded in the introductory sections of chapter 4 and 6.
units that constitute the system are considered, but also their various interrelationships, and the interrelationships between the units and the system as a whole. At a lower level of aggregation (the micro level), studies focus on the various parts that make up a particular unit, but also pay attention to the contextual relations of the unit and its parts. At the macro level, actors involved are supposed to be business units and the like, and episodes appearing in the interface between such units are rendered particular interest. At the micro level, individuals or groups of individuals are identified as actors, and at this level change processes populated by individuals are put in focus. Appreciating the existence of larger systems of interconnected business actors appearing at different levels of aggregation (including that of the individual human being) opens for broader studies of technological change.

1.5.2 Choosing an overall theoretical frame

Following the content of the introductory case it is assumed that technological change makes up an integral part of the business process, and business activity is supposed to comprise both transaction and transformation, or otherwise expressed, exchange between firms or units as well as intra-organizational operations such as manufacturing, logistics, R&D, etc. This view of business\(^1\) implies that technological change is a matter of both intra- and inter-organizational concern, which in turn means that both perspectives are applicable from a research point of view. Moreover, it is assumed that technological change appears embedded in a socio-economic context. The assumption involves the contention that technological, social, and economic elements form an interconnected dynamic system subject to continuous change. A study of technological change based on these assumptions has to take into account the various sources and processes that are supposed to influence technological change, while securing that the various parts of the system, as well as the system as a whole, are considered. If the analysis reciprocally relates the parts and the whole to each other it should be possible to reach an increased understanding of the phenomenon of technological change as it appears in an industrial system. A study of technological change employing a socio-economic perspective ought to be anchored to theories that simultaneously and satisfactorily cover the technological, the social, and the economic dimension. A socio-economic perspective in conjunction with the circumstance that this thesis work emphasizes “what is” rather than “what ought to be”, and processes rather than conditions, make much of the literature in the tradition of economics (e.g. ME and IO) irrelevant, or at least less relevant, for the purpose at hand.

The circumstance that technological change is a phenomenon that has been observed both in an intra- and an inter-organizational perspective complicates the choice of theoretical basis as available inter-organizational theory largely excludes intra-organizational processes, and intra-organizational theory largely refrains from considering inter-organizational processes. The phenomenon has been studied in both

\(^1\) The business concept as applied in this work is further outlined in chapter 4.
perspectives and there is a wide range of research literature available on the topic. But literature addressing technological change simultaneously in both perspectives is rare if existing at all, leaving open a knowledge void in the interface area between the two perspectives. The void becomes particularly notable if assuming that, (1) technological change is an integral part of the business process, (2) business activities transcend organizational boundaries, and (3) technological change is an interesting issue both intra- and inter-organizationally. Each theoretical perspective produces “its own view” of technological change emphasizing certain factors while playing down or excluding other factors. Different foci produce different answers. It follows that each perspective offers a biased view of the phenomenon where some parts are highlighted and other parts are put at a disadvantage.

Thus, a theoretical body satisfying the requirements as to relevance as well as all-inclusiveness ought to (1) include the technological, the social, and the economic dimension, (2) be descriptive rather than normative, (3) relate to processes rather than conditions, and (4) involve both the intra- and the inter-organizational perspective. Unfortunately there is no coherent body of theory available that is meeting all the requirements specified. Theory focusing on business relationships and business networks satisfies the requirements as to item one, two, and three, but sticks to an inter-organizational perspective only. A large part of the literature on organizations with connection to institutional theory also covers item one, two, and three, but is content with an intra-organizational perspective by and large. A possible solution, then, if aiming at meeting all four requirements would be to combine network theory and institutional organization theory. Such a combination would offer an all-inclusive theoretical platform (see Figure 1:1).

<table>
<thead>
<tr>
<th>Level of aggregation</th>
<th>Perspective</th>
<th>Intra</th>
<th>Inter</th>
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<tbody>
<tr>
<td>Macro</td>
<td>Business network theory with focus on business relationships</td>
<td>(Institutional organization theory)</td>
<td></td>
</tr>
<tr>
<td>Micro</td>
<td>(The social aspect of business relationships)</td>
<td>Institutional organization theory</td>
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**Figure 1:1** Theory frame

A phenomenon may be studied at different levels of aggregation and it is supposed that the level chosen to a certain extent determines which will be the questions approached. The opposite is also true. Some questions are better treated at the macro level whereas other questions are only visible at the micro level. Moreover, there are phenomena that can be observed at the macro level but have to be penetrated at a lower level of aggregation in order to be better understood, described or explained. I argue that technological change is such a phenomenon.
Studies of technological change employing a macro level perspective depart from the assumption that such changes are relevant at the level of the firm. It is supposed that it is the business unit that is deciding and acting in essential matters, whether they concern new investments, development of new products, increased production volumes, or requirements on increased productivity, all of them steps taken in order to impact upon various actors in the market. Usually the motive is to satisfy customers or to fight competitors. The actor role is run by the business unit (company, firm, enterprise, etc.), and this collective actor is considered a coherent, homogenous whole assigned almost human qualities. It is supposed, for example, that the company has the capacity to experience uncertainty, develop trust, and adapt to other parties. But although the collective actor is allotted human qualities change processes that take place at a micro level in and between the organizations involved largely remain invisible in studies employing a macro level perspective.

When technological change is studied at a macro level the process outcome is conceived of as either good or bad for each of the collective actors involved. However, very rarely one single actor conceives of the result as both good and bad at the same time. When technological change is studied at a micro level (commonly the operational level of organization) a number of micro-processes become visible, both negotiation processes and more “tangible” processes, in which a broad variety of forces cooperate and oppose each other while striving at reaching the “very best solution” to various questions and problems connecting to the process of change. Perhaps it is necessary to modify drawings or specifications in order to make a piece of new equipment compatible with existing production facilities in the company. The physical location of a new machine in an existing production line might have to be reconsidered. Maybe existing facilities have to be adjusted in order to flawlessly work together with a new machine. It might even be that the original plans for a major investment project have to be revised in essential parts, and perhaps the final result of the project comes out quite different from what was anticipated at the start-up. Maybe the consequences of the modifications are both good and bad for the single company. The various micro level processes generate different outcomes, which impact in different ways on the micro level actors involved (individuals, groups). In the wake of realized technological change there ought to be both winners and losers, because it is reasonable to presume that the change generates advantages for some parties and disadvantages for other parties. A similar standpoint is offered by Karin Knorr-Cetina (1988). She contends that in many cases social structures appearing at a macro level can be understood first if underlying social phenomena and structures at a micro level are detected.

The theoretical scope of this thesis work thus combines theories about business relationships and networks with institutional organization theory. The business network theory applied adheres to the Swedish tradition, which is rooted in research performed primarily at the Department of Business Studies at Uppsala University, and
at the Stockholm School of Economics. This particular research includes a number of seminal contributions in the field of international business. The vein of organization theory referred to traces back to the Carnegie School (Herbert Simon, James March, Richard Cyert), the Columbia School (Philip Selznick and others), and evolution theory (Richard Nelson, Sidney Winter, and others), but also some other literature in the field of organization theory and sociology is appreciated. However, influence also comes from the rich tradition of economics, not the least through the theory frame drawn above, although both network theorists and scholars in the tradition of organization theory usually take a position of either challenging theses forwarded in the tradition of economics, or complementing the descriptions offered by economics as to business phenomena.

Bringing business network theory and institutional organization theory together may open for some criticism as the former rather appreciates collective actors such as the business unit or the business organization, whereas the latter is rendering the individual human being and the group major interest. The former puts focus on what goes on between organizations, whereas the latter addresses what goes on within organizations. It follows that the former directs a higher level of aggregation than does the latter. However, interestingly enough, it has been claimed that “industrial marketing is primarily an organizational problem that must be seen in an interorganizational perspective” (Johanson & Mattsson, 1994, p.329). Business exchange involves marketing and purchasing activities and when two business parties go on performing exchange with each other over time a certain pattern of behavior establishes, i.e. the operations in the interface area to a certain degree become institutionalized and a business relationship interlinking the two develops. Relationships of the kind have to be coordinated in regard of resources and activities and that circumstance makes them akin with “common” organizations. Sometimes the business relationship has also been looked upon as a “quasi-organization” (Håkansson & Snehota, 1995, p.25; Blois, 1972).

A major difference between a legal organization and a business relationship is that the former comprises a hierarchical structure and a formal rule system, which the latter is lacking. Within the business relationship activity coordination is guided primarily by negotiated agreements and informal rules, means of coordination that are also commonly effective in legal organizations as a complement to formal hierarchical structures and rule systems. It follows that operations performed in the interface area between organizations may not be that different from operations performed within organizations, an aspect on human activity that has been comprehensively elaborated by Ahrne (1994). Moreover, business network theory (according to the Scandinavian tradition) borrows heavily from institutional organization theory and social exchange theory. Writings referred to as particularly influential are Homans (1958), Cyert and March (1963), Blau (1964), Cook and Emerson (1978) to mention a few (Johanson & Mattson, 1994). Another most influential source more directed towards business
strategy is Penrose (1959). Especially concerning writings on “the internationalization process of the firm” (Johanson & Vahlne, 1977, 1990, 2003) Penrose’s thoughts come through quite strongly. Thus, convincing support can be mobilized, it is argued, for bringing together business network theory and institutional organization theory to serve as the theoretical foundation for a coherent thesis work aiming at investigating technological change in an international industrial system.

1.6 The process of change and the positioning of technological change

The research question of the thesis – How does technological change come about in an international, industrial system? – draws attention to change dynamics, which is of common interest to any study involving process. Implicitly the research question triggers inquiries such as “what is technology?” and “what is technological change?”, which may trigger another most basic question, viz. “what is it that is changing?”, a question followed up by another one, namely “what makes change occur?”. The words change and process combine into the expression “change process” or “process of change”. Business and technological change are both supposed to be special varieties of the change process. The various concepts are clarified below.

1.6.1 Change and change process characteristics

In its verbal form the meaning of change is “to make different (alter, modify, transform, concert)” or “to give a different position, status, course or direction”. As a noun change is “the action of making something different in form, quality or state (alteration, modification, transformation, conversion)” or “the fact of becoming different, a passing from one state to another marked by radically different makeup, character, or operation whether by sudden mutation or gradually by evolution” (Webster’s Dictionary, [1961] 1993). It follows from the definitions that change is intimately connected to time. Change observed in the introductory case relates to ownership, business focus, strategic direction, competitive context, business exchange patterns, manufacturing processes, logistic systems, administrative rules and routines, etc., all of them phenomena reaching the observer through structure. As structure appears to be the common denominator of any course of events involving change, conceptually change is alteration of structure. That makes change an important process

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1 The word process may be defined as “the action of continuously going along through each of a succession of acts, events, or development stages” (Webster’s Third New International Dictionary, [1961] 1993).

2 Structure (n): something made up of more or less interdependent elements or parts; something having a definite or fixed pattern of organization; the elements or parts of an entity or the position of such elements or parts in their external relationships to each other. (Webster’s Third New International Dictionary, [1961] 1993.)
element, a standpoint associating change closely to time, no time means no change.\textsuperscript{1} However, appreciating the existence of time does not necessarily imply there is always change around. Whether or not change occurs is conditional. Conceptually in this work change is alteration of structure through time.\textsuperscript{2}

Process may be defined as “the action of continuously going along through each of a succession of acts, events, or development stages” (Webster’s Dictionary, [1961] 1993). Process involves change connected to successivity and continuity, both prominent process characteristics drawing attention to problems relating to quality and time. In order to comply with the process format, acts (events, development stages) have to share some common, identifiable quality interrelating them in sequence. The process characteristic of continuity further sharpens the demand for close and reciprocal interconnection of acts (events, development stages). Process is the time-related chain of interconnected occurrences. A problem related to that of internal consistency is the issue of establishing the beginning and the end of process. After a time period characterized by successive change might follow a period involving no change at all, but on that second period might follow still another period characterized by change. The question arises whether all three periods are part of one single process of change or if more than one process is to be considered. Process boundaries may be drawn arbitrarily for various reasons but in order to arrive at a stable point it is wise to ask: What is changing? The process base determines process boundaries, no matter if acts, events or development stages frame the structural content subject to alteration over time. Various change process categories have been identified and labeled. We are for example familiar with the typical features of revolution, evolution, innovation, development, imitation, and adaptation. Each type of process displays typical features. It seems that measures along the two dimensions ‘underlying motives for change’ and ‘rate of change’ are particularly discriminating. But several process categories also involve an evident social dimension. Revolution, imitation and adaptation for example by necessity involve more than one party. Change manifests as alteration of structure. It is the result of various forces in action, proactive as well as reactive, attacking the existing structure and its crafty ally – inertness.

\textsuperscript{1} From a philosophical point of view one may question whether there is time if change is absent.

\textsuperscript{2} For a discussion on change as the dynamics in development over time and the relatedness of change to content see for example Pettigrew (1985) and Melin (1992).
1.6.2 The cycle of action

Any change process comprises a beginning, a continuance, and an end.\(^1\) Initial force starts the process of change by establishing an original position. Continuance manifests as an alteration of established position. Additional force brings about continuance. End of process is arrived at when there is no more alteration. Process end may involve more or less tension depending on the combination of size and direction of the various forces making the established position stay unaltered. The introductory case illustrates the three process phases. The young graduate’s idea of developing a new steel grade is the initial force starting the process of change. Continuance comes about as established positions are altered in several steps, i.e. altering steel grade composition, modifying manufacturing procedures, etc. If labeling the particular change process of the case “development and implementation of a new grade for use in desalination plants onboard on vessels” the end of process is reached as the on-site testing fails, or to be more precise, when the last attempt to restore the project is abandoned. If labeling the process “development of a new advanced stainless steel for use in various demanding wet corrosion applications” the process ends much later as now it includes also the new direction of continuance factually occurring. Thus labeled, the process may still continue if considering a new or modified use of the grade in the future.

The sequence of start-change-stop, sometimes called the cycle of action, is fundamental and universal. It represents a basic principle on which process models are based. It is a simplified abstraction of phenomena observed in the empirical world. Such manifestations of process are commonly both complex and complicated due to parallelism, loops, and other peculiarities but basically all processes of change are repercussions of the simple start-change-stop logic. The start and stop positions may be established either by natural law, by the operations of evolutionary forces, or by reasoning and decision, i.e. rational choice, triggering action. Immediately after start onwards up to immediately before stop there is alteration of structure. Creative forces impacting upon structure drive the entire process. The stop position, which is characterized by no change, is arrived at when there is no more alteration of structure, a situation occurring either (1) in the absence of operating forces, or (2) when forces

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\(^1\) Objections may be raised against this statement but if considering time to have no beginning and no end any process of change is framed by time, i.e. is captured within the perpetual stream of moments, which we use to denote time, and within the time continuum any process of change is delimited to a certain period. So is the life of our entire physical universe for example supposed to be referable to a certain period of time framed within two “brackets”, i.e. the “big bang” and the “black hole” (see e.g. Gamov (1952) and Longair (1981); the latter referred to in Nationalencyklopedin (1992) under the key-word “högenergiastrofysik”). Establishing the beginning and the end of a particular process may be a delicate task, as some processes seem to have no beginning and no end. They appear as an endless sequence of events. But there is/will be an end and there was once a beginning. The problem of process beginning and process end is certainly valid and particularly so when dealing with business strategy. However, as emphasized elsewhere, to establish the beginning and the end of a particular process in practice is commonly a matter of reasoning and decision.
and counter-forces outperform each other, i.e. when a systemic balance (or equilibrium) has been achieved. Process may be studied as a “closed” phenomenon, i.e. process is constituted by a beginning, continuance and an end. As regards process in progress it is not possible to involve process end in a study aiming at interpreting “how things are” (as the end has not yet showed up). The end that has not yet occurred can only be described in hypothetical form. That is exactly what normative studies of process do. They prescribe how to act from a given “now” onwards for the achievement of a hypothetical (desired) end. Basically that is the essence of the traditional view of strategy work, the drawing of action plans for the achievement of future success. Study of a particular part of process may not concern only process in progress. For various reasons a certain time period may be of interest. Then by reasoning and decision large parts of the entire “natural” process including the beginning and the end are left out. When applied such a deliberate or conditionally enforced decision may incorrectly communicate the impression that process does not involve a beginning and an end. As far as this thesis concerns it does, although many studies do not pay attention to the beginning and the end of process.

1.6.3 Intertwined processes and the positioning of technological change

The business firm commonly engages in a vast number of processes, most of them involving business activities. Such activities frequently concern technology application and sometimes also technological change. It has been argued that technological change constitutes an integral part of the business process although the phenomenon may also appear in a non-business environment. One example, although not perfect, is technology development performed in universities. However, it is common that such development is carried out in favor of clients belonging to the business community. It seems reasonable to assign the business context the number one habitat of technological change. The assumption is important because the thesis is restricted to studying technological change appearing in a business context.

Figure 1:2 is a schematic outline positioning the process of technological change in relation to the business process, the internationalization process (of the firm) and the
process of change (at its most general level). As change is assumed to be a key element in any process, and as business is assumed to be a process, it follows that change is a common business element. Technological change, the main theme of this thesis, is assumed frequently to make up an integral part of the business process. This study is delimited to those appearances of technological change that are contextually embedded in the business process, and it is assumed that technological change in many cases also intertwines with the process of internationalization.

1.7 Methodology

The core of the methodological section concerns research strategy, research design, and methods of data collection. As the investigation stretches over several years some clarification about studying processes is forwarded. Quality aspects are covered in a separate paragraph. The section commences with a brief account of the thesis author’s (i.e. my own) relation to the business context of the empirical case through time.

1.7.1 Some words about the author’s relation to the business context

For almost fifteen years I was employed as a professional within the industrial group of Avesta AB, one of the two focal companies making up the main empirical case of this thesis work. For about ten years I belonged to the department of marketing and sales in the Unit Cold Rolled (UCR) where I held various internationally orientated positions. During most of these years I worked globally as a product specialist and for a few years I was appointed regional sales manager responsible for Western Europe and North America. I dealt with a broad range of company representatives and customers throughout the world. I participated in a large number of business activities and exchanged thoughts and ideas concerning a large variety of subjects and with many different people.

The rich experiences of mine thus acquired concerning international business practice in general and stainless steel business in particular, have substantially contributed to my writing as to the empirical material of the thesis. This experience without the main empirical case of this thesis work had not been loaded with its current content. As a matter of fact, during a few months in autumn 1997, a period characterized by crisis, I actively participated in the business process of the case. I was appointed the chairing role of a discussion forum in UCR aiming at resolving several technical problems with

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1 A comprehensive discussion about various change processes is forwarded in section 1.6.
2 To make this narrative reasonably apprehensible the “I-form” is used, i.e. the story is told in first person singular.
3 As an effect of company mergers the name was changed in 1992 to Avesta Sheffield and in 2001 to Avestapolarit. Later the name was changed to Outokumpu Stainless.
4 A unit within the Avesta group specializing in the manufacturing of cold rolled products. UCR is one of the units of the focal business relationship of the main empirical case of this thesis work.
5 During several years I was responsible for the marketing and sales of special grades for UCR.
bearing on the focal relationship of the case. Experiential knowledge (Penrose, 1959, p.54) can only be acquired through experience and I contend that this knowledge of mine has fed living tissue into the narratives told albeit data otherwise gathered makes up the backbone of the main case. My long-term relationship with the stainless steel industry is reflected in my bachelor thesis¹ and in my master thesis², which both of them are inquiries in the field of stainless steel operations. The former is a study addressing the relationship between the firm, the local environment and the outside world, whereas the latter investigates two key customer relationships where UCR is involved as the supplier. But, as a matter of fact, my history with the stainless steel industry started much earlier.

At the end of World War II the UCR business unit switched from mild steel to stainless steel production. At the time I was born in 1946 stainless steel production had just started at UCR, but during the late 1940’s and through the 1950’s the operations grew rapidly and UCR became a respected member of the Swedish stainless steel industry. Over the years that all this happened I used to live close to the plant area in the summers and I can still remember the black, heavy smoke rolling down the valley to the local lake in lazy summer days. The phenomenon appeared each time the steel mill was operating and the wind came in from the south. And I can still hear the dull noise from the hot rolling mill as it handled heavy plate in late evenings. At that time, however, my understanding of the industrial operations of UCR was restricted to these visual and audile experiences.

At the time I did my bachelor thesis in the early 1980’s it was close at hand to gather empirical data from the stainless steel industry as a friend of mine was now working with international sales for UCR. When I proceeded onto my master thesis some ten years later it was a given that I should use data from the stainless industry, as by then I had already been an Avesta employee for several years. Soon after I had completed my master thesis work I applied for postgraduate studies and was accepted for it. Through most of the 1990’s I continued doing close full time work for Avesta while performing research studies on spare time. The development process of mine from the early 1980’s up to the late 1990’s is the result of having one foot in the business world and the other one in the academy. As I went on practicing business in my role as a professional my interest grew as to how the business process comes about, i.e. which are the forces molding the process? For many years I was convinced that managers had the capacity to safely control business operations and their outcome. This conviction of mine made me look for theories and models that could effectively explain the underlying mechanisms. I found many model proposals and I considered them in relation to my own experiences from business practice, but the overall result was discouraging. The “omnipotent” manager sketched in much management literature didn’t seem to exist in the empirical world. The interlinking of organizations as

¹ Linnskog and Henriksson (1982).
² Linnskog (1994).
described in the literature on business relationships and networks also seemed less relevant in some respects as it missed out on several micro-level processes, which I had found were important in business practice. Individual motives and power positions, but also other types of “anomalies”, seemed often to overrule the descriptions and explanations forwarded in the theories and models.

As I went on struggling in both worlds, the business world and that of the academy, I had to reconsider several ideas of mine, ideas which I had previously held for true or at least for appropriate. In a kind of iterative process I compared experience gained by practicing business with various theory proposals picked up in the academy, and as I went on traveling I reshaped my conception of several phenomena observed in the business world, but I also reshaped my view of some of the theoretical models found in the academy. Maybe it is appropriate to call this development process of mine an “abductive journey”¹, as during these years my understanding of stainless steel business was gradually reshaped as a result of cross-fertilizing theory and practice in an iterative process. And it is certainly beyond debate that this “traveling” of mine has left an imprint in the business story presented in chapter 2 below, but it is certainly also true that it has influenced my way of thinking in regard of the development and modification of some of the theoretical models forwarded in this thesis work. In short, this is my story and interpretation of a series of empirical world phenomena most of which I have experienced in person.

1.7.2 Research strategy

Research strategies in contemporary social science and organization research are commonly divided into two broad categories, i.e. quantitative and qualitative research (e.g. Bryman, 2002; Denscombe, 2000; Holme & Solvang, 1997). The two categories have emerged from different ontological and epistemological considerations. Quantitative research presupposes reality to be objective and measurable, whereas qualitative research conceives of reality as socially constructed, i.e. a product created.

¹ Originally developed some hundred years ago by Charles S Peirce abduction is about drawing inferences from results (facts) by the use of rules (hypotheses/theories). The main difference between abduction, deduction and induction has to do with the character of inference. Deductive inference is basically logically reasoning, inductive inference builds on empirical generalization based on probability considerations, whereas abductive inference ends up as possibility, i.e. hypotheses that might possibly be true (Pålsson Syll 2001, pp.110-111). Inferences arrived at by means of abduction do not claim the result to be the ultimate truth or solution for ever valid as a general rule but rather a tentative solution in scope more or less circumscribed. “Abduction is the process with which we engender new ideas, explanatory hypotheses and theories, both in the field of science and in everyday life. … The abductive inference converts what may be a surprising fact into something plausible upon considering it hypothetically as the result of applying a certain rule to a concrete case. … Abduction is not merely a ‘logical operation’, but it is rather, from a semiotic point of view, that spontaneous activity of the mind which makes the strange familiar, making sense of what has surprised us” (Nubiola 1997, p.2).
by those enacting it. Which strategy to employ in a particular research situation depends on which is the problem and which are the potential findings aimed for.

There is often an obvious discrepancy between the ideal ex ante format of a scientific investigation and the way research is actually carried through. When it comes to qualitative research such flexibility is basically an integral part of the research process, which may develop into an extended period of hovering between concepts and empirical material in an attempt to identify stable patterns. In qualitative research focus is at “individuals’ interpretations of their environments and of their own and others’ behaviour” (Bryman, 1989, p.29). The research strategy performed in relation to this thesis work adopts a typical qualitative approach, where interpretations of what has been communicated in the past verbally as well as in writing, but also interpretations of what was done in the past and (in some cases) what was not done, are reconstructed ex post into a moving picture reflecting technological change once appearing in an international, industrial system.

1.7.3 Research design

The research design of an investigation concerns its overall structure and orientation, whereas research methods applied tell about the way data are collected (Bryman, 1989, p.28). The literature on methodology elaborates a fairly broad set of research design archetypes. As this thesis is the end result of a long and winding journey the research design applied cannot easily be referred to one of those clear-cut archetypes. Rather, depending on which research aspect is emphasized, the actual approach comes close to ethnography or longitudinal case study research, both residing in the area of qualitative research.

To a certain extent participant observation has been employed for the collection of data in regard of this thesis work, but data have also been gathered by way of interviewing and by the study of documents. The methods of data collection used hint about which is the type of research design applied. It also goes the other way around. Choosing a particular research design implies that some data collection methods are more appropriate to use than others, and some methods are inappropriate to use along with a particular design type. So it is clear that research designs and methods of data collection are closely interrelated. It follows from the discussion that the set of methods used for data collection in this thesis work points in the direction of ethnography. Bryman (1989) writes: “The method [participant observation] is rarely conducted on its own, in that it is usually accompanied by some interviewing and analysis of documents. For this reason, many researchers prefer the terms ‘field research’ or ‘ethnography’ to describe qualitative research in which participant observation plays a major role” (p.142).
Not only the methods used for data gathering but also the scope and the content of the investigation as well as the report format and style inform about which is the research design applied.

Ethnographers usually prefer a holistic approach emphasizing processes, relations, connections and mutual dependencies between parts. … The ethnographer’s research report … is a construct. It is not a pure ‘reproduction’, a plain photograph of the situation, but rather a skillfully performed construct involving some art of writing (rhetoric), and inevitably to a certain extent it depends on the ethnographer’s own experiences. (Denscombe, 2000, p.85)

The process perspective with focus on relations, connections, and mutual dependencies accompanied with the ethnographer’s (the author’s) own experiences as an important funding element sketches a most appropriate picture of the way research was conducted as to this thesis work. However, to categorize the research as ethnography may be criticized on (at least) one point as most of the time during which experience was gathered my research role was not defined. This circumstance somewhat blurs the picture of plain ethnography as my attention at that time didn’t focus on research but on professional performance.

Looked upon from another angle the investigation involves obvious traits of a longitudinal case study. It “investigates a contemporary phenomenon within its real-life context” where “the boundaries between phenomenon and context are not clearly evident”, and it “copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion” (Yin, 1994, p.13). The investigation also complies with a typical process approach. It extends over a total of almost two decades, and during five years in the mid 1990s characterized by most important technological change the researcher (I myself) operates as a more or less active observer/participant rendered the opportunity to gather information about the course of events as it unfolds. Furthermore, the research inquiry concerns a typical “how” question. According to Yin (1994) the case study approach is a most appropriate choice when “a ’how’ or ‘why’ question is being asked about a contemporary set of events over which the investigator has little or no control” (p.9). Although I had the opportunity to influence the course of events somewhat through a short period of time through the latter part of 1997 on the whole my contribution was almost negligible.

Another issue to consider in relation to case study research is whether to aim for theory development or theory testing, i.e. whether the type of scientific inference made use of is to be categorized as induction or deduction. Yin (1994) stresses the importance of “constructing a preliminary theory related to your topic of study” (p.27) before starting the collection of data irrespective of which is the purpose of the study. He argues:

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1 Translation from Swedish into English from the Swedish translation of Denscombe, 1998.
This role of theory development, prior to the conduct of any data collection, is one point of difference between case studies and related methods such as ethnography … and ‘grounded theory’. Typically, these related methods deliberately avoid specifying any theoretical propositions at the outset of an inquiry.

For case studies, theory development as part of the design phase is essential, whether the ensuing case study’s purpose is to develop or to test theory. (Ibid.)

As the thesis aims at ‘exploring’ and ‘describing’ how technological change comes about in an international, industrial system the issue whether to develop or test theory is actually of subordinate significance here. If successfully performed ‘exploring’ and ‘describing’ how technological change comes about will ultimately converge into ‘understanding’ the phenomenon of technological change and its coming about. It seems reasonable to take the position that ‘exploring’ is more at theory development whereas it takes the support of some kind of rule or model for ‘describing’ to occur. It follows that the research approach comprises both utilization and development of theoretical models, which implies that both inductive and deductive inference modes appear in the research process. The business story told (the empirical case) derives from a base of experience gained through involvement in business practice and data collected by means of interviews and the study of documents. Although the narrative arrives as a reflection of observations made and data gathered, it doesn’t take on random shape and it is not entirely without theoretical substance. Whether the approach applied in this thesis work is better labeled ethnography or case study research is of minor significance. Both are referred to as qualitative research and the two have much in common.

As this thesis work takes on the form of a longitudinal case study, with reference to the issue of research design, there is reason to discuss various process categories. Process has been defined as “the action of continuously going along through each of a succession of acts, events, or development stages” (Webster’s Dictionary, 1961/1993). The conception of process as a “continuous line” stretching through time can easily be comprehended, but if aiming at verbally describing, or analytically elaborating a particular process observed in an empirical setting, difficulties often arise. The reason is to find in the character of the study object itself. The process concept is basically a mental construct developed to reflect the interconnectedness of an endless number of structural alterations occurring over an infinite number of time

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1 With reference to Hanson (1958) Alvesson and Sköldberg (1994) maintain that “facts are always loaded with theory” (p.49; the thesis author’s translation from Swedish). This is so because facts are nothing but the outcome of interpretations performed in relation to a certain frame of reference. The authors also contend that theories are never arriving “out of the blue” (p.50), but follow on work with empirical material out of which at a certain point a particular pattern crystallizes. The authors proceed by claiming that the two conventional modes of inference, i.e. ‘induction’ and ‘deduction’ are unsatisfying on those grounds, and that each mode in isolation offers a poor description of the research process. The iterative process involving both ‘induction’ and deduction’ is denoted ‘retrodiction’ by Hanson (1958). ‘Abduction’ is another “label” used for this kind of research process (Alvesson & Sköldberg, 1994, p.50).
units. The amount of data to be collected and handled in relation to an actual process can vary from just a few to large numbers depending on prevailing conditions. Studies of long-term processes may cause researchers severe difficulties of both methodological and practical nature. Process models by necessity have to be strongly simplified constructs.

In a literature review on the theme of internationalization as a strategy process Melin (1992) identifies four types of process captured by different longitudinal approaches; time series of events (type A), relatively short episodes (type B), longer epochs (type C), and biographic history (type D). Type A processes compare critical events or states while missing out on intermediate periods of less critical character. Melin’s conclusion is that “the process dimension is weakly developed in this type of longitudinal approach” (p.101). Type B processes represent relatively short episodes spanning time periods from a few weeks to a few years. One single episode may be studied or two or more than two episodes may be studied in sequence or in parallel. Type C processes are lengthy epochs, which “may be long periods of evolutionary change disrupted by shorter episodes of revolutionary change” (ibid.). Type D processes, finally, are seen as biographic history descriptions capturing the whole development of a firm from the time of its founding to present time. Melin exemplifies by mentioning the classic case studies of Chandler (1962). As regards research performed on the theme of internationalization as a strategy process, Melin claims that studies employing the type C and D process models are rare although such studies usually offer a richer and more in-depth understanding of the object under study.

The main empirical case of this dissertation complies with the type C process model. The approach is longitudinal spanning a time period of more than two decades where the focal relationship stretches over almost eight years. The change process involves evolutionary as well as revolutionary change. To make the analysis work easier the entire time period of the case is subdivided into stages where type A, type B, and type C processes are identified.

Concerning the theory chapters of the thesis the aim has been to cover the three areas visited, i.e. ‘manifestation of technology’, ‘industrial networks and international business’, and ‘organizations and social structure’, in such a way that the reader can digest each part as a free-standing coherent whole. That implies that some lines of thought may occur in more than one chapter. That is so, for instance, as regards Emerson’s (1962) outline of the relationship between power and dependence. It is also true for the discussion about institutions, which appears in several places in the theoretical parts of the document. Each theory chapter is a comprehensive literature review in its own right, and as such it aims at covering essential themes in the respective area by elaborating central and influential publications, while leaving out on publications that are considered peripheral and/or less influential for the task at hand.
In the end of each theory chapter a conceptual framework is developed intended for use when analyzing the empirical case.

1.7.4 Methods of data collection

Whether or not it is appropriate to label my research ethnography it is a fact that most data were collected by means of participant observation albeit data to a certain extent was compiled in retrospect. However, some empirical data were written down as the events occurred, whereas other material has been put into written form much later. To underpin data validity but also for reason of extending the amount of data at hand complementary methods of data collection have been utilized. Thus, several interviews have been carried out and archival sources have been frequently visited (see Table 1:1). More than 1000 documents filed in the premises of UCR covering the period from late 1993 up to mid 1999 have been studied. The material involves business communication between UCR and Avesta’s overseas representative and others (via fax and mail), purchase orders, order acknowledgements, quality assurance documents, shipping documents, product specifications, invoices, inspection records as well as business unit internal communication concerning production, product quality, technical development, strategy aspects, customer and business evaluation, etc.

Several interviews have been carried out. A semi-structured telephone interview was performed in 1999 on December 10. It took about two hours and involved two key persons of the empirical case. On November 22, 2001, a three hours unstructured follow-up interview was carried out with the overseas representative of Avesta Sheffield working in the home country (X-land) of the focal customer of the empirical case, and on March 27, 2006, another unstructured interview was performed with the person that was appointed managing director at the time the Avesta Sheffield subsidiary was formed in X-land in 1992. Besides, occasional communication exchanged over time with various individuals related to the case has generated complementary information. Table 1:1 offers an overview of the various methods that have been applied for the collection of information in relation to the empirical case.

1.7.5 Quality aspects

The business story involves a lot of information making it both comprehensive and detailed. It is an attempt to present a credible reconstruction of technological change as it once appeared in an international, industrial system. It is a narrative traveling the entire globe while stretching a time period of more than two decades. It is a story that

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1 The individuals interviewed were Hanna Almgren, inside sales administrator at UCR, and Hank Kennyson, area sales manager at ASX (see Appendix 1: List of abbreviations and synonyms). Both names are pseudonyms used for reason of confidentiality. For further information see the empirical case (chapter 2).
2 Hank Kennyson, area sales manager at ASX. Also see Appendix 1 and the empirical case (chapter 2).
is broad, penetrating and far reaching. No matter how comprehensive, still the narrative comes to the reader in the form of a much fragmented description of something that might have happened in the past. Inevitably a lot of information is

<table>
<thead>
<tr>
<th>Method applied</th>
<th>Frequency</th>
<th>Position in time</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant observation</td>
<td>Prolonged participation over several years</td>
<td>1994 – 1998&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Reality (enacted)</td>
</tr>
<tr>
<td>Occasional two-way communication with various respondents (part of participant observation)</td>
<td>Several occasions</td>
<td>1994 – 2006&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Various respondents (mainly within the Avesta Sheffield system)</td>
</tr>
<tr>
<td>Unstructured telephone interview</td>
<td>One occasion</td>
<td>1999 December 10 (ca 2 hours; notes taken in handwriting;)</td>
<td>Two persons playing key roles in the empirical case, i.e. Hanna Almgren and Hank Kennyson&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>Unstructured interview</td>
<td>One occasion</td>
<td>2001 November 22 (ca 3 hours; the interview was recorded;)</td>
<td>The overseas representative of Avesta Sheffield in X-land&lt;sup&gt;4&lt;/sup&gt; carrying the key mediating role in the empirical case, i.e; Hank Kennyson</td>
</tr>
<tr>
<td>Unstructured interview</td>
<td>One occasion</td>
<td>2006 March 27 (ca 1½ hours; the interview was recorded;) 2007 May 25 (short telephone call)</td>
<td>The first managing director, “the Swede”, employed at the new sales subsidiary in X-land in 1992 (see the empirical case)</td>
</tr>
<tr>
<td>Archival information</td>
<td>Several occasions (when needed)</td>
<td>1993 – 1999</td>
<td>More than 1000 business documents relating to the empirical case</td>
</tr>
</tbody>
</table>

Table 1:1 An overview of the methods of data collection applied

<sup>1</sup> The thesis author (I myself) started as an employee in the Avesta Group already in 1985. That implies participant observation may be contended to have taken place (at least to some extent) through all these years from 1985 up to 1998 although not through all the years particularly focusing on the main empirical case of this thesis work. See also section 1.7.1 above.

<sup>2</sup> See footnote 1.

<sup>3</sup> The names are pseudonyms used for reason of confidentiality. Also see footnote 1 on the previous page.

<sup>4</sup> X-land is the home country of Metal Extraction Ltd (MEL), i.e. the company that forms the focal business relationship of the main empirical case along with Unit Cold Rolled (UCR).
lacking, information that could have thrown light over interesting facts had it been there, but as the world is much too complex and much too complicated to lend itself to perfect replication, and as neither the perception nor the memory function of the beholder are fully reliable, the story is impossible if contending to be the “true story”. Whether the story is more or less true might be of less significance as long as it is conceived of as credible.

Most information has been collected through participant observation and by studying written documents. As a complement, information has also been brought in through interviews performed with some key individuals that participated in the actual business process through many years. Using different methods of information gathering, while turning to different data sources is referred to as triangulation (Yin, 1994, pp.91-93; Bryman, 2002, p. 260). By practicing triangulation the validity of an investigation is strengthened. Another way to increase the validity of a qualitative investigation is to have some of the “story participants” read the narrative that is developed, and then ask them to express their opinion as to the content of the narrative, i.e. checking the material for face validity (Bryman, 2002, p. 259; Ghauri et al, 1995, p.48; Denscombe, 2000, p.251). In this particular case four participants have read the narrative and all four validated its content.

It is important to notify that this thesis work addresses one more or less coherent process of technological change evolving over a time period of slightly more than two decades, where the focal business relationship of the case is studied over a period of almost eight years. Thus, the writing offers a rich description of the business process and technological change as they appear in this particular context, but, as it is a “one case” study, comparison with other cases is not possible. This circumstance implies that the findings generated are not necessarily valid outside the domain (temporally and/or spatially defined) in which they were once developed. The issue concerns the external validity of the thesis work, or, otherwise expressed, the transferability of the findings to a broader context (Bryman, 2002, p.46). However, theoretical generalizability may be arrived at by linking the findings to a theoretical body (Bryman, 1989, pp.172-173). It has been claimed that “the bonding strength of the theoretical thinking” determines the level of generalizability as to results achieved in qualitative research (Bryman, 2002, p.271, with reference to Mitchell, 1983, p.207). Although the research problem and the aim of thesis are both held in a quite general tone, the ambition is not to claim the set of findings generated to be valid in all industrial contexts. It will be argued, though, that the findings are valid, most likely, in cases similar to the case studied.

Concerning the reliability aspect of this thesis work one may raise the question whether it would be possible for another researcher at another point in time to repeat the investigation presented here, while arriving at a similar result. The most probable
answer is “no”, and the major argument underpinning such an answer has to do with the problem of getting access to information. As much information is gathered through participant observation performed over many years by an “insider” in the industry (myself) it would be very difficult for an “outsider” (another researcher) to replicate the necessary conditions in order to gather equally good information. Moreover, documents would not be available to an “outsider” for reason of confidentiality. This particular point has to do both with formal constraints (sensitive information would not be given away), but also to constraints as regards trust at the social level. The people who made documents available to me in my role as a researcher are my friends through many years of collegial interaction. “I know, and I know that they know, and I know that they know that I know”\footnote{The formula is borrowed from Hannerz (1996, p.57) and is an explication of the concept of ‘trust’. The original formulation goes: “I know, I know that you know, and I know that you know that I know.”} that I would not abuse their friendship by presenting any information that would be harmful for them. A final argument is that peoples’ memories change over time, which means that an interview performed today would not bring the same information as an interview performed several years ago although both interviews would make use of exactly the same set of questions. And this last condition, i.e. make use of exactly the same set of questions, is certainly not applicable in this particular case as to a certain extent data were collected by way of unstructured interviews.

1.8 Thesis structure

The treatise is divided into eight chapters, which are briefly presented below.

**Chapter 1 Study Approach**

The chapter starts out by briefly discussing technological change in a socio-economic context. An introductory case focuses product development appearing in an industrial context, and the case discussion leads up to the research problem, which is captured in the question: “How does technological change come about in an international industrial system”? Business network theory and institutional organization theory are selected as the core elements of the theoretical frame. The research is carried out as a longitudinal case study involving obvious ethnographic traits.

**Chapter 2 Technology on travel (empirical case)**

The empirical case takes place in an international industrial system appearing at the intersection of the stainless steel industry and the mining and metals industries. The case unfolds over a time period of fully two decades pertaining to the further end of the twentieth century, and the process of technological change progresses over the entire time period studied.
Chapter 3 Manifestations of technology (theory)
To make possible a thorough investigation of the overall research question of the thesis, i.e. “How does technological change come about in an international industrial system?”, it is necessary to conceptualize the word ‘technology’ and the combination ‘technological change’. And then it seems appropriate to raise the following two questions: What is technology?, and What is technological change? As the significance of ‘technology’ and ‘technological change’ are discussed, two typical manifestations of ‘technology’ are identified, viz. ‘technological artifacts’ and ‘techno-human routines’. It is argued that technology is basically an institutional phenomenon.

Chapter 4 Industrial networks and international business (theory)
A brief overview of different modes of coordination and control followed by a discussion about some basic concepts such as ‘the firm’, ‘the market’, and various compound concepts containing the word “business” serves as an introduction. The lion’s share of the chapter is constituted by a comprehensive review of theories on industrial networks and international business. A conceptual framework intended for analyses completes the chapter.

Chapter 5 Business evolution and technological change (analysis)
The empirical case is analyzed while utilizing the conceptual framework developed in chapter 4. Received theory in the field, when employed for the purpose of analysis, proves suitable for continuous processes of change, whereas discontinuous processes (e.g. mergers) call for complementary theory. Thus, as a complement to ‘distance’ and ‘gap’ (two most central factors in received theory) the concept of ‘proximity’ is introduced, and complementary to ‘emerging developments’ (the primary source of continuous change according to received theory) ‘strategic intention’, ‘chance’, and ‘necessity’ are claimed to be important complementary sources of change.

Chapter 6 Organizations and social structure (theory)
The chapter forms the basis for an analysis of the empirical case performed at the level of individuals and/or groups of individuals. Concepts such as ‘domination’, ‘authority’, ‘legitimacy’, ‘power’, ‘dependence, ‘coalition’, ‘social structure’, and ‘social capital’ are given prominence in this context. The account closely connects to institutional organization theory. A conceptual framework intended for analyses completes the chapter.

Chapter 7 Negotiating technological change (analysis)
Anthony Giddens’ (1984, p.175) statement “power is the means to get things done” serves as the guiding principle of this analysis chapter. “How does technological change come about in an international, industrial system?”, the main research question of the thesis, comes closer to being answered as the analysis is brought down to the level of aggregation where individuals and groups of individuals compete to acquire power enough to “get things done”.

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Chapter 8  Technological evolution (conclusive summary)
The overall conclusion is that the appearance of technological change in business more often takes on the form of an evolutionary process rather than anything else. ‘Technological development’ and ‘transfer of technology’ are both viable representations of technological change, but if appreciating the evolutionary characteristic of technological change the way is paved for a richer understanding of the phenomenon. Technological change as an evolutionary process is claimed to comprise both transformation and transaction, and it is concluded that technology may change as it travels through space and time. This particular finding leads up to several consequences, which are presented and elaborated in this conclusive summary. From a managerial point of view it might be healthy to consider that sometimes things happen although you don’t want them to happen, whereas at other times things are not happening although you strive hard to make them happen. And that is probably particularly valid in regard of the phenomenon of technological change when appearing as an evolutionary process constituted by the three sub-processes innovation, interaction, and institutionalization.

1.9  How to read the thesis?
The first chapter ‘Study approach’ is recommended as an appropriate entrance into the thesis, which actually consists of three parts and can be studied accordingly.

Chapter 3, ‘Manifestations of technology’, represents one of those three parts and can be studied as a freestanding text. It conceptualizes ‘technology’ and ‘technological change’ and can be read before or after reading the empirical case (chapter 2) no matter which, or it can be read without connecting it to the other chapters of the thesis.

A second part includes chapter 2: ‘Technology on travel (empirical case)’, chapter 4: ‘Industrial networks and international business (theory)’, and chapter 5: ‘Business evolution and technological change (analysis)’. This part elaborates technological change from a business network perspective.

The third part includes chapter 2: ‘Technology on travel (empirical case)’, chapter 6: ‘Organizations and social structure (theory)’, and chapter 7: ‘Negotiating technological change (analysis)’. By employing an institutional perspective rooted in organization theory with close links to sociology and social anthropology the analysis of technological change is performed at the level of individuals and groups of individuals that are interacting.

As the thesis comprises three more or less distinctive parts revolving around the empirical case, it suffers from some reiterations. However, motivated by an ambition to analyze the empirical material at two levels of aggregation, while approaching
technological change from two different perspectives, i.e. the business network perspective and the institutional organization perspective, I have deliberately developed this particular disposition although it is afflicted with some disadvantages. The two perspectives are complementary and bringing them together results in a richer and more comprehensive understanding of technological change, it is argued (also see the discussion in section 1.5 above). But the division of the thesis into three parts also offers an obvious advantage, because the reader can read each part of the thesis without reading the other two parts and still get enough information to comprehend the full picture, albeit constrained by the perspective chosen. Although the reader may chose perspective at choice when reading the thesis, the full picture of technological change in an international industrial system can only be arrived at by studying the analyses at both levels of aggregation.

In chapter 8: ‘Technological evolution (conclusive summary)’ the main conclusions of the thesis are presented along with a few related reflections.
2 TECHNOLOGY ON TRAVEL (EMPIRICAL CASE)

The empirical case takes place in the minerals and metals industries. Its focus is on the manufacturing of stainless steel products as used in refinery processes where metals are won from ore by way of electrolysis. The environment involves a broad variety of technologies, some of them on travel for several years through the industrial system. A most obvious characteristic of the case is the strong link-up appearing between socio-economic factors and considerations and technological change.

Suppliers and customers involving in business exchange make up the industrial system of the case, where, from the perspective of the stainless steel manufacturer, companies performing metal refining are end-users. However, from the perspective of those end-users the picture is different. They rather consider themselves to be producers of refined metal serving the market with an important input resource. To make their processes operate satisfactorily they need to have the disposal of appropriate refinery equipment. The case ‘Technology on travel’ addresses the metal refinery process as such, but main attention is paid to the function and economy of the stainless steel cathode plate – the core operative element of the electrolytic refinery process – on travel since the late 1970s. Over the years it has passed through several development stages and it has been forged by various forces along the line, but it has also itself contributed to shaping and reshaping the landscape by influencing adjacent technologies. The business story describes this traveling, but as the great majority of the journey takes place in the world of stainless, before presenting the story some words will be said about the stainless steel industry and its development. To further orientate the reader contextually before starting the journey, some information is also forwarded about the Avesta Sheffield Group, the stainless steel multinational playing a central role in the business story.

2.1 Stainless steel and the stainless steel industry

The European stainless steel industry has become increasingly concentrated on the supply side over the last three decades. It all started in the mid 1970s by mergers performed at national level in several countries. Later mergers reached beyond country borders and since the early 1990s four such cross-country mergers have been realized. Increasing concentration has turned European suppliers into a true oligopoly market situation characterized by substantial price and demand volatility. It is likely that also change of a more general character has lately reinforced dynamism into the stainless industry, e.g. the rapid development of information technology but also the progress of the European integration process. Change is and will remain a given element in the stainless steel industry. Sometimes change can be predicted sometimes it cannot. Change forces challenge existing structures whereas counterbalancing forces strive to prohibit change from occurring. Change renders some actors pain whereas other actors
benefit from it. Two change patterns seem to be typical for the stainless steel industry, i.e. short-term price and demand volatility, and long-term structural change. Some comments in regard of those change patterns are given below, but before entering into that discussion a quick overview is forwarded as to stainless steel and the use of it.

2.1.1 Stainless steel and the use of it

Discovered as a certain mixture of iron and carbon “spiced” with about 12-13 % chromium stainless steel appeared almost simultaneously in England, Germany and the United States in the early 20th century. It was found that the new material was capable of resisting corrosion in non-polluted air and fresh water. Consequently it was labeled “stainless”. The protecting mechanism making it resistant against destructive corrosion in such environments is a thin chromium-oxide layer that is developing on the steel surface as the material is exposed to oxygen. Modified versions of stainless steel containing higher contents of chromium but also additions of molybdenum and nitrogen are used in more aggressive service environments. Stainless steels may attain different grid structures. The two most common structures are ferrite and austenite. Modern variants of a mixed structure, the ferrite-austenite or duplex structure, have met with increasing interest since a few decades. It combines some of the good properties of the austenite with some of those of the ferrite, while offering materials combining high mechanical strength and good corrosion resistance with acceptable formability and weldability. Duplex steels are often preferred in applications requiring high mechanical strength in combination with good resistance against stress corrosion. They are typically used in offshore applications and in the chemical and petrochemical industries. Ferritic grades are commonly used for the manufacture of consumer goods (e.g. white goods, automotive exhaust systems) but are also used within the industrial sector (e.g. within mining and materials handling).

Austenitic steel grades make up more than 75 % of the entire world production of stainless. They are widely used in consumer goods (white goods, sinks, cutlery, pots and pans, etc.) as well as in various industrial applications (mining and metals, chemistry and petro-chemistry, pulp and paper, food and dairy, transport, power and heat, building and construction, etc.). Austenitic grades typically involve good ductility, formability and weldability. A wide range of grades designed to meet different environmental conditions are available on the market. Some grades are easily available in many product forms whereas the product range of other grades is more narrow. There are two main categories of standard grades, the 304-type and the 316-type of steels. The former category makes up for 80 % of the entire market while the latter almost strikes the balance. The 304-type contains ca 18 % chromium and 8-10% nickel, whereas the 316-type contains some 17 % Cr, ca 11 % nickel, and 2 - 3 %

1 The denotations 304 and 316 refer to ASTM, the American Society for Testing and Materials. Several other steel classification systems exist but the two subgroups of steel here described are basically the same in all systems albeit the various grades are given different names.
molybdenum. The basic versions of both categories prescribe carbon not to exceed 0.05 %. Modern metallurgical procedures have made possible the manufacture of low carbon versions (C max. 0.030 %), which have become common standard nowadays. Austenitic steels higher alloyed than 316-type are usually named special grades or special steels. Their share of the market is less than one percent.

2.1.2 A historic outlook: Change patterns in the European stainless steel industry

Two change patterns typical for the stainless steel industry will be briefly outlined, i.e. short-term price and demand volatility, and long-term structural change. Right on to the first half of the 1970s the European stainless steel industry faced fairly stable working conditions. In those old days competition in stainless steel business was merely a domestic issue. Stainless steel was produced in several countries and in most of them there were two or more than two companies involving in competition. By that not said that trade didn’t occur between countries. Certainly it did, but the predominant share of the business was domestic. In the mid 1970s, in the wake of the oil crisis, conditions changed, and the Swedish stainless steel industry now encountered strong economic pressure. In 1984 the industry was subject to consolidation, the result of which was the formation of Avesta AB. During these years other European countries followed the same change pattern and in the early 1990s the number of European stainless steel producers covering the entire route of operations from steel smelting to the manufacturing of “ready-to-use” flat stainless steel products had dropped to just seven. In the meantime the various domestic markets for stainless steel gradually grew into one common European market showing a true oligopoly structure populated by just a few large multinational companies on the supply side. The concentration of resources to a small number of competitors triggered large-scale production and the employment of marketing strategies strongly focusing on price.

From the mid 1970s to the late 1980s the nominal price of stainless steel products on the European market increased by roughly 30 %, but inflation reached even higher numbers at an average during the same period of time. Thus, the net effect was rather a price drop than a price increase. What is more interesting, though, is the changed price pattern. Previously the price of stainless had been relatively stable, but from the mid 1970s through the 1980s it became markedly volatile. In 1987/1989 it ran wild

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1 This section offers a summary description of the development of the European stainless steel industry through the last four to five decades. In Appendix 2 a comprehensive account of the development of price and demand in the European stainless steel market is presented as well as some statistics about the development of raw materials prices. A few comments in regard of structural change in the stainless industry are also forwarded. The data are discussed from a managerial point of view, i.e. the way stainless steel practitioners commonly reflect upon issues and conditions in business.

2 The companies were: Avesta AB (Sweden), Outukumpu (Finland), British Steel Stainless (UK), Krupp-Thüsen-Terni (Germany/Italy), ALZ (Belgium), Cruseot-Loire/Ugine (France), and Acerinox (Spain).
triggered by extremely high raw materials prices. The nickel price peaked four times above the normal in the end of 1988 but also chromium and molybdenum were traded at escalated prices. The stainless steel oligopolists handled the inconvenience by establishing an “alloy surcharge system” that transferred most of the raw materials price increases onto their downstream customers. As all European stainless steel producers embarked upon the system the customers were unable to escape the tough conditions by switching to another supplier.

To parry the upcoming situation both end-users and distributors (intermediates in the distribution channel) began booking order volumes larger than their actual needs, and they went on overbooking as long as they anticipated further price increase. As a result the apparent consumption of stainless steel increased far beyond the normal, which in turn made prices soar. When the nickel price suddenly dropped in the second quarter of 1989 the market for stainless steel ran out of steam. The halcyon days rapidly turned into a price war, and in an attempt to land enough orders to keep the wheels turning the steel producers threw themselves into cut-throat competition, as running a steel mill below full capacity utilization is not considered an alternative in the industry for various reasons. However, during the good days a lot of money had accumulated in the industry, money that was now invested in new and more efficient production facilities. And the new investments made the plants grew larger and manufacturing capacity expanded. The propensity to invest in additional and more efficient capacity was driven partly by competition and partly by a strong belief in an ever-growing market. Since the 1950s the Western World consumption of stainless steel had grown at an average rate of 4-5 % per year and that was an argument as good as any for those considering investing in new capacity, because an investment causing overcapacity in the industry at a certain point in time would soon be absorbed by the growing market. And until then the new production facility would easily outperform older facilities leaving the company doing the investment in a better position than its competitors.

In the years of 1994/1995 raw materials prices peaked a second time and the effect on price and profitability followed the same pattern as in 1987/1989. The stainless steel industry made large profits, part of which was later invested in new capacity and improved technology. Over a time period of ten years from 1989 to 1997 the base price for Type 304 stainless steel dropped from ca 4,00 DEM/kg down to a level of about 2,50 DEM/kg, a price drop corresponding to about 35- 40 % before inflation is accounted for. It seems reasonable to assume that the price reduction is a reflection of productivity improvements attained in the industry over the ten-year period. If that is so productivity has increased tremendously. The conclusion is that price and demand volatility when combined with a growing market seem to create (1) extensive surplus profit for all members of the industry during the good years, (2) cut-throat competition during the bad years leaving only the most efficient producers profitable, and (3) a necessity to invest in improved technologies and extended manufacturing capacity in order to survive the next coming cycle of good and bad years.
2.2 The Avesta Sheffield Group - Some background information

Avesta Sheffield is the third largest stainless steel producer in Europe, with total production of about 1 million tonnes per year, of which austenitic stainless steel accounts for around 95%. The group regards the Nordic region, the UK and North America as its home markets. It has a world-wide marketing and sales organization with some 25 wholly-owned sales companies in the Sales & Distribution Division. These subsidiaries sell the Group’s products on behalf of the product units. Many also operate service centres, where the steel is further processed to customer requirements. (Avesta Sheffield AB, annual report 1996/97, pp.4-5.)

The quotation offers a brief overview of the Avesta Sheffield Group at a point in time when one of its business units struggled to satisfy a demanding customer operating a product application that was new to the unit and new to the Group. The application is related in the business story below and concerns the use of stainless steel cathode plate in the process of electrolytic refining of metals. The most critical period as to technological change and relationship building appearing in the business story refers to the mid 1990s. This was also the time when Avesta Sheffield after a few years of very profitable operations run into a period of poor profitability, a condition that should stay firm for the rest of the 1990s. The background information forwarded below serves as a platform for the business story to be told in the subsequent sections of the empirical chapter.

2.2.1 Merger history, group structure, and market presence

Avesta Sheffield AB was formed in 1992 by the merger of Avesta AB and British Steel Stainless Ltd, a former division of British Steel plc. Prior to this particular merger several mergers had been carried through in the European stainless steel industry. In Sweden Gränges Nyby and the stainless part of Uddeholm merged into Nyby-Uddeholm in the late 1970s, and in 1984 Avesta AB was formed by the merger of Avesta Jernverk, Nyby-Uddeholm and the stainless operations of Fagersta. In the UK former United Steel Companies Ltd, English Steel Corporation Ltd, Firth Vickers Ltd, and Richard Thomas and Baldwin Ltd were pulled together under the umbrella of British Steel Corporation during the first half of the 1980s while forming a separate stainless steel division, British Steel Stainless, and in the early 1990s three UK distributors, the Walker Group, B.S.S.C., and Bore Sampson formed British Steel Distribution UK, which was linked to the stainless steel division of British Steel Corporation. It all ended up in the establishment of British Steel Stainless Ltd. By the merger of Avesta AB and British Steel Stainless Ltd in 1992 more than ten companies located in two countries had merged into one single company within a time span of less than 15 years. And the new company, Avesta Sheffield AB, took on the
responsibility as the main producer of stainless steel in Sweden and the UK for the rest of the 1990s.  

In the mid 1990s the Avesta Sheffield Group is a multinational company with global presence. The production of flat products (coil, sheet and plate), the core business of the Group, is located to Sweden, UK and the USA. The manufacture of downstream products such as welded tubes, fittings, flanges and some other products is also spread to several countries. Service centers operate from various locations throughout Europe while offering customers special local services such as slitting and cut-to-length operations, polishing, brushing, etc. Strategically located warehouses keep various stainless steel products and grades available from stock. Own sales companies cover sales in more than twenty markets. Other markets are served via a network of almost thirty agents. The number of employees in the Group amounts to about 8000 in the early 1997. More than half of them are working outside Sweden.

The Group is structured into five divisions, i.e. three product divisions, one geographically organized division (North America), and a division responsible for the sales and distribution. The largest product division, Coil & Primary Division, accounts for about half of the sales of the entire group. It lodges two steel mills, one in Avesta and another one in Sheffield, engaging in steel melting and continuous casting. The smelting capacity of the two mills amounts to one million tons per annum. The division also operates a hot rolling mill (Steckel mill) located to the Avesta site. Four production units, two in Sweden and two in the UK perform downstream cold rolling, heat treatment and finishing operations. The Hot Rolled Plate Division, the second largest product division of the Group, produces heavy stainless steel plate, also known as "quarto" plate. The division runs one plant in Sweden and one in the UK. The Manufacturing Businesses Division, the third product division, is like a disparate conglomerate dealing with the manufacture of various downstream products such as precision strips, welded tube and pipe, fittings, flanges, bars, wire, welding consumables, etc.

The North American Division is more or less self-contained as regards the production and sales of hot rolled "quarto" plate as well as welded tubes and pipe. Complementary products are imported from the European product divisions of the Group. The Sales & Distribution Division organizes the Group’s sales subsidiaries (except for those located to the North American market) including four European regional hubs responsible for materials logistics and stockholding. Within the jurisdiction of the division lays the responsibility to establish and uphold contractual

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1 In the year 2001 the Avesta Sheffield Group and the stainless operations of the Outokumpu Group merged into AvestaPolarit Stainless. Later Outokumpu purchased all shares of the new company. Today it operates under the name of Outokumpu Stainless and constitutes one out of three strategic entities within Outokumpu Oyj. Over the last three decades the European stainless steel industry as a whole has gone through as similar change pattern, and a few years after the turn of the century it comprises just four major players.
agreements with sales agents operating in various parts of the world. Group Management is established in Stockholm and involves the CEO and the heads of the five divisions as well as those responsible at the corporate level for finance and accounting, market development and R&D, strategic planning, personnel and information.

2.2.2 Overall strategy of the Avesta Sheffield Group

"Corrosion is our business!" Per Molin\(^1\) claimed in a speech to company managers in October 1988, and expressed the mission of the Avesta Group to be "to develop, produce and deliver stainless steel products suitable for qualified use in corrosive environments." Moreover he emphasized the importance of closely cooperating with end-user customers and to become the market leader within selected product segments and geographical areas. Ten years later it seems that the statements stand firm. Excerpts from the annual report 1997/98 for the Avesta Sheffield Group support the assumption.

About leading positions in certain areas:

Avesta Sheffield’s overriding objective is to provide its shareholders with consistent long-term growth in the value of their investments. The Group aims to achieve this by continuing to be a leading stainless steel supplier in chosen products, market segments and geographical areas. (p.13)

About products for qualified use and increasing production volumes:

Production is heavily focused on value-added products. These are products which have been alloyed or processed to obtain enhanced properties of corrosion resistance, mechanical strength, heat resistance or formability… Avesta Sheffield’s strategy is to increase further the proportion of added-value products… At the same time, the Group is increasing total production volumes to ensure that it can respond to the growth in stainless steel consumption, which is estimated at 4 - 5 per cent per year. (p.4)

About leading position, product assortment, and cooperation with customers:

Avesta Sheffield’s global aim is to become the leading supplier to prioritised markets and segments by:
- offering a wide range of stainless steel products and the possibility of processing at service centres
- understanding and satisfying customer demands for quality and delivery reliability
- working in close co-operation with its customers. (p.24)

About customer focus and customer cooperation:

[۷]he Group will continue to focus on its customers and will aim to follow its policy of concentrating on specific selected product and market segments, whilst still pursuing its cost reduction programmes. (p.11)

The Group is seeking to increase the proportion of business with end-users, as this offers advantages in terms of cost reduction and efficiency gains. (p.24)

\(^1\) CEO of the Group from 1984 to 1997.
Avesta Sheffield strives to achieve an intensive, long-term partnership with its larger customers. With this in mind, every chain of supply is being optimised to meet highly specified demands. This may involve agreements with mills directly, or an extension of local service centre facilities. (p.25)

About raw materials purchase within the format of stable supply relationships:

[the Group pursues policies of establishing long-term stable supply relationships with raw materials suppliers, both for primary and secondary materials. (p.28)

The above quotations emphasize some important business aspects: (1) leadership in selected product and market segments, (2) focus on qualified value-added products, (3) cost reductions, (4) production capacity expansion in pace with the market, (5) and the establishment and maintenance of long-term relationships with selected customers and raw materials suppliers. Aiming at satisfying all commitments made would certainly become a bold venture, and it is interesting to ponder upon whether all commitments could be met in reality, because the strategy seems to involve several contradictory ambitions. To simultaneously offer qualified value-added products, adapt to customers, and achieve cost effectiveness is certainly a difficult task. A strategy signaling such a task does not invite the organization to an easy ride. Difficulties relating to the practice of strategy become visible as the business story unfolds.

2.2.3 The Group’s economic performance through time

The economic performance of Avesta Sheffield AB as well as that of former Avesta AB follows the development of the market base price of stainless steel.\(^1\) When price goes high profit goes high and when price goes low profit goes low. Table 2:1 shows the development of ROCE (return on capital employed) for the Group through the years 1984 – 1998. The profitability pattern coincides with that of the price of stainless steel, which in turn seems to depend short-term on the price of raw materials and long term on the technological and organizational development occurring in the industry.

The development of the business cycle of the stainless steel industry is crucial to its members but it is probably impossible to predict when the next peak will appear though Table 2:1 hints about a periodicity of 6 - 7 years.

\[\text{Table 2:1 The ROCE development of the Group 1984 – 1998; Sources: Annual reports of the Group}\]

\(^1\) For further information about the economic development of the stainless steel industry and the development of prices on the markets for raw materials see Appendix 2.
2.3 Introduction to the Business Story: The focal actors and the main technologies

2.3.1 The focal actors and the business at large

The focal relationship of the empirical case involves Unit Cold Rolled (UCR), a business unit belonging to the Avesta Sheffield group of organizations, producing stainless steel sheet and coil, and Metal Extraction Ltd. (MEL), an engineering company, owned by a large mining corporation, constructing and manufacturing plants and equipment for the electrolytic refining of metals. Business exchange between the two parties is based on supply of stainless steel cathode plate, a customized product designed to operate in the MEL refinery process. The relationship emerged during the former half of the 1990s and came to involve considerable struggle over the years concerning product quality. Gradually new technology grew into the operations of UCR and at the turn of the century, after several years of business exchange, the counterparts had developed a rich and well-functioning relationship involving technologies effective for their business.

UCR, being a member of the stainless steel industry, is used to operate in a volatile environment as regards price and demand. Although UCR’s business with MEL carries the project format, and thus suffers from uncertainty as to demand, price is reasonably stable as the product subject to exchange is adapted to meet the need of the customer. Undoubtedly, uncertainty about demand is a disadvantage to UCR, but the negative effect is reduced as MEL early in the process of purchasing is forwarding information to UCR about new projects under way. When an order is finally placed UCR is well prepared to effectuate it. A normal refinery project consumes a large amount of stainless steel. The manufacturing phase usually extends over three to six months, sometimes more, and involves a couple of Avesta Sheffield units including UCR. Through information exchange with the customer and administrative arrangements planning and manufacturing can be performed under orderly conditions in the UCR mill. For UCR the business with MEL has become predictable and profitable after several years of struggle with product quality and technological modifications.

From the invention of the new technology in the late 1970s onwards MEL’s business gradually increased up to a point where they found themselves enforced to look for alternative sources of stainless steel supply in the early 1990s. Former arrangements with re-rollers had been associated with too much uncertainty, and, as safe stainless steel supply was and is a most crucial aspect of MEL’s operations, the only logical

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1 As the empirical case contains a large number of company names abbreviations are frequently used in order to increase readability. Most company names as well as names on people involved are concealed for reason of confidentiality. A list of abbreviations and pseudonyms used are given in Appendix 1.
solution was beginning to look for a major producer of stainless steel with whom to ally, i.e. to aim for cooperation with a steel mill. And MEL found UCR. Over time UCR developed into a capable and reliable supplier of stainless steel cathode plate, i.e. the core operative element of the electrolytic refinery plant. But in order to arrive at a business relationship built on trust and commitment both parties had to undertake several steps of adaptation and development. And still today additional tuning and corrective action is sometimes called for although the more substantial issues have already been sorted out in the past.

2.3.2 The technologies of the case

UCR and MEL operate various technologies. In the early stage of the relationship there is an obvious misfit between the ability of the supplier and the need of the customer, a technological gap that gradually closes as the parties adapt to each other over time. UCR, the supplier, performs manufacturing in a mill area situated in the middle part of Sweden whereas the premises of MEL, the customer, are located far away from Sweden in a distant part of the world. The large geographical distance between the two firms renders interaction more difficult. Maintaining a continuous process of interaction is hampered especially as business exchange is project based. The technologies employed by the parties have a major impact on the interaction between them. In this particular case also the technologies employed by MEL's customers have to be considered because the performance of these technologies to a certain degree depends on what is achieved upstream as various units belonging to the Avesta Sheffield system perform their operations.

The technologies operated by UCR and related Avesta Sheffield production units largely conform to the state of the art in the stainless steel industry, but there are exceptions. UCR has developed and operates some unique technologies. A few other technologies commonly employed in the stainless steel industry are utilized somewhat differently by UCR. The electrolytic refining technology manufactured by MEL is based on conventional technology, which is modified and further developed. In comparison with conventional refining equipment the MEL process brings significant advantages to the user i.e. the customer of MEL. The empirical case involves a vast number of technologies. Stainless steel production counting several of them but in the other end of the line there are various technologies related to the electrolytic refining of metals. Common manufacturing technologies belonging to the engineering industry complement the two groups of technologies identified in the empirical case. Some of the technologies operated by UCR, MEL and MEL’s customers are described more in detail below.
2.3.3 Stainless steel production

The route of stainless steel production includes the following major operations: raw material supply, steel smelting, continuous casting, hot rolling, cold rolling, finishing and downstream processing. The last stage being a category containing a wide range of production and manufacturing processes some of which, it could be argued, belong to the field of stainless steel utilization rather than that of stainless steel production. Below the various operations are described.

Steel smelting and continuous casting

Avesta Sheffield is operating steel mills in Avesta (Sweden) and Sheffield (UK). Steel smelting starts out from stainless scrap and alloying metals such as chromium, nickel and molybdenum, and is performed in electric arc furnaces. The furnace in Avesta operates heat sizes of 80 tons with a total annual production of 500,000 tons (financial year 1997/98). The volume produced in the UK mill is equally large although the size of the Sheffield furnace is somewhat larger, 120 tons. The molten steel is treated in accordance with ordinary metallurgical procedures. After smelting the material is continuously cast into a stainless steel cord. The cord is cut into rectangular pieces called ‘slab’, which serves as the input material for the production of stainless plate, sheet and coil. Long products (bar and wire) are produced from blooms or billets.

Hot rolling

Quarto plate (HRP) and hot rolled coil (HRC) are products produced by hot rolling, which is carried out at a temperature of about one thousand degrees (°C). Quarto plate rolling is performed on a heavy plate mill where the slab is rolled to final shape. In the Avesta Sheffield system the maximum quarto plate width amounts 3.2 meters, a measure that should be compared with the maximum width of a hot rolled coil, which is just above 2 meters. After hot rolling the material is softened and descaled before it is further processed or finished according to customer requirements.

In the Avesta Sheffield system hot rolling of coil is done in a Steckel mill located in Avesta. The slab is subject to longitudinal deformation at high temperature as it is pulled back and forth through the mill. Every pass makes the material become thinner. For standard grades a minimum thickness of 2–3 mm can be reached depending on which is the steel grade and which is the width of the material. Standard grades can usually be rolled to thinner gauges than can special steels. After rolling the coil is covered by an oxide layer. Due to its dark grayish-black surface the material is now called ‘black coil’. By softening (heat treatment by annealing), descaling (blasting or brushing), and pickling operations the ‘black coil’ is further processed into a ‘white coil’, the surface of which is light grayish-dull. The ‘white coil’ may be further processed by cold rolling or it may be brought to the market as ‘white hot coil’ (WHC), which if cut into length is labeled ‘continuously produced plate’ (CPP). Although cold rolled material is dominating the stainless steel market also large
volumes of stainless steel in hot rolled execution are sold to the market and particularly so in the form of CPP. Typical for hot rolled products (when comparing with cold rolled material) are wide thickness tolerances and a rough surface.

**Cold rolling**

Whereas hot rolling is performed at a temperature level of about one thousand degrees (°C) cold rolling is carried out at room temperature although the temperature may rise to about one hundred degrees (°C) in the material as a result of cold deformation. By cold rolling tension is introduced into the material making both strength and hardness come up. As the material becomes increasingly stronger and harder it resists further thickness reduction. To prepare it for further cold rolling or other manufacturing operations the built-in tension has to be relaxed. That is achieved by soft annealing (heat treatment and quenching), which is followed by descaling (blasting and brushing in combination with electrolytic and acid pickling). The final cold rolled product has a smooth surface and narrow thickness tolerances. Various standard surface executions such as 2D, 2B and BA are available on the market.\(^1\)

**Finishing**

The cold rolled coil is further processed through various finishing operations. It is either slit into strips or cut to length into sheets. Slitting is performed on a slitting mill where the mother coil\(^2\) is divided into strips of appropriate width. In the cut-to-length line coils are cut into sheets, but before cutting the coil has to be edge slit to establish the appropriate width of sheet. To an outside observer finishing operations might seem trivial in comparison with the "real stuff", i.e. operations such as hot and cold rolling, heat treatment, and pickling, but that is underestimating the difficulties that interconnect with finishing. Stainless steel is tough and sticky. It often resists external attacks in ways not anticipated. Although it is moderately strong in comparison with ordinary mild steel it is tough and its propensity to cold harden is a vicious element challenging many a user not familiar with stainless steel manufacturing. High requirements raised on straightness (strips) or flatness (sheets) challenge the skills of

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\(^1\) 2D, 2B, and BA are codes representing various types of surfaces and how to produce them. The codes are part of a standardization system for testing and materials denoted ASTM, American Society for Testing and Materials.

2D: The material is annealed and pickled. The surface is smooth, white and dull.

2B: The 2D material is improved by smooth cold rolling (pinch pass) in a pinch rolling mill. The end result is improved smoothness and brightness. The surface of 2B material is less dull than that of 2D.

BA: The BA product follows a different production procedure after the cold rolling stage. Annealing is carried out in an atmosphere of inert gas implying the cold rolled surface stays unaffected (no oxidizing) during the heat treatment process. This type of annealing makes subsequent descaling and pickling redundant. BA is the abbreviation for "bright annealing", which in a way is misleading. The annealing as such doesn't make the surface bright but the inert gas prevents the surface from oxidizing during the heat treatment process leaving the bright cold rolled surface unaffected.

\(^2\) Various standard widths of the mother coil are 1000, 1250 and 1500 mm.
the manufacturer. Customer needs of the kind discriminate competent stainless steel producers from those dealing with mainstream production. Sometimes the product delivered has to meet demands for high general quality at the same time as it satisfies specific customer needs.

**Downstream processing and exchange value**

Stainless steel material is used for the manufacturing of various downstream products and both hot rolled and cold rolled material is further transformed into various geometrical forms and shapes. Downstream manufacturing occurs both within the Avesta Sheffield system as well as outside the Group. In the empirical case Unit Cold Rolled makes up the outward boundary of the Group, i.e. the point where the material is appraised by a counterpart representing another legal body. As the exchange value of the product is established the effectiveness of the supplier is evaluated by the customer.

2.3.4 Electrolytic refining of metals

Electrolytic refining of metals has been performed for the last hundred years or more. Nickel, copper, zinc, etc. are metals commonly refined through electrolysis. The technology of electrolytic refining can be described as follows: "refining of a metal (as copper) by electrolysis, the crude metal used as the anode going into solution and the pure metal being deposited upon the cathode - called also electrolytic refining"\(^1\). The entire refining process is carried out in a process tank house, which includes four discrete major components: the anode machine, the electrolytic sections, the cathode preparation line, and the scrap machine. The equipment employed and the refining process is described in brief below.

**Conventional electrolytic refining**

Basically the refining process is simple. The anode, consisting of prefabricated pieces of crude metal\(^2\) to be refined, is introduced into an electrolyte\(^3\) as are starter metal plates\(^4\) forming the cathode. The anode starts emitting ionized metal atoms when the electric circuit is closed. The cathode attracts the ions and refined metal builds up on the surface of the cathode. The cathode is gradually adding weight as the anode is consumed. At a certain stage the process is interrupted. The cathode, now making up

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\(^2\) The "metal" to be refined may be nickel, copper, zinc or any other metal suitable for electrolytic refining.

\(^3\) "A non-metallic electric conductor (as a solution, liquid, or fused solid) in which current is carried by the movement of ions instead of electrons with the liberation of matter at electrodes. Def.: A liquid ionic conductor.” (Webster’s Third New International Dictionary, [1961] 1993.)

\(^4\) Conventional refining technology makes use of starter plates prefabricated out of refined material of the same metal as that to be refined. That implies large amounts of starter plates are "consumed" in the process as the plates are "captured" within the deposit, i.e. the commercial product, and cannot be detached from it but are delivered to the user of the refined metal along with the deposit.
the final product of the operation, is removed from the electrolyte as is the remaining part of the anode, now considered as scrap. The process described takes place in electrolytic sections where thousands of prefabricated pieces of crude metal and thousands of starter plates are involved. Crude metal, the feedstock of the process, is prepared into anode format by the application of blade pressing and lug pressing in an anode machine. For the achievement of highest possible productivity it is important that the shape of the anodes is compatible with the shape of the cathodes.

The conventional process of electrolytic refining consumes large numbers of starter plates simply because it is impossible to remove the deposit from the starter plate after the electrolysis has been finished. The starter plate and the deposit consist of the same metal making a strong metallurgical bond establish between the two during processing. It follows that the material used when manufacturing starter plates has to meet the quality requirements of the deposit as regards inclusion of alien elements, etc., because the starter plate ends up as an integral part of the commercial product to be delivered to the customer. In order to safely administer the conventional metal refining process the operator has to store sufficient numbers of starter plates. That implies all the common costs for stockholding have to be considered including the making of allowances for the uncertainty relating to metal price volatility. Moreover, each starter plate has to be carefully machined in order to operate safely when brought into service and the consumption of starter plates in the conventional process of refining is huge. A large refinery plant may operate 30 000 to 40 000 starter plates in one cycle whereas a plant of medium size may use between 7 000 and 10 000 plates.

The MEL process

At the first look the MEL process of metal refining seems to be similar to the conventional process. Both apply electrolysis as the working method of refining and both start out from anodes consisting of crude metal pressed and otherwise formed to shape. And finally, both use as the collector of refined metal cathodes manufactured to shape from flat material. The genius of the MEL process is that the cathode plates are reused over and over again in the refinery process implying the cost for stockholding becomes, if not zero, but close to negligible. Also the costs relating to cathode plate preparation go down. The entire administration is reformed by the introduction of the stainless steel cathode plate. If taken altogether the impact is substantial in terms of cost savings.

Starter plates consumed in the conventional process are liquid assets, which in turn raises demand for comprehensive administration in terms of the continuous purchasing and handling of material. In the conventional process activities of the kind are of major concern as here the starter plate operates as a one-time collector of refined metal. It is delivered along with the refined metal to the customer and is thus "lost" in the process of refining. In the MEL process the conventional type of starter plate has been replaced by a stainless steel cathode plate, which is re-circulated in the process of
refining. Its lifetime ranges between five and fifteen years depending on which are the working conditions of the particular process. That makes the stainless steel cathode plate a fixed asset subject to depreciation over time. By substituting stainless steel cathodes for conventional starter plates administration work is reduced considerably, and as a bonus, the superior geometry of the stainless steel cathode plate enhances the reliability of the entire refinery process while increasing its productivity. Changing from conventional starter plates to reusable stainless steel cathode plates substantially rationalizes the electrolytic refining process. But there are also some obstacles involved …

**Using stainless steel cathodes in the MEL process - some crucial factors**

The successful operation of the stainless steel cathode plate in the MEL process is conditioned by two particular characteristics of the plate (1) the surface finish of the plate and (2) its flatness. To be suitable for operation the stainless steel plate has to stay within a certain specified "window" as regards these two dimensions. In regard of surface finish the material must be neither too coarse nor too smooth. During electrolytic refining the cathode gradually builds up weight and the adhesive force appearing between the cathode surface and the deposit has to outbalance the weight of the deposit through the entire process cycle. If the cathode surface is too smooth the deposit may slip off the substrate\(^1\), fall to the bottom of the basin, short-circuit the system, and at the worst shut off the entire process. If the surface is too coarse another problem may occur as now it will be difficult or even impossible to detach the deposit from the substrate. The adhesive force may be so strong that the stainless plate gets damaged during the stripping operation. Thus, in order to remain suitable for the purpose surface roughness has to stay within a certain range.

The other crucial plate characteristic – material flatness – is crucial for the reason of process productivity. The more flat the cathode plate the higher the productivity achieved in the refinery process, because the more uniform the geometry of the plates, the stainless steel cathode plates as well as the anode "plates" shaped out of crude metal, the more uniform the space arising between any pair of anode-cathode plates operating in the electrolytic basin and the more balanced the entire refinery process. As previously mentioned stainless steel becomes harder and stronger when cold worked. It follows that cathode plate manufactured out of stainless steel may accommodate some residual stress that is negatively influencing material flatness in case the material is not properly handled subsequent to the final heat treatment operation.

Now, concerning the MEL process not only material flatness as such appears as a crucial factor, but also the method used to measure flatness. The problem closely interlinks with the particular product application of the case i.e. the way the plate is

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\(^1\) This particular phenomenon is called “pre-stripping”.
used in the refinery plant. When in service the plate is used free-hanging while attached to a bar in the upper end, and, according to the MEL cathode plate product specification, this is also the appropriate material position in which to measure material flatness. In this respect the specification deviates from common standard, which prescribes material flatness to be measured with the plate or sheet laying flat down on a plain horizontal substrate. With the material thus positioned flatness is measured as the distance between the substrate and the highest peak of the material. It becomes obvious then that common standard for measuring flatness does not exclude the impact of gravity, and it is equally clear that the standard method of measuring flatness does not suffice to discriminate material inappropriate for use in refinery plants. Consequently, to make sense for this particular application the flatness test has to be carried out while the material is free-hanging vertically.

The operations of MEL
Technologies presented so far primarily concern the stainless steel industry and the electrolytic refining of metals, while the factual activities of MEL have largely been left out. Operating refinery plants is not really the business of MEL, but rather the business of MEL’s customers. MEL dispose of the knowledge to design and build refinery plants and equipment, but of course they also have deeper knowledge about how to use such assets. Besides this type of knowledge they are experienced in the engineering and manufacturing of process equipment although much of the factual work is actually subcontracted to other firms. Basically MEL is an engineering company specialized in the construction and assembly of electrolytic sections and the manufacturing of complementary equipment for the running of metal refinery plants.

2.4 Business Story Part I: Exploitation of a new idea in metal refining technology

2.4.1 Metal refining technologies – an overview

Metal refining has been an issue as long as man has benefited from the use of metals. Traditionally refining was equivalent with removing slag and other alien elements from crude metal by remelting. Over the last hundred years electrolysis has been an alternative method when it comes to the refining of metals such as zinc, copper, lead, etc. Due to lower energy consumption electrolysis is more cost effective than remelting. In the electrolytic process the anode is made up of crude metal. As the process is run metal ions dissolve from the anode, move through the electrolytic bath and deposit as refined metal on the surface of the cathode. The conventional process of electrolytic refining uses cathode starter plates fabricated from refined metal of the same type as that to be refined (zinc for the refining of zinc, copper for the refining of copper, and so on). As the starter plate is captured under the deposit and cannot be separated from it large numbers of starter plates are “consumed” in the conventional
refinery process (the starter plate ends up as an integral part of the output product). A large refinery plant may operate up to 30,000 – 40,000 refinery cells making starter plate procurement an important part of the business. It is certainly both difficult and troublesome to obtain enough many starter plates on the market through an entire economic cycle to secure such an operation, while considering price uncertainty and volatility. With the entrance of the MEL process the procurement problem is abolished, as the new technology is employing reusable cathode starter plates that can be used over and over again through several years\(^1\). But maybe even more important the new technology also renders the user a major cost saving.

2.4.2 Technology development in a domestic context

Back in the 1970s Domestic Mining Ltd (DML), a large mining company situated in X-land, a country in a distant part of the world, encountered problems concerning supply of disposable cathode starter plates. As a consequence their entire metal refining operations were threatened. Out of the stressful situation was born the idea that maybe it would be possible to use reusable starter plates instead of disposable. Some testing was performed using starter plates fabricated out of titanium, but the result was discouraging and the idea was dropped. A few years later a young engineer working for DML brought up the idea another time while claiming: “Hi, why won’t we use stainless?”\(^2\) The man was known as an “engineering entrepreneurial type of guy”, and his initial idea was to improve the refining operations of the company. New tests now with stainless plates were performed and after some time in operation it was clear that the innovation was proven a technological success.

The business relating to the manufacture and assembly of refinery equipment and refinery plants was soon organized into a separate company within the DML group, i.e. Metal Extraction Ltd (MEL), and for several years DML was the most important customer of the new company. Since the start up in the late 1970s until the first half of the 1990s MEL used Domestic Steel Ltd (DSL) as their single source supplier of stainless steel cathode starter plate. It was a natural thing for MEL to buy from DSL, as DSL was the only domestic manufacturer of flat stainless products, and MEL was keen on supporting another X-land company. During the early years starter plate design, as well as the route for starter plate manufacturing, evolved as a more or less cooperative venture involving MEL, DSL and DML, and all interaction between the companies saw the young “engineering entrepreneurial type of guy” as a particularly important process catalyst. Certainly, also actors other than DSL and DML directly or indirectly contributed to the development of the MEL refinery process. Among those

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\(^1\) With the estimated corrosion rate in the current service environment and with the “contact time” as determined by the refinery process the life time of the stainless steel cathode plate is calculated to 10 – 15 years.

\(^2\) Interview with Hank Kennyson on November 22, 2001 (also see Appendix 1: List of abbreviations and pseudonyms).
were the suppliers of production facilities and consumables but also various subcontractors other than DSL, most of them located in X-land. During these years DSL ran the entire production route in-house, both regarding carbon steel and stainless steel manufacturing – from smelting to finishing operations. In 1988 they made the strategic decision to close down their own steel smelting and hot rolling operations as to stainless steel production. From that point in time hot rolled coil was supplied from British Steel Stainless in the UK. With the change followed reduced possibilities to influence steel smelting and hot rolling operations, as those were no longer directly controlled by DSL.

It seems that the industrial environment of X-land had been suitable for the development of the new technology and for many years the MEL refinery process was a phenomenon primarily of domestic concern although quite early the new technology was also exported to some refinery plants located in other countries. Concerning stainless starter plate design some aspects refer to historical circumstances. By tradition a disposable starter plate measures one by one meter. The basin in which the starter plate is operating is constructed to house a set of starter plates conforming to the historically established dimensions. Thus, when using reusable starter plates in an existing refinery plant the plate dimensions have to conform to the plate size for which the basin was once designed. As more often than not reusable starter plates are substituting disposable plates in existing plants reusable plates have to conform to the dimensions of disposable plates concerning length and width. When it comes to plate thickness another influence is ruling and that is the applicable measuring system as such, where some countries adhere to the metric system, and others stick to imperial measures. In this particular case imperial measures were ruling.

Thickness, width and length were product features that could easily be met by DSL, but regarding surface morphology and flatness there were still a lot of uncertainty around and it seems that many problems were left unresolved in those early days. Pickling operations performed back in the 1970s and early 1980s were not particularly well controlled and most material that left the DSL production system was heavily over-pickled. Maybe that was not all bad because by over-pickling strongly hollowed out grain boundaries were created, and those hollows helped the deposit “to take a toe-hold” as it successively built up in the process of electrolytic refining. This was actually an argument forwarded by the DSL technicians to justify the over-pickling. But more troublesome was the combined problem involving at the same time surface morphology and material flatness. In order to reach the flatness specified by MEL, as a final manufacturing operation DSL performed piece-mal roller leveling of the material, and the more the material deviated from specification regarding flatness the heavier it had to be rolled to reach the specified flatness. But as the material was made flatter by rolling the surface also became finer and sometimes it ended up so fine that it was no longer suitable for use in the electrolytic refinery process because of the increased risk of pre-stripping.
Although some of the problems relating to the design and manufacture of the stainless steel starter plates were not perfectly resolved in the early days a lot material was produced and let into service in the MEL refinery process. And all in all the results were very satisfying. By far the MEL process surpassed the conventional method of electrolytic refining. And the people at MEL looked at the process and said: “Well, it’s so successful. Who are we in [X-land] that can prevent someone in America or wherever from copying our system. We can’t stop it. So..., well, why aren’t we making money out of it, we are going to sell it to our competitors.”

2.4.3 Metal Extraction Ltd goes international

The new metal refining technology was patented and later an American subcontractor got a license rendering them the right to supply the technology in a certain part of the world. However, also another overseas company started to exploit the new technology but without having purchased a license. They just got around the patent. The first installation on European ground of the MEL refinery process was made in the mid 1980s. Continental European Refinery Ltd (CER), a company part-owned by DML, purchased a license and embarked upon the new technology. Later on in the latter part of the 1990s CER referred to the license another time as they were now about to replace the set of cathode plates they had bought some 12-15 years before.

During the 1980s many refineries situated in different parts of the world adopted the new technology. To a large extent its spread was the result of the work of one devoted person, i.e. the “engineering entrepreneurial type of guy”, who had once initiated the whole process. Later, in his role as the “engineer com-salesman going around the world selling the process”, the man strongly contributed to its realization, and as the crusade went on an increasing number of refineries took on the new process. Though the commercial success was a fact not much of market intelligence had been developed in relation to the sales process so far. The technology was so strong in itself that selling was just a matter of spreading the information and the “entrepreneurial type of guy” was the right person to do it. As the business grew some supply problems were encountered. The manufacturing capacity of DSL was limited and one very obvious bottleneck hampering large volume production was the piece-mal roller leveling performed by DSL. To overcome the constraints MEL tried a few alternative suppliers, among those an Indian re-roller, but with discouraging results.

In 1992 Avesta AB and British Steel Stainless merged into the Avesta Sheffield Group and soon MEL faced new supply opportunities. Hank Kennyson, a marketing and sales type of person possessing a solid technical know-how, was employed by the merged company as one of their sales representative in X-land, and as things evolved Kennyson should soon become a most important person for the development of the

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1 Interview with Hank Kennyson on November 22, 2001.
Group’s business with MEL. Already in the late 1970s he had become familiar with DML and MEL in his former role as an X-land representative of Sandvik Steel, but as Sandvik Steel didn’t promote any hot rolled products no cathode plate business had been established with MEL. Later Kennyson worked for some traders selling stainless products in X-land, and close to the merger between Avesta AB and British Steel Stainless he worked for an independent X-land agent contracted to trade a narrow assortment of stainless steel flat products produced by Avesta AB. Through all those years, from the late 1970s up to the early 1990s, Kennyson had been well aware of the business potential adhering to the operations of DML and MEL, as, for years, he had lived and worked in the geographical area of X-land where DML had its headquarters. Kennyson’s main concern as to the development of the MEL business had always been the loss of a stable and reliable source of supply for flat products. The kind of source he had sought for was some kind of internal supply, i.e. supply from an in-house manufacturer. Containing the demanding product specification of MEL through the more loose type of cooperation that the involvement of an external steel manufacturer would imply was not realistic according to his understanding. Without support from a dedicated in-house producer of cathode plate the business project, if launched, would become a failure, he thought.

With the merger in 1992 business conditions changed. Supported by a multinational company specializing in the production and sales of stainless steel flat products Kennyson now had at his disposal the appropriate resources for the development of the business with MEL. Another factor that should positively influence the development of the business between Unit Cold Rolled (UCR) and MEL was the assignment of the first managing director of the Avesta Sheffield sales company in X-land (ASX). Interestingly enough, the man was a Swede that prior to the merger had worked as the marketing manager of UCR. As the business between MEL and UCR gradually developed MEL extended its international operations to comprise not only comprehensive sales of refinery plants and equipment but also large-scale supply of their most important input factor, i.e. the stainless steel cathode plate.

Involving in business with the Avesta Sheffield Group meant more to MEL than just getting provided stainless steel. Management teams in heavy industries more often than not seem to carry higher density of engineers and technicians than do management teams in other branches, or otherwise expressed, management teams in heavy industries usually contain more than sufficient competence in the field of technology but do sometimes miss out on competencies in other areas, and companies that organize around a specific technological innovation may give the technological

1 The agent upheld the agency for the merged company for a short period of time, but various problems and irregularities in the administration of the business made Avesta Sheffield terminate the agency agreement quite soon.

2 In this context ASX is the abbreviation used for the particular Avesta Sheffield sales company operating in the home country of MEL, i.e. in X-land, a country located in a distant part of the world if looked upon from a Swedish perspective.
aspect of their business particular emphasis when composing their management teams. MEL may serve as an example of such a company. The company was formed to manage the development of the new refining technology and all managers appointed were engineers or technicians by education. It seems that the marketing thinking was not particularly well developed in the company, a circumstance that Hank Kennyson found out after he had become somewhat familiar with MEL. Kennyson describes his observations as follows:¹

Something which I discussed with them when I first come to understand a little bit more about the business. They tended to not have marketing people – and a sale was a sale and they didn’t at that stage … realize the fact that they had the opportunity to make a further sale over a period, which for electro-winning would be about seven years and for electro-refining would be about 12-15. And they basically tended to lose contact … Yes, I said to them, I put a proposal to [the process development manager (MM)], who became the manager at the time, and said, you know, really, if people have been in this since 1978, you know all customers, you know what sales you have made, you know what the life expectancy is. Have you looked at it in a spreadsheet … so you can say where the sales will be coming?

The message was well received by the process development manager (MM) and others in MEL’s management team and when they brought together the numbers for the calculated growth of the refinery industry, the potential numbers for change over from the old technology to the new technology of the existing plants, and the possible reoccurring orders from customers already utilizing the MEL process the total matched fairly well the manufacturing capacity of MEL’s operations. Kennyson again:

And [the process development manager (MM)] went through it and he just chuckled when he said ‘yeah, you know its pretty …’. But he picked up on the fact that we were looking to say where the market was going and where their sales would come, but they hadn’t, they had just… an old traditional salesman, whatever, he sold the thing and when the customer wanted it they rang you up and they want it to move. And as I’d explained to [(MM)], as the business grew they had to realize that we won’t be able to respond immediately and give them a delivery in a week. We and I have to schedule-base it. So he’s changed that all around. He had his people revisiting all their existing customers.

The MEL business grew and at the turn of the millennium more than a million pieces of stainless steel cathode plate had been delivered to a rather small number of end users spread into various parts of the world. The collected capacity of those end users accounted for roughly fifty percent of the world refinery capacity as to the certain metal for which the MEL process had proven particularly suitable. If calculating the number of players actively operating in the industry the size of industry is small, but if considering the importance it is playing for large numbers of people throughout the world the industry is a giant, and MEL as one of its more prominent actors is holding an advanced position in the industry.

¹ Interview with Hank Kennyson on November 22, 2001.
2.5 Business Story Part II: Unit Cold Rolled enters into cathode plate business

2.5.1 “Sipping at” cathode plate business

Refinery Plant Construction Ltd (RPC), a competitor of Metal Extraction Ltd (MEL), placed the very first order of stainless steel cathode plate at Unit Cold Rolled (UCR). The year was 1993 and the material was intended for the construction of a new refinery plant in Canada. No business had yet developed between UCR and MEL and to UCR the cathode plate application was still brand new. The order amounted almost two thousand tons of cathode plate. The offer was made in the middle of the summer during the holiday season when most people were off the lines at UCR. Had the inquiry arrived in UCR at a time when most functional managers had been on post it had probably never resulted in an order, as it included a very demanding product specification. Besides, the RPC order also represented a quite large manufacturing volume that had to be squeezed into an already bulging order book for delivery during the coming autumn.

How come the order was accepted by UCR? The person responding to the inquiry was a product manager in the marketing department, an experienced old-timer, well known for his entrepreneurial mind, a person knowing all the details about the operations of UCR, a figure who had drawn many projects of different kinds through the mill over the years. After the offer was made the order soon arrived at UCR and later in the autumn it was effectuated. As the order was run some manufacturing problems were encountered. Rejects had to be compensated for and the economic result was not particularly promising. When the order was finally finished many UCR employees breathed a sigh of relief. Expediting the order had certainly brought some learning to the UCR organization in the area of cathode plate manufacturing – with implications for the future – but the economic result was poor.

2.5.2 Unit Cold Rolled meets Metal Extraction Ltd

A few months later UCR offered MEL stainless steel cathode plate for the first time. The offer related to an enquiry that MEL had received from North European Mining Ltd (NEM) concerning the construction of a new refinery plant at NEM’s mining site in the northern part of Europe. NEM was part of a large industrial concern active in several branches, the activities of which included the distribution of a broad variety of industrial goods including stainless steel products that were sold on an agency basis. Information about NEM’s large investment plans seems to have reached the distributor sister company of NEM and someone in the distributor company (DIS) obviously saw an opportunity to make money out of the project by partaking, if just at the margin. Unfortunately information is lacking about the communication rounds that occurred between NEM and DIS but it seems that MEL was instructed by NEM to direct their
inquiry for stainless steel cathode plate to DIS. Probably NEM “advised” MEL to do so, and on February 1, 1994, MEL sent an inquiry for stainless steel material to DIS. The managing director of DIS responded by fax: “To be able to give you necessary local service we have instructed our partner in [X-land] to quote you.”

The partner referred to in the fax was Avesta Sheffield’s sales company in X-land (ASX). The managing director of ASX made the necessary arrangements and on behalf of UCR ASX offered MEL 26 000 pieces of stainless steel cathode plate amounting 750 tons material. The date was February 17. The offer comprised a standardized product principally missing out on the specific requirements concerning flatness and surface finish, properties that should later be subject to extensive debate in relation to this particular business. However, it should be noted in this connection that, prior to the merger of Avesta AB and British Steel Stainless in 1992, the managing director of ASX had been the marketing manager of a product division within former Avesta AB and that division had contained UCR and another manufacturing unit. An engineer by education but a true businessman by mentality and profession, in his former position the man had gained a lot of experience in regard of mill manufacturing and business practice. Regarding the business operations of UCR his understanding was both detailed and comprehensive, as he had worked for the unit for several years. There he had been an important member of the management team and he had developed close relationships with many people at different levels in the organization. When ASX offered MEL cathode plate in mid February 1994 it was the startup of a process of information exchange and negotiations that should come to reach far into the future.

In late February two representatives of MEL visited NEM in Europe for a negotiation round and in early March in a telephone call NEM informed UCR that MEL were not considering buying steel from Avesta Sheffield, as they had found that the offered price was much too high, far beyond the current market price. They also claimed that the payment conditions offered were not attractive. The sales manager of UCR forwarded the information by fax to the managing director of ASX. In his fax he included the price level indicated by MEL and attached some solution proposals:

I am prepared to give you 90 days. I want to reduce your commission to 6 %. The balance we are prepared to absorb. [MEL] are prepared to visit UCR on Friday if we are ready to negotiate around above figures. We can only negotiate the CIF price, costs in [X-land] we do not want to discuss! Is this OK? Do you see complications?

The negotiations between UCR and ASX were not particularly difficult. They conformed, by and large, to common practice concerning transfer pricing involving business units1 and sales units as applied within the Avesta Sheffield Group. In parallel

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1 In the Avesta Sheffield system of units and companies the manufacturing unit situated closest to the market along a product line (manufacturing chain) is carrying the responsibility for the overall economic result of the entire product line. Thus, the overall results for the various product lines involving UCR are accounted for by UCR.
UCR involved in negotiations with the distributor company (DIS) about which commission to apply for the lead in case the business with MEL should materialize.

In the meantime the inquiry was also checked against the long-term business running between the British operations of Avesta Sheffield and DSL (in X-land) concerning supply of black hot coil. The crucial issue to clear had to do with the business DSL had with MEL. How would DSL react upon competition coming from a “sister” of their feedstock supplier? As things developed the issue didn’t seem to be particularly sensitive to DSL probably because they had already realized that for the future they wouldn’t be able to stand up as MEL’s single supplier of stainless cathode plate. The volumes needed by MEL had grown just too large. In the past MEL had placed order sizes in the region of 200 to 300 tons each at DSL. Now MEL were aiming at 3,000 – 4,000 tons of stainless steel for each project. The future growth of MEL’s business seemed to be more than DSL could realistically match unless they shared it with another supplier.

The recent involvement in the RPC business had created some confidence in the cathode plate application among UCR’s employees although many of them were still skeptical. A preliminary material specification arriving from MEL was passed on to the various instances at UCR for evaluation. Most paragraphs in the specification were immediately approved by UCR but some were not. One of the non-approved paragraphs concerned the surface finish of the plate. MEL specified an upper as well as a lower limit for surface roughness. UCR were inclined to accept the upper but not the lower limit at this stage of negotiation. Another paragraph that was not approved prescribed edge trimming of the plate. UCR found the flatness tolerances specified by MEL narrow but still possible to accept, as they were supposed not to cause any major manufacturing problems. How to specify the product was an issue involving a lot of information exchange between MEL and UCR over an extensive period of time. What one party wanted the other party found unacceptable and vice versa. According to UCR the “suitable user window”, as prescribed by MEL, was assessed much too narrow for feasible manufacturing of cathode plate to occur, and according to MEL the

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1 Accepting a lower limit as regards surface roughness is giving away, at least to a certain degree, the opportunity to improve material flatness by post-rolling the plate, i.e. leveling the plate after it has been cut to length. The point is that piece-mal, post-manufacturing leveling can be performed only by rolling, not by stretching, as the latter practice destroys the surface in the areas where the jaws clutch the material. But post-rolling results in a finer surface and if a lower limit is accepted some possibilities to carry out corrective action by roller leveling is given away. It is worth mentioning that MEL’s original supplier of cathode plates, Domestic Steel Ltd, did practice piece-mal leveling by posterior rolling. Using cathode plates with too fine a surface in the metal refining process is risky. In case pre-stripping occurs the refining process is interrupted too early, and implicitly productivity goes down. At worst the refinery equipment may be damaged as well.  
2 The slitting and cutting of stainless steel flat material always leaves an unwanted burr on one side of the material. The burr may vary from small, which can be accepted in most product applications, to large, which may cause problems in some applications. The burrs can be removed by machining (edge trimming).
“desirable manufacturer window”, as claimed by UCR, was found much too wide to secure efficient use of the cathode plate in the refinery process.

As UCR and MEL went on interacting discussions and negotiations also progressed between MEL and NEM. The chief development engineer of MEL visited the technical people of NEM in Europe. Problems identified by UCR concerning the cathode plate product specification were also brought into the discussions performed between MEL and NEM. That the specification of the stainless starter plate was crucial to the relative success of the operations of the new refinery plant was a fact that all parties involved could agree upon, but the agreement didn’t reach very far because what was found to be good for one party was found less good or even bad for another party and vice versa.

In the beginning of April MEL formally submitted the order to UCR concerning the NEM project although some items on the product specification were still left unresolved. UCR acknowledged the order on June 22 by booking it into their material processing system. In the meantime all necessary practicalities had been arranged regarding price, terms of payment, packing, terms of shipment, replacement plates (in case of rejections), transportation, etc., and the product specification had been discussed at length until an agreement had finally been reached. UCR’s refusal to accept a lower limit regarding surface roughness had been challenged. The final compromise included the acceptance on the hand of UCR of both an upper and a lower limit but the range between the two had been held quite wide. Another issue that had been vividly debated was how to measure surface morphology. If a common measuring method could not be agreed upon the limits negotiated concerning surface roughness would have no meaning, and the issue would still be one on the list of unresolved problems. Finally, after several intensive negotiations an agreement was made about how to collect test data and how to evaluate them. Several development engineers from MEL had been involved in the process as well as various technical personnel from UCR among those the QA manager and some technicians working in the manufacturing department. Also people at NEM had influenced the final solution. And at the time everything was finally settled and the order was acknowledged about half a year had passed since MEL started the procurement process for the NEM project.

During the initial period of interaction the sales manager of UCR together with Hank Kennyson (ASX area sales manager) coordinated most communication lines between UCR and its new customer. Early Kennyson shouldered the intermediary role while sharing his loyalties between the company he legally belonged to and the company he was eager to serve. In his contacts with MEL he promoted the capability of UCR but in relation to UCR he was at the same time “the ears and the eyes” of MEL. The large geographical distance between UCR and MEL allowing mill visits to occur only at rare occasions seems to have been a major reason for him to choose the middleman
position. Other reasons are probably to find in his personal character. Anyway, non-prestige and neutral coordination was to be carried out somewhere along the line to make things develop and the area manager of ASX picked up this coordinating role. The man, a true problem-solver and a good negotiator as well, gradually, as the relationship between the two developed, accumulated a substantial amount of respect in both camps, in the UCR mill as well as in the factory of MEL. Both parties found him highly competent, undaunted and trustworthy and he was perceived a man eager to make things go right. A particular episode may serve as an illustration.

During the most intensive negotiations, when the product specification was under development, the issue of replacement material was brought into focus. How to handle rejects identified after arrival in the premises of MEL? In a fax addressed to the sales manager of UCR Kennyson forwarded a detailed description of MEL’s position after he had penetrated the issue thoroughly with the development engineers at MEL. Although the fax was clearly promoting MEL’s current practice in relation to other suppliers of stainless steel the last sentence of the fax was an illustration of his intermediate role: “Hopefully your [RPC] experience will give us a guide as to how to address the reject problem assuming that they have a similar tight specification as [MEL] have.”¹ The sentence highlights the necessity of providing a solution to the reject problem given that rejects will always appear now and then as a consequence of the tight product specification. But it also relates to UCR’s experience in the field by raising inquiries about probable past problem solving activities carried out by UCR when delivering cathode plates to RPC, assuming the two product specifications were similarly tight.

Until the orders between NEM and MEL, and MEL and UCR respectively were finally placed several months of negotiations involving exchange of desires, proposals and counterproposals had passed. It was obvious for all three parties that they depended on each other for success and various constraints and opportunities were elaborated upon until an acceptable compromise could be established. In the end it was decided that representatives of MEL and NEM should attend the UCR mill at the time the first batch of cathode plate was manufactured.

2.5.3 Struggling through the first order for Metal Extraction Ltd

In August 1994 UCR started the production of starter plates for MEL and on August 31 the representatives of MEL and NEM showed up at UCR’s premises. Development engineer (GG) working as procurement manager at MEL should have attended, but as he had suddenly got ill with short notice an engineer at MEL working with industrial design was sent in his place. NEM was represented by a project manager arriving together with an external consultant from ‘Swedish Testing and Inspection Quality

¹ RPC, Refinery Plant Construction Ltd, is a competitor of MEL with whom UCR had its first business based on the cathode plate application.
Consultant Co’. The visitors were taken on a mill tour and then they stayed for four hours at the cut-to-length line where they observed the various finishing operations. They also participated in discussions with various UCR representatives, among those the sales manager, the quality manager, the quality assurance manager, a person from technical market service, the production manager of the finishing department, and the sales person responsible for the MEL account. The visitors said they were satisfied with what they had seen and heard. The design engineer of MEL wrote an extensive report based on the observations he had done during the visit. The report was spread internally within the MEL organization but copies were also distributed to UCR, ASX, and NEM. The document described and scrutinized various aspects of the production procedures of UCR in relation to the manufacturing of the cathode plate product and concluded:

Avesta Sheffield appear committed to supplying a product of high quality, and in accordance with our specifications and requirements. Judging by the inspected samples, their operations and their obvious experience, I do not see any reason for MEL to receive any inferior product.

Three overall recommendations were explicitly forwarded in the report:

1. A [MEL] representative, if in Europe during a future production run, should pay a follow up visit to Avesta Sheffield.
2. On the strength of the quality of the stainless steel sheets inspected, and in the interest of competition, Avesta Sheffield should be invited to tender for future supplies.
3. Supply of [MEL process] brochures and a video to Avesta Sheffield for educational purposes of their production crews.

In the late autumn the first lot of cathode plate arrived in X-land and the punctuality of delivery impressed on MEL. In order to jointly inspect the goods at arrival Hank Kennyson flew up to the harbor in X-land the vessel had touched at. Five containers were opened. Inspection revealed that the goods had traveled well. A few days later, however, another piece of information reached Kennyson. As the other containers had been undone damaged material had been found in some of them. The goods in one container had shifted during transportation and caused damage to some pallets. There was also slipping of plates in pallets in some other containers. Probably the strapping had stretched and allowed plates to move. Kennyson flew up to the harbor a second time, now to inspect the damaged material. A few days later he informed UCR by fax:

On initial inspection there appear to be about 10 pallets, which have broken or loose strapping and plates have spread and/or have at least edge damage. Tomorrow I will have the pallets unstacked to make a further assessment.

The problem appears to be that pallets are boarded on two sides with two ¾” straps, they need to be also boarded on the other two sides, and strapped perhaps with heavier strapping.

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1 Report title: “Cathode plate steel production commencement for [North European Mining Ltd.] plates.”
Further assessment revealed that the goods had not been appropriately packed for sea transportation, at least not for sea transportation to be performed under tough weather conditions. Kennyson wrote a long fax to the sales manager of UCR in which he described the current situation. He included some recommendations about how to avoid similar problems for future deliveries while claiming: “The material ready for the 4th delivery will have to be repackaged to overcome the potential for pallet breakage.” A few days later he sent another proposal including some drawings addressing the problem of how to load the pallets into the containers in order to avoid pallets shifting about during sea transportation. As the material from the first delivery had been thoroughly inspected for transportation damages five plates had also been given a preliminary flatness check and all five were found to be out of specification. Kennyson again: “Whilst this was on damaged plates it is of great concern to [MEL]. Tomorrow we will check undamaged pallets.” Two days later reassuring news arrived at UCR:

Tests which we carried out on ten pallets, both damaged and undamaged, taking a plate from each showed all but one to be in tolerance, flatness, finish, dimensional and squareness all OK. The badly damaged one tested yesterday was out due to transit damage. [MEL] have accepted them.

Now everything seemed to be in place concerning the first shipment except for fifty plates that had been identified as damaged during sea transportation and had to be replaced. Alongside with the handling of the arrival problems connecting to the first shipment for the NEM project Kennyson started discussing future business opportunities with the MEL people. According to MEL a large Belgian project was under way and it was early indicated that ALZ, a competitor of Avesta Sheffield, was eager to supply the stainless material needed. As a matter of fact it seemed that ALZ had danced attendance upon the Belgians to get the business, but the MEL people had told the Belgians that they were not willing to make use of ALZ material in their refinery system. However, the people at the Belgian refinery had discussed making finished plates themselves, but at MEL they were convinced they should get the business while using UCR material.

In early December the second shipment from UCR arrived in X-land and with that a new problem. Although the material had not been damaged by mechanical shock this time the interior of the freight containers was very damp and the way the pallets had been placed inside the containers made unloading almost impossible should the pallets be kept intact. As a result some material was damaged during unloading. An intense problem solving activity relating to packing and transportation issues was now initiated involving ASX, UCR and relevant external parties concerned with shipping operations. The aim was to secure that future shipments should not suffer from the same problems that had been encountered so far. Kennyson intensively participated in the problem solving while worrying about packing material and practices, stacking of plates, loading of containers, etc. Despite the transportation problems the first shipments seemed to end up in success and the quality of the products delivered so far
was conceived of as very good. The material conformed to customer specification except for the plates that had been damaged during transportation. The third and the fourth deliveries arrived at MEL later during December and in January 1995 respectively.

MEL soon started to process the material. When in production the product quality was more thoroughly investigated and quality problems not previously observed were now detected. Also plates other than those that had been damaged during transportation were found to be out of specification. An additional number of plates (about two tons of material) were found not to meet the flatness specified and some other plates suffered from surface defects (shear marks, fork marks, rust and oxide). A week later additional material was reported to be out of specification in regard of surface finish, several plates displayed too smooth a surface while measuring far below the lower limit specified. Now an intensive period of communication, testing and corrective action was initiated. UCR committed themselves to replace the unflat material and a second round was initiated concerning how to measure surface morphology. But the process had just begun when another alarming report arrived at UCR. An ominous fax from Hank Kennyson commenced: “Further drama!” It went on informing about a comprehensive internal quality assurance audit that had been performed at MEL’s premises. The audit had revealed that cathode plates out of flatness had been allowed through manufacturing. About twenty tons of material out of tolerance had been found during the initial audit. As a result the quality assurance department had overruled production and all plates out of specification had been rejected. Then the audit had been extended and as a result another thirty tons of unflat material had been identified. A new problem of magnitude had been encountered calling for powerful corrective action.

To understand the nature of the surface quality problem the parties exchanged several samples, which were separately tested by UCR and MEL. Soon it was found that the respective measuring instrument used by UCR and MEL didn’t match. Additional testing was carried out to eliminate the mismatch. In the meantime information about the current problem situation had reached NEM who got most concerned, as they had heard about an episode in the past where a client of MEL had run into severe pre-stripping problems. To test the adhesive force MEL carried out adhesion tests on the UCR material while comparing the results arrived at with results achieved when testing reference material. The results from the adhesion tests proved the suspect UCR material to be appropriate for the application.

1 In this particular case an Indian re-roller, here called Stainless Steel Re-roller Ltd. (SSR), had supplied the cathode plate material.

The thing is that between the surface of the starter plate and the deposit (which is building up during electrolysis) an adhesive force has to develop enough large to carry the deposit during the entire cycle of electrolysis. However, the force must not exceed a certain level because then difficulties will arise when aiming at mechanically detaching the deposit from the starter plate in the end of cycle.
The more troublesome quality problem concerned material flatness. UCR didn’t consider it realistic to take about fifty tons of plate back to Sweden for piece-mal roller leveling because (1) the long distance transportation would cause the customer an unacceptable time-delay, (2) too much costs would be added to the product, and (3) the Swedish part of the Avesta Sheffield manufacturing system had no suitable equipment for piece-mal roller leveling of thin plate at their disposal. The situation was certainly precarious, but finally a quite peculiar solution was developed. The Swedish managing director of ASX approached MEL’s original steel supplier, i.e. Domestic Steel Ltd (DSL), while asking for help. DSL had at their disposal equipment suitable for the corrective action in-house, and they ran their operations on X-land ground, so they would fit in well for the job, no doubt. The question was whether or not they were willing to cooperate. Anyhow, they were asked to make an offer in regard to roller leveling of a certain amount of material.

It may seem strange that UCR turned to DSL for help as the two were competing for the MEL business, but there were some particular circumstances around impacting upon the situation. After DSL had closed down their own metallurgy operations (steel smelting and hot rolling) as to stainless steel manufacturing in 1988, onwards DSL operated as a stainless steel re-roller. But in their role as a re-roller they had to rely on external supply of hot rolled coil, which they secured by entering into a contract with British Steel Stainless. By the merger in 1992 UCR and the former unit of British Steel Stainless – who went on supplying hot coil to DSL after the merger – come to belong to the same multinational corporation. Implicitly, in relation to DSL the Avesta Sheffield Group was now both a supplier and a competitor. It is obvious that this circumstance was a moderating factor when UCR (via ASX) approached DSL for help.

There is probably also another good reason to why DSL wasn’t too upset about the Avesta Sheffield presence in X-land. Since ASX settled down on the X-land market in 1992 DSL and ASX had frequently talked to each other. Among the issues addressed in these discussions was that of product assortment. Which products should ASX offer on the X-land market? Which products would be complementary to DSL’s products and which would compete with the products of DSL? As the assortment of Avesta Sheffield suffered from additional costs due to long-distance transportation ASX concentrated on special steels and added value products, while most of the standard products were left for DSL to supply. The choice of strategy had created a situation where ASX and DSL more looked upon each other as complementary suppliers rather than heavy competitors. Finally, as already noted above, DSL probably foresaw that the growth of MEL’s business would soon reach a point where the manufacturing capacity of DSL would not suffice to match the volumes needed by MEL, and when arriving at this point there would be need for complementary supply anyhow.
DSL accepted to do the roller leveling for ASX/UCR and soon the corrective action was negotiated and subcontracted. From ASX/UCR the business was organized by Kennyson who later wrote a fax to UCR telling: “They [DSL] indicated that in the interest of our good relationship they will not ‘rip us off’ with a high rate.” Such was the course of events unfolding in regard of the first order that UCR had accepted to do for MEL, that in mid spring 1995 the final operations were performed. More than a year had passed since the first contacts had been taken between the two companies, and it is somewhat peculiar to note that these final expediting operations were performed on X-land ground by DSL, who involved in a mixed relationship with the Avesta Sheffield Group. Previously DSL had appeared both as a competitor and a customer in relation to Avesta Sheffield, but now they could add on their cast also the supplier role vis-à-vis the Group.

After all struggle the stainless sheets that had once been shipped from UCR to MEL were now further fabricated and assembled into ready-to-use starter plates aiming for service in the new refinery plant of NEM. And soon the equipment left for Europe. Later in a fax directed to the managing director of ASX, dated September 22, 1995, Hank Kennyson writes: “[NEM] project has been commissioned and no ‘prestripping’ has occurred and current density is high. This means that both flatness and finish are okay.” Expressed in plain language the message said that the equipment had been brought into service by NEM, and that it performed well in the refinery process. However, although everything was fine in the end, at that point in time MEL didn’t conceive of the UCR material to be as good as material delivered by DSL, but the MEL people expected UCR to catch up for the future at least to a level where they could meet the performance of DSL.

2.6 Business Story Part III: Business exchange and product quality crisis

2.6.1 The problem of procuring input resources on a volatile market

After Domestic Steel Ltd (DSL) had closed their metallurgy operations as to stainless steel in 1988 Metal Extraction Ltd (MEL) come to depend entirely on re-rollers for supply of stainless steel flat material. By definition re-rollers perform downstream cold rolling of black hot coil purchased from major stainless steel producers. That makes them depend on their upstream suppliers for the sourcing of input material. When the market gets “hot” (in times of prosperity) it is sometimes difficult for re-rollers to procure enough input material to contain full capacity utilization, as the steel producers in such situations usually prefer to supply customers requiring higher-value products.1 While reflecting upon this circumstance in the early 1990s MEL began to

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1 The lower-value black hot coil may serve as a buffer regulating capacity utilization in the steel mills.
nurture the idea of getting closer to a major producer of stainless steel and when the market for stainless suddenly escalated in the mid 1990s the matter became urgent to them.

The raw material price for molybdenum had started to rise already in the early 1993 and at the turn of 1994/95 it peaked at a level five times the normal. During the latter part of 1993 also the nickel price started to move upwards and it went on increasing through the entire 1994. In the early 1995 it peaked at a level two times the normal and it stayed there for most part of 1995. As both nickel and molybdenum are important stainless steel alloying elements\(^1\) the price of stainless steel also went high\(^2\). As a consequence many customers began to hoard material because they anticipated further price increases. The demand for stainless steel rouse to a level far beyond existing production capacity in the industry and prices went even higher.\(^3\) As the major producers (the steel mills) ran short of capacity they started to choose whom to supply.

Companies performing downstream manufacturing of stainless products were the ones suffering from the situation. As the demand for stainless steel went high they simultaneously suffered both from short supply and high prices. And that was particularly true for customers buying simple standardized products like black hot coil. Consequently, in the mid 1990s many re-rollers encountered procurement problems and MEL, who still used DSL as their main supplier of cathode plate, foresaw future supply problems. Adding another re-roller for complementary supply in a market characterized by boom would certainly not be an effective solution to their potential supply problem they pondered. To approach a major stainless steel producer in a situation when the entire industry was short on capacity was also problematic. However, in case a major producer was approached it was not for the purchase of a simple low-value product but a demanding product representing a decent price. In late 1994 the area sales manager of ASX, Hank Kennyson, insightfully read the situation. After a visit in MEL’s premises and discussions with six of the company’s leading managers he writes in his travel report of November 22:

> It is obvious in their situation they require continuity and quality of supply. I suggested the need to “get in bed” with a major producer such as ourselves and they agreed. … I believe that we have an excellent opportunity to cement an ongoing relationship with [MEL] and that the present Stainless Steel situation is working in our favor with this customer.

\(^1\) The stainless steel used by MEL contains ca 2\% molybdenum and ca 11\% nickel.

\(^2\) See section 2.1.2 above as well as Appendix 2 where the interrelationship between raw materials price changes and price changes as to stainless steel are discussed in connection to the ”alloy surcharge system”.

\(^3\) It should be noted, however, that price changes as those described here, i.e. short-term price changes regarding raw materials such as molybdenum and nickel, do affect the costs of the steel mills just at the margin, because the major portion of all raw materials are procured through long-term contracts. For a more detailed description of the economic development in the European stainless steel industry see Appendix 2.
The discussion had been performed at a time when the first Unit Cold Rolled (UCR) shipment of cathode plate had just arrived in X-land, and Kennyson had visited MEL to inspect the material after arrival. It is interesting to note, however, that already before MEL had brought any UCR material into production they showed an interest in getting closer to a major stainless steel producer in order to secure the inflow of stainless plate. Though UCR’s expediting of the first order involved a lot of trouble MEL went on discussing future potential projects based on deliveries from UCR. At the time the stainless steel market showed an upward trend and it should soon develop into an extreme boom period making users of stainless steel vulnerable should they need to extend their current input supply. It was in this particular market that UCR reciprocated the interest shown by MEL.

Any major producer of stainless steel represents an integrated production system covering several production stages from steel smelting to downstream manufacturing and fabrication, and such systems involve logistic procedures that are usually both complex and complicated. The Avesta Sheffield Group certainly made up no exception from the rule. As part of the Group, UCR for several years had been running an internal coil reservation system to secure material supply. The system linked UCR to the collected steel smelting and hot rolling capacity of the Avesta Sheffield Group, a capacity that was located to the Coil & Primary Division (C&PD). A certain share of the C&PD capacity was reserved for UCR for further processing downstream implying that UCR had both the rights and the obligation to order a certain tonnage from C&PD over each time period. The order size equaled the melt size of the respective steel mill – 80 tons per melt for Avesta material and 120 tons per melt for material produced in Sheffield. For each melt UCR had to specify steel grade, week of delivery, coil weight (ranging from 10 to 25 tons), and the width and thickness of the hot band. Commonly the various stages in most large production systems are bound together into one or more product lines involving complex logistics where each activity performed along one line has to match upstream and downstream activities in regard of functionality. If considering the production system as a whole the capacities at the various stages have to strike a balance for the entire system to operate efficiently. Preferably bottlenecks should be avoided and if occurring they should soonest be eliminated.

As MEL’s business grew their demand for stainless plate grew accordingly. Already in the late 1994 the managers of MEL had been told that it wasn’t feasible to anticipate quick deliveries on short notice of large volumes from the UCR mill (or any other major steel producer), as such manufacturing systems by nature involve a substantial portion of inertia. And in a booming market, in particular, manufacturing capacity stands out as the crucial limiting factor making future planning a necessity. Especially when it comes to large order volumes forward planning is a must. Turning again to Kennyson’s travel report of November 22, 1994, and we find him arguing with the MEL people.
I further explained that they will have to give a tonnage commitment to the Mill to ensure capacity is allocated at the budget stage. They understand that they cannot just pick up tonnage such as theirs on an ad hoc basis.

The discussion triggered MEL to start pulling together data for an estimate of their future consumption of stainless plate and some half-year later UCR received budget numbers from MEL. The necessary reservations were made in UCR’s coil reservation system, and when MEL afterwards placed orders at UCR the capacity required for their execution was drawn from the reservation system.

2.6.2 Pricing policy and new marketing management at Unit Cold Rolled

During spring 1995 MEL placed a large order at UCR. Due to volatility on the stainless steel market the order was booked at firm price including 7 % duty and a certain alloy surcharge\(^1\), which was calculated on the factual spot prices for raw materials. Soon after the order was booked it was decided that a development engineer of MEL should visit the UCR mill in May/June in order to inspect the material at the time it was under way through production. Lockout of workers and production shutdown in the mother company of MEL at the time the man was about to go to Sweden prohibited him from going. Instead he invited the X-land representative of Avesta Sheffield, i.e. Hank Kennyson, to take his place, go to Sweden, and once there to be his “eyes & ears” during manufacturing. Possibly MEL would also arrange for a customer representative of theirs to join Kennyson for the inspection round. This was good news for the managing director of ASX (who had previously been the marketing manager of UCR). During his years at ASX, i.e. 1992-1996, he fostered his key personnel to travel to Europe in order to learn about and familiarize with the manufacturing units and sites of Avesta Sheffield. As the MEL account was about to develop into big business, and as the so far business with MEL had been quite stressful, both in regard of punctuality and product quality, it was certainly important for Kennyson, in his role as the key account manager for the MEL business, to visit Sweden and UCR in order to find out about the capabilities and operations of the UCR mill, but also in order to spread information about the specificities of the MEL business. Further information about what happened during the visit has not been found but it seems that the new order was handled in production during the former part of the summer. A notification from August 24 announces some delivery delay but it also tells that the delay will not detrimentally impact upon the operations of MEL.

In mid 1995 the sales manager of UCR retired and in the early summer a person from the British marketing operations of Avesta Sheffield moved to Sweden to pick up the

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\(^1\) Further information about the price development of stainless steel over time and the application of an “alloy surcharge system” is forwarded in Appendix 2.
position as UCR’s marketing manager.¹ The man was certainly well experienced in marketing and sales but he was not closely familiar with the manufacturing procedures and administrative routines of UCR. Neither was he familiar with the people working in the UCR mill. He knew some of them but most of them not. In the mid 1995 the market for stainless steel was peaking and the users buying stainless were all operating under severe tension. The situation was particularly troublesome for companies performing business where the cost of the input material (raw material/semi-products) represented a large portion of the price of the output product, i.e. users adding just little relative value to the material through their operations. MEL was such a company, and, as the technology they offered to metal refineries all around the world happened to be embedded in stainless steel, they suffered from uncertainties and volatility appearing on the market for stainless. And it deserves to be mentioned that MEL’s customers were probably neither impressed nor particularly knowledgeable about what happened on a “distant market” such as that of stainless steel.

Now, such was the situation when MEL negotiated for several new refinery projects in various parts of the world, and to reduce some of the uncertainties linking to the projects MEL asked UCR for firm price offers for a certain amount of stainless plate to be delivered at certain points in time. The marketing manager of UCR had just picked up his new position and as most people in the stainless industry he was absorbed by the “raw materials price battle”. He preferred to play safe when responding to the enquiries from MEL while prescribing that all offers should involve a ‘rise & fall clause’. The ASX representative, Hank Kennyson, who had previously placed orders based on the principle of firm price with the former sales manager of UCR, now got very concerned. In a fax dated July 21 addressing the marketing manager of UCR he writes:

Notwithstanding [DSL,s] reluctance to offer firm and to develop a rise & fall clause I don’t believe that this will satisfy [MEL].

[MEL’s] customers in the past have always insisted upon firm prices. [MEL] always have to take forward exchange cover, as their customers will not accept even dollar rise & fall. [MEL] don’t receive their orders until they receive firm prices.

With [Belgian] order [(SJ)]² bought forward on nickel and moly at time of order and then we went back to [MEL] to adjust any variances. I don’t see why we can’t continue to do this.

A month later the issue was still not resolved. Now Kennyson directs his fax to Hanna Almgren, the inside sales person at UCR taking care of the [MEL] account. He writes:

¹ After the merger in 1992 the divisional management for the cold rolled operations was located to England. The division included three business units, a small one in Wales, a middle-size unit in Sweden (i.e. UCR), and a large unit in Sheffield. Until summer 1995 no marketing manager was physically located to the UCR premises, just a sales manager. The marketing manager responsibilities for UCR were supposed to be covered on remote control from Sheffield, although as things evolved in practice the sales manager of UCR was covering also the marketing manager responsibilities of UCR.

² The former sales manager of UCR – (SJ) name initials.
Attached find copies of faxes relating to [MEL]. Enquiries that were previously sent to [(WN)]… The situation is unchanged and [MEL] need firm offer on some or all of the enquiries. …

[MEL] don’t want rise & fall. They expect us if necessary to buy forward on raw materials as [(SJ)] did with [Belgian] order. I can’t understand why we can’t do it again. Maybe [(WN)] is still trying to familiarize himself with [UCR] procedures. Anything you can do to help would be appreciated.

Now a short but intensive period of information exchange followed involving several individuals; the marketing manager of UCR, the marketing manager and the managing director of ASX, Hanna Almgren and her superior in the order administration group at UCR, and probably a few more people. In a day the previous pricing principle that had been applied under the supervision of the former sales manager of UCR was reintroduced. A few days later Kennyson in a fax to Almgren expresses his gratitude to the people who had contributed to the rescue operations:

Thank you all for your efforts and the tonnages. [MEL] are very pleased so all I have to do is get some orders. …

I am trying to get orders for each month’s tonnage with varying alloy surcharge and as [MEL] receive final sizes etc. then go back and fix the alloy surcharge.

This way we lock them into the tonnage and then let them allocate it to their scheduled production.

With a purchase budget, capacity reservations and a pricing policy in place the MEL-UCR business was back on the track ready to face new challenges and opportunities. Now should follow a period of time during which MEL repetitively placed new orders in the UCR mill. The orders were expedited but the level of success in relation to product quality and delivery performance varied. MEL’s business expanded into several parts of the world where metal refineries were operating. During most of this time period stainless steel prices were high and soaring and MEL claimed firm prices from UCR when booking new orders in order to protect the profitability of their business. Administrative routines were established and business turned around fairly smoothly.

2.6.3 Product quality crisis triggers the formation of a project group

After a few years of business exchange the relationship between UCR and MEL had reached a certain stage of maturity. The parties’ knowledge about one another had increased and administrative routines supporting exchange operations had been established. Though the relationship had stabilized there were still unresolved product quality problems to handle. MEL forwarded complaints about material received out of specification. The line manager of the cut-to-length line (CTL), Carl Juhlin, in a written report dated December 17, 1995, informs three upper officials of the UCR

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1 The Brit who had become the marketing manager of UCR – (WN) name initials.
2 The cut-to-length line is situated in the finishing department where the coils are cut into the length specified. Thus in the cut-to-length line the band is cut into sheets. Also see section 2.3.3 above.
organization – the plant manager, the marketing manager and the quality manager – about the difficult situation he is facing in his position as production manager in the latter end of the product line. He writes:

Unfortunately we can conclude that several problems show up in relation to the deliveries to [MEL] of so-called cathode plate. That problems relating to flatness still remain unresolved, for example, is very surprising. To secure sufficiently flat material is produced for the application certain contributions are called for both from our personnel and equipment, but that problem is nothing that the customer should suffer from. We have gained a great deal of experience concerning this kind of production (Canada), and we know what is required and we know what to do if things go wrong.¹

According to Juhlin workable production procedures were in place and the experience gained when expediting the Canadian order two years earlier would be enough to encourage people to produce the right quality. To remedy the emergency situation he proposed all concerned to involve in an extensive review session before processing the next order. Furthermore, he approached the question whether to involve the quality department in continuous inspection of manufacturing operations and he concluded “that would be a clear evidence of the failure of current arrangements, but if necessary we have to do it in order to secure the right quality.” Other deviations from established routines mentioned in the report concerned the inability to consistently adhere to the administrative procedures comprising signing and filing of documents, inappropriate separation of defect material in the CTL line, and insufficient packing of the final product. The report was the first major internally sourced written criticism highlighting the inadequate performance of the UCR manufacturing department in regard to the business with MEL.

In the late 1995 the marketing manager of UCR decided to assign a product manager in the marketing department the responsibility of monitoring and caring for the cathode plate business in general and the business with MEL in particular. In an internal memorandum he writes:

I think we have to look at the opportunity that exists for [UCR]. I suggest that [(OJ)²] investigates the market opportunities …, what the volume potential for [UCR] could be and of course whether we can manufacture profitably. Given the size of the opportunity it may be that we have to consider further plant/process improvements.

In the early 1996 the product manager (OJ) started to investigate the market and he also to some extent got involved in the everyday business with MEL. UCR’s delivery performance stayed at an unacceptably low level and UCR’s business exchange with MEL suffered from a lot of friction.

In March 1996 Hank Kennyson, responsible for the MEL account at ASX, in a fax to UCR commented upon the troublesome situation: “As you know our record with [MEL] for on-time delivery is very poor and I can’t keep pulling ‘rabbits out of my

¹ The text is a translation from Swedish, which was the language used in the original report.
² The product manager responsible for the cathode plate business at UCR – (OJ) name initials.
hat”. It is obvious that Kennyson found himself to be caught in a situation where he was enforced frequently to take urgent measures in order to parry recurrent emergency situations. Basically UCR’s lousy delivery performance derived from an inability to produce the right product quality, and as material defects were commonly identified during the final stage of production, i.e. in the end of the CTL line, dropouts were compensated for late in the manufacturing process. Material removed at the CTL line had to be compensated for by entering additional material into production, but before reaching the CTL line the new material had to pass through the entire set of manufacturing operations upstream the product line, activities that consumed time and caused late delivery.

In mid March a second fax from Kennyson communicating prompt urgency arrived at UCR. In the light of UCR’s miserable delivery performance and its inability to sort out the quality problems MEL considered splitting the next order between UCR and DSL. Kennyson writes:

[MEL] are bending overbackward to give us some tonnage to enable us to complete our learning curve on MEL spec. … In the back of [MEL’s] mind is the fact that as yet we haven’t delivered on time. We have only been able to rectify mill problems locally, and on the timing for [the next project] this could be a big problem. … [MEL] are conscious of the time and cost, which [the previous] orders have caused [UCR] and want to assist with more orders. They know that it is in their interest to have us as a reliable supplier to [MEL] std. This brings me to fact that if we get some of [the new] tonnage we must perform. …

Whilst we all believe that we have made progress on the CTL line, we still have some areas to improve. … I believe that we need to pay more attention to quality aspects during processing prior to CTL department. Whilst I was there it appeared to me that material was received at the CTL, which had defects, which meant that majority of coil was scrapped. This is not only costly, but causes time delays with non-standard thickness…

I believe that we should ‘extend back’ into the processing line, the same level of care and attention to details, such as surface finish, which is now being done on CTL. If the coil is received at CTL with scratches it is too late to do anything about it. The corrective action needs to be taken at the source. … Operators need to understand that they control the material condition and have a major influence on the end result. Please don’t misunderstand me, when I make these comments, as I’m sure that you and others are aware of the importance to perform, as we may not get many more chances. … never-the-less we can produce, we just need to have our production operators and Q.A. involved and fully aware of the requirements.¹

The situation was precarious but the message was clear, without improvement future business would not materialize. This was the starting point for a serious attempt to improve the UCR mill performance in relation to the MEL business. The marketing manager of UCR initiated a comprehensive process addressing both review and development activities. As part of the UCR Customer Satisfaction Program MEL was

¹ The underlining corresponds to that done by Kennyson in the original fax.
now considered key customer and issues were raised about how to proceed with the MEL business in particular and with the expanding cathode plate market in general. It was a point in time when UCR explicitly committed themselves to the MEL business and they clearly communicated their commitment to Kennyson for further transfer of the information to the MEL management. The fax from UCR’s marketing manager read: “I see [MEL] as a key customer and we must take the appropriate steps to ensure a high level of performance. I will talk to [the plant manager of UCR] again and come back to you with details of the safeguards we will introduce throughout the process route.”

Under the guidance of the product manager (OJ), who had been assigned cathode plate business responsibility already in December the previous year, a project group was established in the UCR mill. Its mission was to develop a reliable production route for the safe manufacturing of cathode plate as specified by MEL. The group involved four production managers with different responsibilities in the production department, the quality manager, the inside sales administrator (Hanna Almgren) responsible for the MEL account, and the product manager (OJ). The entire production route was carefully scrutinized. Some upstream activities along the product line were found to influence the properties of the final product more than had previously been anticipated. It was also found that some standard manufacturing procedures applied along the line caused too much of variance to the product under manufacturing to secure that the MEL specification could be regularly contained as to the final product. The message arrived as a surprise to most UCR employees concerned. The findings indicated that handling the product quality problems relating to the fulfillment of the MEL specification was neither a matter of extended inspection nor a matter of improved control as long as the manufacturing procedures utilized were not tuned for the purpose.

The project group developed a modified production route for the safe manufacturing of cathode plate according to the MEL specification. Several production steps were subject to change among those were cold rolling, slitting, cut-to-length, line inspection of material, and documentation. Concerning the cut-to-length operation it was prescribed that a larger amount of material should be removed from both ends of the coil in order to reduce the risk of dispatching to the customer material that was not conforming to the flatness specified. Implicitly production of cathode plate performed in accordance with the new prescriptions made manufacturing efficiency drop low when calculated as output divided by input, i.e. output/input. As the proportion of ‘prime material’ decreased the proportion of ‘arisings’ increased and the latter had to

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1 The portion of the material ending up as non-suitable for the customer for whom it was once activated is left out of the ‘output’ variable when calculating production yield.
2 ‘Prime material’ is the product outcome of purposeful manufacturing operations that conforms to the material specification making up the target for production. In relation to customer-oriented order-based production it is the output product that is matching the need of the customer. ‘Arisings’ is material that is not, for one reason or another, meeting the material specification for which it was
be sold at reduced price on the market. Although the ‘arisings’ didn’t reach up to the MEL specification, had MEL specified standard measures concerning width and thickness the ‘arisings’ could have been sold to the market as ‘prime material’ according to any established product standard, and then the calculated manufacturing yield had been much higher.

The yield drop had economic consequences for UCR and in an attempt to find out about the economic result of the MEL business a profitability analysis was performed utilizing the Activity Based Costing (ABC) methodology. Though the average X-land market price for 316-type material was at the low end in comparison with prices for the grade on other markets the price to MEL was a bit higher than the average price for the grade on Avesta Sheffield’s home markets (the Nordic countries and UK). The profitability analysis revealed that the MEL business was somewhat less profitable than the average business in the same steel grade and thickness range although the price hit the upper end. Based on the findings it was decided that the yield numbers had to be raised to a level where the MEL business proved more profitable than the average business in the grade.²

By the work of the project group UCR increased its ability to produce the product specified by MEL and many people in the UCR organization learnt a lot from the various discussions and exercises performed through the year 1996. Most importantly the investigations done by the group had extended backwards into several manufacturing operations not previously approached in relation to the cathode plate product and some of those operations were found to have substantial impact upon the final properties of the output product. Based on the findings a production route appropriate for the purpose was developed and brought into service. The opening sentence of a report of January 31, 1997, established by the production manager of UCR reads: “We have now developed a reasonably safe process route for [MEL] intended. It might be that the material is too short or too narrow for the purpose, or it might fail to meet the product specification for which it was intended along any other dimension. ‘Arisings’ occurs as the unintentional but unavoidable outcome of purposeful manufacturing. Technically ‘arisings’ may be considered ‘prime material’ but from a use point of view it does not fulfill the particular requirements raised by the customer for which it was drawn through production. Commonly ‘arisings’ is surplus material arising when producing a customized product for a particular customer. The material might find a suitable use in the market but usually it has to be sold at reduced price because it doesn’t conform to an approved product standard. The term ‘seconds’ may include ‘arisings’ but more commonly by ‘seconds’ is meant material that is suffering from some kind of defect whether the defect relates to physical, mechanical or design properties. ‘Scrap’ is material that is non-suitable for downstream manufacturing. It is re-circulated and goes back into the smelting process. ‘Waste’ finally is material that is lost at various stages along the product line and cannot be recovered. ‘Waste’ arrives as the result of grinding, de-scaling, and similar operations.

¹ See section 2.1.1 for explanation.
² It is worth noting, however, that the profitability analysis was based on data gathered during the years 1994/1995. Consequently the data represented one of the strongest boom periods ever seen in the stainless steel industry. Compare with the numbers shown in section 2.2.3 and Appendix 2.
material.” The report proceeded by specifying the operations to be performed at the various stages of production in order to arrive at the right product quality.

2.6.4 Doubts about delivery performance and the resolution of pricing uncertainties

Although a lot of work had been invested into appropriating the manufacturing procedures to fit in with the MEL product there were still doubts around concerning UCR’s ability to deliver on time. Production was now under closer control and the product quality had improved but apart from that too often the MEL orders suffered from short supply. In the mid 1996 there had been a shift of managing director at ASX. The Swede who had held the position since the sales company startup in 1992 had been replaced by a former sales manager of the UK sales organization of Avesta Sheffield. When commencing his new appointment the man was a true outsider in relation to the UCR-MEL business. His knowledge about the manufacturing procedures of UCR was superficial and the particularities of the UCR-MEL business he knew nothing about. He certainly tried to influence the business in a positive way but with varying results. As the business had suffered from poor delivery performance since long, he proposed that UCR should hold a safety stock of coil rolled to thickness for the MEL account. It is not known whether or not the proposal was his own invention, but it is clear that the new managing director of ASX pushed the issue forward. In an update report from late October Kennyson writes: “As yet [UCR] have not responded regarding the proposal to hold coil rolled to thickness at the mill as proposed by [the new managing director of ASX].”

The safety stock proposal was later rejected by UCR because holding a stock of material rolled to a final, non-standard thickness would constrain the opportunity to use the material for purposes other than those of MEL should the material not be used for the MEL account over a foreseeable future. The discussion was redirected into whether a buffer stock of white or black hot rolled coil\(^1\) should be held in the UCR mill for the account of MEL as a means to reduce the start-up time should an urgent need arise. The new managing director of ASX backing off from his safety stock proposal raised demand for 120 tons (two melts) of white hot coil to be stocked by UCR. After discussions back and forth the new managing director of ASX and the marketing manager of UCR (both Brits with a past in the UK operations of the Avesta Sheffield organization) agreed that UCR should store one melt of ca 70 tons of hot coil for the MEL business. In a mail of November 28 the UCR marketing manager

\(^1\) The output product of the hot rolling operation is a black hot rolled coil also denoted ‘black hot band’ (BHB). In the Avesta Sheffield production system hot rolling to coil is performed in a Steckel mill. The black coil is the input product for operations performed downstream in various cold rolling units, e.g. UCR. After arrival in a cold rolling unit the black coil is preparatory annealed and pickled and thus becomes a white hot coil ready for the cold rolling operation. By storing white band for a particular purpose the time from startup to finished product is considerably reduced. Also see section 2.3.3 above.
confirms the agreement: “Re stock. We agreed on the phone yesterday to put down one cast for [MEL] (c 70t). [Hanna] will confirm the timing.”

In this period of time MEL had a new large project under way should their negotiations with a major customer turn out successfully. The chance to become part of a large business project extending over more than two years made actual the issue of long-term pricing as to the business of UCR and MEL, and this was an issue that the new managing director of ASX found himself obliged to involve in. Again he directed his inquiry to the marketing manager of UCR. In a mail of late November 1996 he writes:

When we last discussed [MEL] you agreed to work out a price with which you would be comfortable taking into account all aspects of the product, the customer’s potential of anywhere between 3000 and 6000 tonnes and the fact that current pricing would make it very easy for a competitor to embarrass us.

… we need to understand what your longer term minimum requirements are, to allow us to talk sensibly to the customer about his longer term needs.

The answer arrived in a few days:

With regard to the long term minimum price I think we need to gain fresh experience with the new contracts to see what yields and processing times we achieve. My hope/expectation is that we will improve our performance both with the greater focus on this business and by having a regular flow through the plant. I propose that we together review our performance (and costs) after each contract and from that decide on any future change to our pricing especially since we have already reduced the price.

I accept that we may be vulnerable to competition especially if they priced with the assumption that they could achieve the required standard without difficulty.

As the price UCR charged MEL was high in comparison with the market price for standard material in the same grade and thickness the issue of price had been approached several times before in relation to the UCR-MEL business. It was just that the product specified by MEL was not a standard product, but indeed a very special product specifying super-narrow tolerances in regard to flatness and a very special surface finish. The reason the price issue had become particularly urgent to MEL at this point in time was the large project that was under way, a project that should stretch over more than two years of production for MEL should it materialize. Already in the summer 1996 Kennyson had raised claims to UCR concerning the need for robust pricing in relation to the project, and in September he had also called for price reductions (fax on September 16 to Hanna Almgren with a copy to the new managing director of ASX):

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1 Information is lacking whether the agreement comprised the stocking of black or white coil but it is likely that the UCR people reserved the right to themselves to choose at which level to put the stock from time to time. The expression “put down one cast” might even indicate that the marketing manager of UCR intended to make a reservation of one melt for MEL in the coil reservation system of the unit rather than physically locating a number of coils at UCR’s backyard.
I have had many discussions with MEL indicating to them that we believe that we can effect cost-savings during production, which we will pass on to them in an attempt to make them more competitive worldwide, and to use these comments to justify price reductions.

In the meantime MEL had lost a medium size project to Refinery Plant Construction Ltd – the competitor of MEL who had originally pulled UCR into cathode plate business a few years earlier – and it was clear that the order had been landed on price. Also Domestic Steel Ltd – MEL’s original supplier of stainless plate – was supposed to offer keen prices in the near future as they planned to withdraw from stainless steel business within a year or so and still had some material in stock watching for orders. Still another threat was brewing. The metals division of Outokumpu was likely soon to start discussions with MEL about a new refinery plant, and at the time that project would start moving the steel division of Outokumpu would certainly like to have a say in the matter. Such was the situation when the issue of establishing a robust pricing formula was raised to the top of the UCR-MEL business agenda. A proposal involving raw material pricing calculated in US dollars was worked out by the product manager (OJ) of UCR, and with the involvement of Kennyson, the new managing director of ASX, and the marketing manager of UCR the formula was approved in the late autumn of 1996. Before the end of the year MEL had secured a minor part of the large project and deliveries were scheduled for the latter part of 1997. In a fax of December 6 addressed to the product manager (OJ) Kennyson writes:

This is I believe a test, so to speak, of our combined abilities and as so much rests on first impressions, …, it is a golden opportunity for us to all cement our position as number one with [the large project].

Copies of the mail were also sent to the new managing director of ASX, the marketing manager of UCR, and Hanna Almgren, the inside sales person at UCR. By now UCR found themselves prepared to take on deliveries of cathode plate for the new large project that MEL were hopefully going to land.

2.7 Business Story Part IV: A second crisis and the handling of it

2.7.1 New equipment creates new problems and a second crisis

The modified production route UCR had created for the MEL business promised an improved product quality and in the early 1997 the attitude towards the MEL business was positive in the UCR camp. In the end of January an announcement from the production manager had told that a reasonably safe process route had now been developed for the MEL material. The new route included the operations of a new cold rolling mill – a major investment in UCR – that had recently been test run with good results. The new mill was designed to significantly improve manufacturing productivity in general. It was also preparing for the further extension of the thin end
of UCR’s product program. Soon it was brought into regular service but after some time in operation it was recognized that the number of surface defects had increased tremendously with the new mill. There were roller marks, rolled-in oxides, mechanical scratches, etchings, etc. and all those surface imperfections made the yield drop far below the normal for all orders expedited. In regard of cathode plate manufacturing the introduction of the new rolling mill was about to jeopardize the entire business with MEL. During a start-up period extending into more than half a year the new machine did not perform well, and, as it was built on the foundation of the old cold rolling mill, switching back to the old one was not an option as it wasn’t there anymore. Product quality in general collapsed and so did the quality of the product delivered to MEL, but as surface perfection was not a crucial issue as to the cathode plate product MEL could accept some defects that other customers would reject although the defects were found to be aesthetically inferior. While referring to MEL’s posture in regard of roller marks Kennyson writes:

Obviously, whilst they are accepting most of the roller marks as being not detrimental in service, they are concerned as aesthetically it looks very poor if there are too many marks per plate. I think that we need to be careful how we handle this acceptance in production. My concern is that plates with roller marks will be seen as the acceptable standard and the quality focus will go away. We need to keep the pressure on to find a solution to alleviate roller marks. If the roller marks appear to no longer be a problem then I feel that coils will no longer be reported as defected, and the problem will appear to have gone away.

I would suggest that we should not give the authority to the line operators to OK these marks. They should be still reporting/rejecting and have the Q.A. pass final judgement. This way the Q.A. will still have to file a report and the problem will still be highlighted to management. … I believe it is important how this is handled otherwise we could have more problems if people begin to make their own decisions.

Some surface imperfections but far from all could be accepted by MEL but as there was a vast amount of defects continuously appearing a lot of material was reallocated or scrapped on its way through the product line. Short supply and delays implicitly followed.

Not only surface imperfections hampered UCR’s performance during this period of time. A new stacker that had been installed a year earlier did not operate satisfactorily when taken into service for a new MEL order but was rough with the sheets. As a result a number of sheets went out of flatness. Carl Juhlin, the CTL line manager, suspected that maybe the material had been unevenly heat treated during the annealing operation, while leaving some material with more and other material with less built-in tension. Based on the appearance of the material in the cut-to-length line he compared the annealing temperature curves for a large number of coils. Juhlin faxed the curves to Hank Kennyson as enclosures to a message informing about the flatness problem:

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1 In a fax to Hanna Almgren and Carl Juhlin in late March 1997. The underlinings are the original ones.

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As we had different types of problems during the first batches we did not get many sheets per coil as you can see from the enclosed overview. … We scrapped lots of material due to difficulties of the flatness process. We needed to reset the leveler at one time because we had big difficulties to get within the flatness tolerance with margin.

The project group that had been appointed the task of improving the UCR performance in regard to cathode plate manufacturing a year earlier had now to address all new problems deriving from the investment in new manufacturing equipment. Under the guidance of the product manager (OJ) several meetings were carried through involving people from production, quality and quality assurance representatives, and logistics and inside sales personnel. Many people were involved but the quick positive outcome was conspicuous by its absence. Instead a second crisis was in the offing and this time more was put on stake as now big business was in sight. In early June it seems that the patience of MEL was exhausted and so was the patience of Hank Kennyson, who writes an open fax to the quality manager of UCR about the untenable situation. Copies of the fax are forwarded also to UCR’s new plant manager (FH)¹ and several functional managers in the UCR organization as well as to Kennyson’s boss, i.e. the managing director of ASX. Kennyson writes:

As you are all aware we have experienced extreme difficulties with the recent production of plates, which has severely jeopardized our possibility to be the number one supplier to [MEL] of approx. 3000T per year into the future. [MEL] are comfortable with our current efforts to reflatten the material received and incoming as we have not caused them any delays. They are however concerned at our ability to consistently produce to spec. at the mill. Whilst we have been reassured by your recent results it is still not enough to convince [MEL].

Now is the time when we need to produce a document along similar lines to that which was compiled for the KLCC project by I believe [TD]. … My idea is that the document should contain details of the production route with a step by step description of how each operation is to take place and the relevant test/check procedures at each stage. Every action needs to be included and given parameters – machine settings, line speeds, temp., shot blast pressures, roller leveler setting, stretcher tensions, loop heights and configurations, shear settings etc. Theoretically the document should be able to be the “recipe to bake a cake” – a very flat one at that.

At any stage of production I expect to be able to read the document and see that the steps are being adhered to, within reason, it goes without saying that not all of the feed behaves the same and that there is a need for variations. However these variations need to be justified and documented to enable a better understanding as to why they occur and what additional controls need to be in place to prevent them occurring. This may sound very basic, however I believe that if we don’t establish a base, we can very easily run-off track again if operators begin to individually interpret how it should be produced.

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¹ (FH) had recently replaced the previous plant manager of UCR, who had now retired after many years in leading positions at the unit. Prior to the appointment (FH) had held various positions as marketing manager and plant manager at other business units within the Avesta Sheffield Group.
What Kennyson actually asked for was a detailed quality plan for the safe manufacturing of the cathode plate product, i.e. a plan giving all the details and prescriptions step by step about how to produce the product. So far fire fighting had saved many critical supply situations for MEL as DSL had been able to re-flatten material that had arrived in X-land out of spec. But as DSL were about to close their stainless operations in mid 1997 there would be no possibilities left to perform rescue operations on X-land ground in the future. This had also been underlined by the marketing manager (WN) of UCR in the beginning of the year. A conclusive sentence mediated in the minutes from a January meeting reads: “This means no second chances!” In the first half of 1997 there was also a change as to the marketing manager position at UCR. The Brit that had run the role on a two-year contract now left for UK and in his place was appointed a former expatriate, a Swedish engineer that had been working for several years in the US and UK in various positions in the area of marketing and sales. Far back in time the man had worked in the sales department of UCR. The new marketing manager (KL) picked up the responsibility of the MEL business at a time when things were all but perfect.

It seems that the supply situation had become particularly crucial for MEL sometimes in the mid of the summer. The instructions to airfreight 14 tons of material from Sweden to X-land, as commanded by the plant manager (FH) of UCR in early August, serve as a good indicator of the disastrous situation. The marketing manager and Hanna Almgren, both on holidays at the time, are informed later by their superior via intra-mail:

Have talked to [the managing director of ASX] last Monday and told that we have sent 14 t by air last Monday. (Cost 404 KSEK, which is more than the invoice value for the order.) [He] wants some kind of buffer (ca 10 t) to make the customer feel safe. I have promised nothing, just told him that I understand what he says. You have to give some kind of answer to this during week 35 and an updated delivery schedule.¹

It was an extraordinary measure to send 14 tons of stainless steel by air across the globe and the action certainly shows that the supply situation was problematic during the summer holiday period. When back on post in the end of the month the marketing manager (KL) in a mail to the managing director of ASX and Hank Kennyson – with copies to the plant manager (FH) of UCR, the vice president of the Avesta Sheffield Group responsible for the Sales and Distribution Division, the director of marketing and business development of the Coil Products Division, and a few other people among those Hanna Almgren – acknowledges the unit’s poor performance and informs about two actions undertaken to remedy the troublesome situation. The mail commenced by describing how competently the day to day communication was handled by Kennyson and Almgren as to the UCR-MEL business and then it proceeded:

¹ Translation from Swedish by the thesis author.
I do agree with you that our past performance causes concern and we are doing two actions to safeguard delivery performance. The first is to increase our material in production for this customer so that rejected and stopped material should cause less of disruption at the customer. The second action is to rewrite our quality plan for this customer and thus reviewing our own procedures to more accurately handle problems. [MEL] is now one of [UCR’s] most important customers … We must work to improve our performance now when we have been trusted with even more orders all through 98.

The point was that earlier in August the first major order of the large two-year project had been landed by MEL and as UCR was still MEL’s single source supplier as to cathode plate the situation was indeed precarious. Big business, single source supply responsibility, poor performance, and involvement of high level officials close to the top of the Avesta Sheffield Group combined into a stressful setting for the UCR management to handle. As summer turned into early autumn the production people at UCR struggled with the processing problems relating to the MEL product and after a meeting with the cold rolled group Carl Juhlin is updating Hank Kennyson in a mail:

From now on we will have two technicians (metallurgists) working with trouble shooting. One of them will be connected to the rolling mill and work with questions like why we have all those roller marks, the shape control, surface roughness etc. The other one will work with the annealing/cooling process and try to analyze more in detail the impact the process has on the different thicknesses as we have had problems with that. I will give you more information of the outcome.

Our quality people are working with a QA plan for [MEL], which should be finished this week, I guess. I have seen a draft of it a few days ago.

We cut 6 coils yesterday with very good result, flatness and yield.

The information mediated to Kennyson was held in a positive tone showing that action was undertaken although little had been achieved so far. The overall impression, however, was that UCR had got stuck in a morass of low product quality and poor delivery performance. The business had encountered its second crisis due to UCR’s inability over a long time period to adequately fulfill the commitments given to MEL. The crisis was rooted in a defective manufacturing capability but it manifested itself also as a crisis of confidence.

2.7.2 Forming and operating a forum for discussions
The UCR marketing manager (KL) was seriously concerned about the inability of the unit to satisfy the customer’s requirements and became increasingly annoyed as it seemed that nothing was done about it. In an attempt to get the business back on the track he turned to one of his more experienced subordinates while asking whether the man was willing to take on the responsibility of forming and running a discussion
A forum focusing on the MEL business.\(^1\) This, he found, was a most urgent matter as the project group that had previously worked on the task under the guidance of the product manager (OJ) had closed down some time ago. The inquiry was raised in late September 1997 and within a couple of weeks the first meeting was arranged.

In the meantime Carl Juhlin, responsible for the cut-to-length operations, in a mail to Hank Kennyson complains about defect material arriving at the CTL line.

During the weekend we cut lots of [MEL] plates with a positive result. There were some coils with a bad surface standard, i.e. we had to scrap lots of material for that reason. One of the coils with a fairly good inspection record from L55\(^2\) was so bad that we cut off 226 meters as scrap, of those meters we had 50 due to flatness. So I have put aside 3 coils for reinspection because I have questioned the inspection routines in L55 and of the quality people. If there are surface defects which will be of severe kind and will be classified as scrap in CTL line that material must not pass to the CTL from L55 or other lines, it is waste of material, money, etc. I think as long as we can not assure a high surface standard or at least good enough, we should have a number of coils in stock so we are sure to keep the delivery on time. We seem to be behind the schedule all the time. We must always chase for more material when some coils fail. By experience we know that we will face this as long as we do not change or improve the general quality.

The message was very clear and straight to the point and Kennyson chimed in.

I am amazed that we still are trying to push coil to CTL which is not suitable from the point of view of surface finish. Who is allowing the coil to go to the CTL? Don’t we have a ‘kontrol’ document which should be adhered to, if we have, then someone is not aware of what it means. We need to sort this out quickly because as you say we are always going to be behind schedule when we don’t have back-up coil. Is [the marketing manager (KL)] aware of this or [the quality manager] or for that matter [the plant manager (FH)] as we need some action.

The communication exchanged between Juhlin and Kennyson increased the urgency of activating the discussion forum. The marketing manager (KL) in a mail to me, Hanna Almgren, and Carl Juhlin, with copies to the logistics manager and the quality manager, writes:

We have to quickly start our meetings concerning [MEL]. Since last summer I have promised that in case our process route is not reliable we have to work with a larger stock. However, this has been blocked primarily by [the quality manager] and [the logistics manager] who both claim that we don’t have a substantiated process route and therefore can’t lay down a stock. I can’t wait any more. The matter is about to explode and we have to be able to tell what we are doing. I will ask [the production manager] to raise the matter in the management team while asking for either the right

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\(^1\) The person asked to take on the responsibility of forming and running a discussion forum was me – Leif Linnskog – the author of this thesis work. For more information about my professional work as an employee in the Avesta Sheffield Group see section 1.7.1 above.

\(^2\) One of the annealing and pickling lines (the author’s comment).
to raise a stock or an instruction as to what answer we shall give. One thing is clear:
WE CAN’T WAIT A DAY LONGER UNTIL WE TAKE ACTION.¹

The logistics manager, a well educated young man, lately employed in UCR, had
raised complaints about the low production yield of the MEL business and while so
doing he had also questioned the profitability of the business. His logic was simple;
low yield in production signaled low profitability. He concluded that either the yield
numbers must come up significantly or the business ought to be abandoned, and the
appropriate action to take, according to him, was to develop a clear and safe
production route. Creating a back-up stock, he claimed, would just leave people happy
with the current standard of operations and the low yield problem would remain
unresolved. As a member of the management team he made a strong inquiry for yield
improving action, but in his role as the logistics manager of UCR he stubbornly
referred to average statistics based on steel grade, thickness and width when
calculating the volume of input material required for the production of a certain output
volume of the MEL product. However, because of the modified manufacturing
procedures the yield numbers arrived at when producing the MEL product were
significantly lower than those found in the average statistics for the steel grade,
thickness and width. During the cut-to-length operations, in particular, substantial
yield drop occurred as the coil ends were withdrawn and downgraded into seconds.
The unwillingness to adjust the input volume to the actual yield factor in combination
with the resistance to lay down a back-up stock resulted in a systematic mismatch
between ordered volume and produced volume. At each occasion of manufacturing the
output volume produced was too small to meet the volume ordered by the customer.

The discussion forum gathered twelve people for the first meeting all of them closely
tied to the operational handling of the MEL business, some of them also carrying
managerial responsibilities in the formal organization of UCR. The following
functions were represented in the meeting: production, quality assurance, technique,
technical market service, inside sales, logistics, and marketing. As an introduction I
informed about the profitability of the MEL business while, based on an actual ABC
calculation, showing that the MEL business for the financial year of 1996/97 generated
a profitability considerably higher than that of the UCR business at an average.² To
accentuate the significance of the business I also stated that MEL had now put orders
for several thousand tons at UCR to be expedited during the coming nine months. The
rest of the meeting came to focus upon two major issues, i.e. MEL’s product
specification and the manufacturing and delivery problems UCR suffered from. The
former issue addressed material flatness and surface roughness, the latter comprised

¹ Translation from Swedish. The capital letters comply with the original mail.
² After a peak in 1994 and 1995 the stainless steel market entered into a down period where the profit
from standard products dropped very low. The most efficient producers in the industry balanced
between profit and loss whereas most producers ran their bulk business with negative numbers. The
markets for special grades and some value added products to a certain extent resisted the decline.
Businesses based on customized products also defended their profitability levels fairly well. (See also
section 2.2.3 above and Appendix 2.)
delivery performance, water etchings, rolling marks, inspection, and material classification. The minutes from the meeting reported improvement proposals in four areas: delivery performance, water etchings, roller marks, and inspection/classification in L55. Under the subheading ‘delivery performance’ was reported:

Short term acceptable delivery performance is secured by starting more material and by placing a buffer stock of annealed coils rolled to thickness (already decided by the management team). Appropriate volumes are to be established in consultation with [the logistics manager].

The quality plan for the manufacturing of the MEL product was attached to the minutes with the comment “to be revised”. The plan had been established on the first of September 1997 and comprised twenty operations. During the meeting the operations had been discussed and some of them had been subject to modification. Afterwards Carl Juhlin informed Hank Kennyson via intra-mail about the main issues that had been covered in the meeting.

One morning a week later Kennyson in a mail to Hanna Almgren and the marketing manager (KL) of UCR writes:

Whilst I know that we have been having an abnormal amount of rejects it appears from what [Carl] has said that things are improving. We need to demonstrate to [MEL] that we are moving quickly to improve. I think therefore that we should immediately instigate the safety stock of 200T …

The mail also told about MEL running out of material due to postponed deliveries from UCR and that they should now be lacking material for several weeks. Some hours later a second mail from Kennyson arrives at UCR and now to the mailing list is added the names of the managing director of ASX and an order administrator at ASX dealing with the MEL account.

[MEL] cannot operate their business without deliveries being on time and the possibility is real that their management will cease to support them. The other option is that [UCR] will lose this business to others who may not be better and [MEL] management will close it anyway. Whichever way we look at it we need to keep [MEL] in business to have any chance at all.

Now things moved fast. The order administrator of ASX came up with a proposal of a weekly telephone conference involving people at UCR and ASX to be held “in order to assist in avoiding problems such as those that we are now confronted with”. His proposal involved the idea of arranging a telephone conference every Tuesday morning at 08.00 AM Swedish time linking together UCR with two of the branches of ASX. He proposed that “in this call we go through the progress of all files item by item documenting any problems and listing any corrective actions. If we have serious issues to resolve we have another meeting on the Thursday at 8.00 A.M.” He finally proposed a number of people to involve in the conferences. The proposal was approved and the telephone conferences soon became a routine.

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1 Translation from Swedish.
About a week later the logistics manager of UCR announced in a memo that now he had increased the amount of input material to be allocated for the manufacturing of the MEL product so that it better corresponded to the actual yield numbers achieved for the application. In his memo he also commented upon the “alarming low [yield] numbers” while claiming that “we have to resolve our problems, if the business is to be healthy long term”. He also announced that he was about to gradually build up a safety stock of 200 tons of material rolled to thickness. The measures taken as to the allocation of input material were of outmost importance for the future business with MEL. From now on the chance to well serve the customer had increased as now the material flow through the mill was balanced. Still things could certainly fail in course of the manufacturing process but the systematic miscalculation as to the allocation of input material had been corrected.

A couple of meetings followed during the autumn and early winter within the format of the discussion forum. Certain issues were elaborated, tests were performed, and information was exchanged. Over time the MEL business became less dramatic and manufacturing gradually turned into the normal. In mid December the discussion forum was closed. My final report stated: “Our business with MEL is attractive and should be given priority.” The following arguments underpinned the statement: (1) the business is substantial (several thousand tons in a year) and it addresses a fairly well defined product, (2) the business is profitable well over the average through an entire economic cycle as it doesn’t suffer from poor profitability during periods of recession\(^1\), and (3) the product specified by the customer is not easy to produce implying that it is not easy for competitors to break into the business. To the third point was connected a discussion of long-term relationship including learning and productivity improvement opening for reduced manufacturing and handling costs, gains that could be shared by UCR and MEL in the future if realized.

Two issues relating to UCR’s manufacturing problems were given priority in the final report, (a) the low yield in production, and (b) the need of a buffer stock. The former was thoroughly penetrated by stepwise calculating the factual “loss of material”\(^2\) at each stage along the modified manufacturing route adapted to MEL’s specification. It was found that the yield loss of the “MEL route” was two times as high as that of the “standard route”. The result confirmed what was already known by people dealing with the MEL business as part of their everyday work, i.e. as long as standard yield numbers had determined the amount of input material that was started for the “MEL

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\(^1\) Periods characterized by strong demand and high prices for stainless steel in general put the profitability of the MEL account at a level similar to that of the average business in the grade but during recession periods the profitability of the MEL account by far exceeds the profitability of most businesses in the same grade and range of dimensions.

\(^2\) By “loss of material” is meant that portion of the input material that never reaches the customer, i.e. material that is reallocated, downgraded, or scrapped during the various operations along the product line.

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route” every order by necessity had to end up undersupplied. Thus, the report supported the decision made a month earlier to increase the input material to match the yield numbers historically achieved in production. As to the latter issue the report justified the need for a buffer stock because of the difficult product specification, and by now the issue involved no more controversy as it was broadly agreed that uncertainty was still around. It was not a given that manufacturing should produce the right quality each time. Concerning upstream operations uncertainty was particularly evident as UCR’s possibilities to constrain steel mill and hot rolling operations were most circumscribed.

2.7.3 The pricing issue revisited

Besides the problems relating to manufacturing and delivery performance the price issue was still an obstacle. At the time the first major order of the large two-year project was landed by MEL in August 1997 the issue of pricing was given increased priority, as MEL was now facing increasing competition in the market. Already a year before MEL had began rewriting their product specification while aiming at specifying a cheaper product linking closer to common standard. Thus, a leaner steel composition was proposed and a thinner plate as well. Plate thickness was proposed to be reduced by some 5% placing it in the narrow end of the tolerance interval. The adjusted measures were proposed as a possible way to reduce costs and UCR was much cooperative. The leaner steel composition was no problem and UCR immediately said “yes”, although, for whatever reason, it seems that the change never materialized. Some test manufacturing of material with reduced thickness was performed sporadically in the UCR mill during 1997 but with discouraging results. The flatness problem seemed to escalate with decreasing thickness. Orders that were booked by MEL in the UCR mill through the years 1998 and 1999 show that neither was a leaner steel composition specified nor was a reduced plate thickness prescribed. In case MEL succeeded in reducing costs it was obviously achieved elsewhere.

After the peak in 1994/95 the stainless steel market slipped into recession and in 1996/97 the prices for standard grades and products hit the low end. Simultaneously raw material prices went low. As a result the price gap between standard and customized products grew larger and the change occurred at a time when MEL saw a new large project being under way. Now, from MEL’s and UCR’s perspective the project was afflicted with a particular problem as Outokumpu (one of Avesta Sheffield’s main competitors) shared ownership in it. And as Outokumpu was active both in the mining and in the stainless steel industry it was close at hand to assume that they would involve in cathode plate bidding at the time the project was opened for bids. In an e-mail received by the marketing manager (KL) of UCR and Hanna Almgren in late October Hank Kennyson writes:

… it is inevitable that [MEL] will come under pressure to use their [Outokumpu’s] material and in fact [MEL] have already indicated to me that they are expecting this to
happen. Whilst it is unknown if they can be competitive or in fact can produce to [MEL] spec. it would not be in our interests to give them a chance.

…..

We need to be proactive and I suggest that we should revisit our pricing as we had originally told [MEL] we would, once we had produced plates over an extended period and were able to evaluate our production costs. We are now in a position to review our ABC analysis on costs and see where we stand, if this has not already been done, mindful that a lot of the low yield problems have been overcome as indicated to me by [UCR], and that we are now running more smoothly, so we should focus on the ABC which relates to “smooth” production.

[MEL] are aware of the falling nickel raw material prices etc. and it would be reasonable to expect there to be some reduction. If we can offer some reduction we can couple it to some form of formalized agreement with [MEL] into the future, during my visit to [MEL] the next week.

Sooner or later we are going to be faced with the pricing issue and I would rather it be done under our control and timing.

The mail also asked for a precise price offer in response to a minor enquiry that ASX had received from MEL, and this was obviously the only issue that the marketing manager (KL) of UCR responded to, because the next day Kennyson reverts to him and Almgren but also involves his own superior, the managing director of ASX, on the mailing list.

Obviously I haven’t communicated well. Firstly thank you for the [price]. However, what I was trying to do was to initiate a discussion regarding a longer term approach say over 3 years where we commit to a rolling cost reduction as and when it is achieved by the mill.

…..

I would like to be able to say to [MEL] that within a given timeframe we will aim to return to them savings of “x” in increments of “y” based upon actual achievements by the mill. … In other words show them that we are genuinely striving to improve not only for us but for them and thus grow the business in partnership. We need to develop an open and honest relationship which make it difficult for others to drag [MEL] away from a commitment which they have entered.

Two weeks later Kennyson reminds about the issue a second time:

[the managing director of ASX] and I are traveling to [MEL] next Tuesday and would like something upon which to base some initial discussions on price reduction.

Two days later the marketing manager (KL) of UCR is responding:

Thank you for reminding me about this issue which I discussed with Hanna last week and promised to come back to you with a response.

As you know Carl Juhlin, Leif Linnskog and others are busy trying to pull together a long term sustainable production route for our orders to [MEL]. So far my interpretation is that progress has been made in understanding our problems and they are big but very little progress has been made in solving these problems which now are as big as they were 1 to 2 years ago. IN OTHER WORDS THERE IS NO
PROGRESS TO BASE A PRICE REDUCTION ON IF THEY NEED TO RELATE LOWER PRICE TO PROGRESS IN YIELDS OR PRODUCTIVITY. We are not negative to price changes but we cannot relate them to better performance so we must find another reason for price adaptation to market realities.

Personally I am very worried in being the sole supplier to [MEL] with our present performance and our ability to improve. Sorry for being so negative but the truth must be understood by everybody. Any good ideas from your end are welcome and remember that we have still not given up and Leif will keep you posted on our latest investigations.

The marketing manager was right in regard of yield numbers and productivity when considering the development of the MEL business over time but at the same time the business was very much profitable and particularly so during times when the stainless steel market was weak.

In late November 1997 a board meeting was held at the X-landian subsidiary of Avesta Sheffield. The director of marketing and business development of the Coil Products Division carried the responsibility as the chairman of the board and he used the opportunity when in X-land to visit some major customers of the Group. The number one customer visited was MEL. After a common description of the products and technologies involved his traveler’s report reads:

Thanks to the efforts of the [X-land] sales team in conjunction with [UCR], we are currently 100% supplier to [MEL]. However, this has not been without difficulties. After establishing an initial process route, various changes at [UCR] since Summer 1995 have led to consistent failure to meet schedules, together with significant rework in [X-land].

Leif Linnskog is now heading a cross-functional project team aimed at stabilizing performance through the mill and ensuing sufficient quality hot band is placed in a buffer in front of the process. A weekly telephone conference is also held. With greater general stability evident at [UCR] since the summer, it is to be hoped that the performance to [MEL] can be upgraded to that achieved for Alfa-Laval.1

In the Managing Director’s Commentary presented at the board meeting the MEL account is described as “the single biggest contributor to our success.” But the MD of ASX also forwards his concerns about the way the business is run. He writes:

We have been battling very hard to keep this account happy. [UCR] are receptive, if somewhat slow, to our suggestions and we are undoubtedly making progress. However we have a very long way to go before we can count this as a safe account. On the other hand, [MEL] themselves have nothing but praise for our ability to solve their problems. While the problem solving has been effective, it has been more in the nature of fire fighting, rather than real step changes to our long-term performance. It is difficult to hit the right tone to describe the situation, without appearing to ignore the

1 A similar project work was performed earlier as to UCR’s business with Alfa-Laval Thermal, another key customer of the unit.
efforts being made by [UCR], but I am concerned that we are not making sufficient improvements quick enough.

Apart from the quality issue, there is also that of price. We sell at something like [xx %] above current market prices, and are therefore very vulnerable. On the other hand, [UCR’s] yields are very poor. It is a difficult product and should always command a premium. We have approached [UCR] and told them we need to address the long-term pricing to this customer by offering a year on year cost reduction program that reflects their improving yields and longer production runs. Their reaction has been sympathetic, but I believe that we will need to push them to give this issue considerable priority. In a sense, the higher price we are charging the bigger the comfort zone and therefore the lower the urgency for improvement.

When 1997 turned into 1998 UCR had been supplying MEL cathode plate for four years. During these years the business had developed tremendously and many problems had been solved, whereas other problems were left unresolved. There were still doubts in various camps about UCR’s ability to manufacture and deliver according to schedule, an issue that had created much debate and information exchange through the years. Pricing was also still an issue and particularly so in times of receding market prices for standard products. All the time competition was there eager to break into the business because of the large premium that was paid for the customized product, a premium that bulk producers found very attractive especially during periods of recession, i.e. when both demand and price for standard products were low. But it seems that competition every time based their offers on insufficient information either they were lacking knowledge about the difficulties accompanying the manufacturing of the customized product or they just ignored the difficulties. Through the years standard material was used in several refinery plants but in most cases with poor results.

2.8 Business Story Part V: Performing business in a mature relationship

2.8.1 A new strategic direction, new problems and the “final” solution

Work done in connection with the discussion forum and elsewhere in the UCR organization contributed to the unit’s ability to manufacture and deliver the MEL product according to schedule. The adaptation process had been slow and difficult but after several years of business exchange and lengthy discussions involving pros and cons the necessary modifications had been done and manufacturing procedures and logistic routines had finally been tuned for the purpose. However, it is worth mentioning in this connection that UCR’s business with MEL comprised just a few percent of the unit’s total annual output, and against this background it is important

1 The factual data are hidden for reason of confidentiality.
also to understand that the difficult customized product manufactured in accordance with the MEL specification was to be squeezed into a production system where a large variety of products were produced, the bulk of which was made up of large volumes of standard products demanding highly efficient manufacturing operations to be performed at high speed. The fact is that UCR is running an extremely complex production system and if considering also upstream manufacturing operations the picture becomes even more complex.

In the beginning of 1998 the MEL process technology manager (MM) is planning a business tour to Europe and announces that he would like to pay a visit to the UCR premises in Sweden. Kennyson prepares the visit by proposing several issues for discussion and as the meeting is carried out UCR personnel from production, quality, logistics, and marketing and sales participate. Half a year after the visit the UCR people receive information from Kennyson telling that (MM) is about to leave his position at MEL for another, more prestigious job within the mining group that MEL belongs to. In a formal letter directed to Kennyson and the ASX crew (MM) writes:

I believe that the [MEL] Process Technology along with its partners will remain the premier [metal] electro-refining and electro-winning providers, going forward into the future and will only go from strength to strength on the back of our current developments. The supply of our stainless blanks by Avesta to high quality standards and competitive pricing is proof of such strong partnership. On a personal note, I have enjoyed immensely the dealings I have had with yourself and the Avesta team over the last two and a half years and know that the relationship has helped broaden my professional outlook.

The process technology manager position of MEL was now filled by the person (LN) who had held the position prior to (MM). The solution secured no discontinuity would appear in the business contacts between UCR and MEL.

Business exchange between UCR and MEL flourished in 1998. The large two-year project was running and a steady flow of material left Sweden for X-land with little friction involved. Now and then, though, problems appeared. In late 1998, for instance, Carl Juhlin quite excitedly reports to Hank Kennyson: “We are facing flatness problems again.” The problems, which were soon resolved, had probably been caused by inappropriate hot rolling in the Steckel mill. Another episode tells about a large batch of material that had been too heavily pickled due to an administrative mistake. The inspection system of UCR identified the defective material and corrective action was taken. Still another incident tells about material out of flatness arriving at MEL forcing them to reorganize their assembly activities while losing out on productivity. But such minor “crises” were handled quite routinely within the frame of the mature relationship between UCR and MEL. Sometimes problems were solved locally while at other times involvement of the other party was required.

This was also the time when UCR got a new plant manager as the former one left for a professional position outside the Avesta Sheffield Group. The new plant manager (JL)
had worked for the Group in the area of precision strip manufacturing\textsuperscript{1} for several years, and as UCR’s new cold rolling mill (V3) was designed to roll wide material to thin gauges a new strategy of UCR focusing on thin material gradually evolved under his leadership. In the mid spring of year 2000 the plant manager (JL) in an interview in a local newspaper\textsuperscript{2} announced that a major investment was under way in the UCR plant. 148 million Swedish kronor were about to be invested in a new slitting line. The purpose of the investment was to enhance the processing of thin material.

The new equipment will make possible the processing of thinner steel coil. Going from the current average thickness of 1,04 mm to an average thickness of 0,8 mm. …

The market pays more for thinner gauges and with the new equipment the coil weight and width of our products will increase. That implies we will become more cost effective and we will occupy a more optimal position in the market.\textsuperscript{3}

The new strategic direction rendered the MEL business a less favorable position in the customer portfolio of UCR as the MEL product was positioned in the thicker end of the unit’s cold rolled product program. Through the last few years before the shift of millennium the new plant manager (JL) with an eye to the future prioritized the thin product strategy, and, as he did, he also chased manufacturing costs. The upper official of an organization is commonly supposed to set the overall tone for the operations of the organization (at least to a certain extent). And in this particular situation several subordinate managers at UCR adopted the attitude of the plant manager (JL) and began to show less interest in cathode plate manufacturing. The business was still prioritized and procedures and routines were in place for its execution, but it did no longer gain the undisputable support from the management.

With the new slitting line in sight Carl Juhlin was soon transferred to the new project, and by then the old slitting mill was left in the hands of new personnel. To reduce costs the new plant manager (JL) took all inspection people off the old line, while leaving to the line operators to take the full responsibility for the manufacturing outcome. The result was not long in coming. The product quality as to cathode plate manufacturing went down markedly and the business slipped into a poor condition. “Unless [Carl Juhlin] was involved and his responsibility was elsewhere, no-one actually had the responsibility; not the quality people, not the production people, no-one” Kennyson claims in an interview a few years later.\textsuperscript{4} The quality plan was still around to guide manufacturing operations but detailed instructions were lacking. From a manufacturing point of view the MEL product was now more than anything else looked upon as a standard product, an approach that was certainly not appropriate for the manufacturing of a high quality customized product. The responsibility once shouldered by Carl Juhlin had not been transferred to (or picked up by) anyone else.

\textsuperscript{1} I.e. thin cold rolled material.
\textsuperscript{2} Eskilstuna-Kuriren.
\textsuperscript{3} Eskilstuna-Kuriren, March 6, 2000, page 4, translation into English by the thesis author.
\textsuperscript{4} Interview with Hank Kennyson on November 22, 2001.
During these years Kennyson encountered increasing difficulties to render his mission support. In an attempt to influence the operations for the better he visited the UCR mill more often. The quality plan was still in place but as neither the line operators nor the quality people were really prepared to seriously take on responsibility for the manufacturing its execution to a large extent was guided by standard operating procedures. The special operator knowledge that had been gained as a result of customer related development work a couple of years earlier was now lost (or dispersed) to a certain extent due to organizational changes and new employments. Whether the decline was rooted in new personnel not knowing about the specificity of the MEL product or in a general shift in the business climate of UCR is difficult to say. Maybe both are viable explanations.

It is clear that the knowledge of how to successfully produce the MEL product had been in place quite recently in the UCR organization. But whether that knowledge had been written down and saved in documents for others to learn from that is another issue. If the information had been documented “inventing the wheel a second time” would not be necessary. So, the core question was: Had somebody put the information down in writing? Kennyson gives a straight answer to the question:

No, they hate that. I mean, there were some loose control documents, but, I mean, I have given talks to everyone on that plant when I was over here for about four or five weeks, trying to get people to better understand what the process involved and the reason for why they [MEL] wanted things. And of course, with the change of management it just became a thing of production. …”Can’t you make this thing go faster?”

In summer year 2000 Kennyson visited UCR and in a meeting he raised the question whether somebody would be willing voluntarily to shoulder the responsibility for the manufacturing of the MEL product, i.e. to be the “eyes and ears” of Kennyson in the UCR mill, as now Carl Juhlin was no more available. A quality assurance (QA) guy put up his hand saying that he was willing to take on the responsibility, which he was also immediately assigned. Although much information about how to manufacture cathode plate had never been written down most of it was probably still lying by those who had previously been working with the product, but, if so, the information was broadly spread among a large number of employees. Initially the work of the QA guy was directed towards the detailed mapping of all machine settings and control numbers that were known to produce a high quality product. Bringing all information together was a comprehensive task requiring both much time and energy. As the mill went on producing cathode plate the product outcome was regularly crosschecked against the procedures and routines that were successively redeveloped, written down and taken into service. Kennyson describes the detective work performed by the QA guy and the effect it had on the manufacturing of the MEL product as follows:

He’s put in place a whole series of … documenting the procedures back to basics. So that we set the machine … Well, first of all we are not going to set the machine. We

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1 Ibid.
clean the machine down. We have the maintenance people coming in. Check everything out and then we lump together all these small orders, which we have had, into a campaign, which will last two or three days so that we then go back and zero all the equipment. And he has also written a control document, which tabulates all the setting on the equipment, that your inlet gap is 0.84 and the outlet 3.5 and that’s this and its so, so anyone can come along and press the buttons to make these numbers come up, whereas previously it was a mystery.

... And it has taken a bit of mystery ... off the operator. ... Within reason you still have to have a lot of feeling with the equipment, but, within reason, if you put the right numbers in ... within reason, the right stuff should come out in the end.¹

Within a year from start-up the entire process involving several procedures and routines had been reworked and written down. And even more important the product quality had recovered. In November 2001 Kennyson comments upon the new process with reference to a recent shipment: “This shipment here has been done using that process, and, we’re quite honest, it is the easiest I’ve ever seen in advance.”²

2.8.2 Unit Cold Rolled loses a major contract to Outokumpu

In the late autumn of 1998 North European Mining Ltd (NEM) – the mining company that had once introduced UCR into the business with MEL – was about to extend their refining capacity and they approached MEL to get an offer for further refinery equipment. MEL offered a price that NEM considered as much too high while referring to an option signed by MEL at the time they had got the original order from NEM back in 1995. The option was based on a formula involving steel plate pricing and local inflation. MEL, and indirectly UCR, was now put under pressure to reduce the price and the numbers that had been used in 1994/95 were asked for in order to up-to-date the prices in line with the formula. In the meantime NEM also scanned the market to learn about the current market price. After a lot of calculating and information exchange in late February 1999 Hank Kennyson sketched his view of the present situation and forwarded it to the marketing manager of UCR (KL), Hanna Almgren, and the management team of ASX in a comprehensive e-mail. At the time the process technology manager (LN) of MEL was in Europe discussing the issue with the NEM people. Some excerpts from Kennyson’s mail read:

[The process technology manager (LN) of MEL] who is currently over there has had a meeting with [NEM] who indicate that they ([NEM]) are seeking an alternative stainless supplier due to price.

.....

¹ Interview with Hank Kennyson on November 22, 2001.
² Ibid.
Whilst it has not been [MEL’s] policy to manufacture from free issued plates it appears that [NEM] are being forceful and it is not surprising given the current differential with std. CR T316.1

.....

It isn’t the first time [MEL] have been confronted with this approach, however the differences haven’t been as great, which adds weight to [NEM’s] argument.

I think that [NEM], if they choose another supplier, need to ensure that their supplier has legs on the ground out here if anything goes wrong, which it does even with our experience, and are prepared if required to airfreight replacement plates as we have and more importantly are holding at the mill whiteband of a non-std gauge to produce replacement plates. Maybe if they can get these reassurances the price difference will not be as great.

.....

We need to get to someone at [NEM] to ensure they are aware of all the side issues that we have learned from painful experience, we need to be up front with them in the same way that [MEL] have been. This will maybe make another supplier reconsider their offer if they are aware of all the pitfalls.

A week later a fax from Kennyson to UCR commences “Not a good day”. It proceeds by informing that the NEM project was now placed with another steel supplier, namely Outokumpu. The process technology manager (LN) of MEL had tried all possible arguments to convince NEM to use Avesta material but without success. The MEL specification had also been discussed in detail with people from Outokumpu “who said that this was normal cold rolled off their production line??”2, and NEM had decided, notwithstanding the potential problems that had been described in detail by the process technology manager (LN), to free-issue plates to MEL produced by Outokumpu. Kennyson’s fax proceeds: “Whilst [MEL] don’t want to go this way, if their customer adamantly said that they will supply, they must accept it and help them.” Then the fax turned into the necessity of establishing a long term supplier agreement between UCR and MEL including a formula of transparent pricing in order “not to jeopardize the potential for [MEL] to win projects [at a time when the market for metals is low]. Whether we like it or not we have been forced to appraise our price and to decide what premium we want for long term on this product. Out of this we have an opportunity now that they [MEL] are talking long term supplier agreement, to put to [MEL] a proposal and sign an agreement before Outokumpu can prove if they can or can’t produce to [MEL] spec.”

The question remains whether Outokumpu succeeded in delivering high quality material to MEL for the NEM project. The answer is positive. They performed fairly well. MEL had to lessen their requirements somewhat but most of the material was delivered according to spec. It was good material and MEL later told Kennyson that

1 Standard cold rolled 316-type material according to ASTM.
2 The quotation including the question marks is brought in from Kennyson’s fax to UCR of March 3, 1999.
“you know, it was a pretty good shot for the first time they produced this material, to get so close.”¹ But Outokumpu took a fairly dogmatic approach: “This is what we’re going to get.” They took on the old mill approach: “We are the mill. We produce this. This is what you gonna get.” It seems that there was a kind of misfit as to the modus operandi of the two companies. Afterwards MEL has admitted that they didn’t feel comfortable with the business style of Outokumpu. But the episode served as an igniting spark for the first real formulation of a sensible pricing formula between UCR and MEL, a formula that was later further developed.² However, at this point in time UCR’s management was not particularly optimistic about the possibilities to reduce manufacturing costs by increasing productivity. They claimed that new investments were needed both in line L55 (one of the annealing and pickling lines) and in the CTL (cut-to-length) line for substantial productivity improvements to be achieved. Such investments had been discussed to some extent in the past but so far no proposal had been presented to Avesta Sheffield board of directors.

2.8.3 The creation of AvestaPolarit and a merger effect

The first rumors about a pending merger between Avesta Sheffield and the stainless steel division of Outokumpu were spread in the early autumn of year 2000, and within a few months, more precisely on the first of January 2001, the merger was a fact. With the establishment of AvestaPolarit the second largest stainless steel producer in the world was born. What had been announced as a merger should soon turn into an acquisition as the Finns took the lead in several ways. They gradually increased their ownership and after a few years AvestaPolarit had become a fully owned daughter company of Outokumpu Oyj. As a consequence the company soon crossed off from the stock exchange.

For the cathode plate business of UCR the merger caused a new situation. The market competition that had previously appeared at the interface between UCR and the former stainless operations of Outokumpu had become an internal issue as both parties were now part of the merged multinational corporation AvestaPolarit. Whether UCR should go on producing cathode plate for MEL or this particular business should be transferred to Tornèå³ was a matter for the new corporate management to determine. It was finally decided that UCR should take care of the cathode plate application, but some other products of UCR were transferred to Tornèå. The overall division of the product program gave responsibility for special grades and niche products to UCR, whereas most of the bulk products concentrated in Tornèå. The corporate management had taken a clear standpoint in the matter and that seems to have made the UCR management change their minds about the MEL business. Maybe the message from

¹ Interview with Kennyson November 22, 2001.
² Ibid.
³ Tornèå is a town in northern Finland situated close to the Swedish border. Prior to the merger most of Outokumpu’s stainless steel operations were concentrated at a large integrated site in Tornèå.
the top also involved an instruction prescribing that the business should be treated with care (who knows?). Be that as it may, but Kennyson reports that there was a positive shift in attitude from the UCR management in regard of the MEL business after the merger.

Another factor of major importance for the MEL business was the gradually improving yield numbers that were reported from the production department of UCR. Certainly this circumstance also influenced the attitude of the UCR management in a positive direction. The improvements followed on the reestablishment and further development of the old manufacturing processes that had been operating for quite some time in UCR before the “new thin strategy” had insensibly been enforced upon the unit. The yield difference between the manufacturing of cathode plate and standard products in the same grade and size had decreased by one half with a strong impact on profitability. And those improvements derived altogether from the development work of one particular individual viz. the QA guy “eyes and ears”.

2.9 Reflections and inquiries

The empirical chapter of the thesis narrates a comprehensive story, a story that may stimulate to reflection as it challenges the more stereotype view of what technological change may be. Without really knowing I guess that the stereotype of technological change, held by many, is researchers and engineers performing experiments and development work behind closed doors, and that the resulting outcome is showing up on the market in the form of various products. The view of technological change as mediated in the business story of the thesis is something different. Several technologies are presented and discussed in the empirical case and many actors of various kinds, be it individuals, groups of individuals, departments, business units, companies, or industrial groups, are obviously related to the technologies in various ways. But what is actually the source of technological change? Who or what makes it come about? Before approaching questions of the kind by necessity a few other more fundamental questions have to be approached, viz. What is technology? and What is technological change? Chapter 3 aims at conceptualizing ‘technology’ and ‘technological change’. The chapters 4 – 7 are focusing on the main research question of the thesis, i.e. How does technological change come about in an international, industrial system? Chapter 8 is forwarding a conclusive summary of the thesis work.
3 MANIFESTATIONS OF TECHNOLOGY (THEORY)

The concepts of ‘technology’ and ‘technological change’ are discussed and ascribed significance. Material artifacts and organized processes as structural manifestations of technology are elaborated while relating to technology utilization and technological change.

3.1 Technology, knowledge and skills

What is technology? How to understand the concept of technology? And how does technology relate to knowledge and skills? Questions of the kind are certainly relevant and particularly so in the era of information technology (IT) that is currently present in contemporary society. In some contexts everything is technology, whereas technology is conspicuous by its absence in other contexts.

3.1.1 Technology here, there, and everywhere

Technologies when applied transform and move matter and information in space through time. Any significant change caused by man is the result of the application of some kind of technology. Modern living is characterized by a widespread use of an almost infinite number of technologies. The wealth of our entire society is based on the employment of a multitude of different technologies. But also the most terrifying threats against single individuals as well as mankind as a whole emanate from existing man-created technologies or technologies to be created in the future the effect of which we can only speculate today. The technology phenomenon concerns all of us as the life of modern man is saturated by, and at the same time largely depends on, services offered by a large variety of technologies. No matter which level of human aggregation is brought into focus, the single individual, the group, society, or mankind as a whole, technologies strongly influence and to a large extent determine our lives.¹

In everyday life the word technology is associated with products, equipment and manufacturing processes. Contemporary society is flooded by bits and pieces saturated with technology. Toys and leisure equipment (including computers) the technological content of which is taken for granted occupy much of the interest and time of the rising generation. Similarly, adults and elderly people pass their time in front of the TV or with various technical things like cameras, computers, cars and so on. For many people technology has become a demanding creature calling for attention and time. Some live their lives in cyberspace. Many more find themselves captured in

¹ At a colloquium in Colmar in April 1985, arranged by the European Science Foundation, Georg Henrik von Wright gave a lecture entitled “Images of Science and Forms of Rationality”. The lecture developed into a book that was published in 1986: “Vetenskapen och förnuftet” (“Science and rationality”). Those who are interested in reading a critical review of today’s strongly rationalized and instrumentally technicalized society may approach von Wright’s thoughts.
technology is also an important ingredient in the world of enterprising. But then, what is technology and how does it interlock the physical world with human interests and activities?

3.1.2 Technology defined

There is a bundle of words that we relate to and sometimes confuse with technology, words such as knowledge, skill, competence, capability, routine, procedure, recipe, process, etc., etc. It is necessary to be precise about the conceptual meaning of technology if aiming at making trustworthy a study of technological change. Semantically the word technology is formed by combining ‘techno’, from Greek ‘techne’ for art, craft, practical skill, with ‘logy’, from Greek ‘logos’ for word, reason, speech, account. General definitions of technology are “the science of the application of knowledge to practical purposes, applied science” and “a technical method of achieving a practical purpose” (Webster’s Dictionary, [1961] 1993). Philosopher Georg Henrik von Wright (1986, p.33-34) adds some flesh to the bones. He discriminates between three related concepts: technics, technique(s) and technology. Technics is the “production of artifacts (‘artificial’ objects and other things) for a purpose”. Technique(s) is the “capability or skill (the ‘methods’) needed to bring about the artifacts”. Technique refers for example to the course of action of the craftsman or the artist. As regards the concept of technology von Wright writes:

> By technology I will understand technique, which is founded in scientific knowledge, in an insight into that logos that constitutes the ground for techne, i.e. familiarity with the rational principals (natural laws), that the technician applies in his work (von Wright, 1986, p.34).2

But nowadays the two concepts technique and technology are often used as synonyms according to von Wright.

From the general definitions (Webster’s Dictionary, [1961] 1993) follow that technology is considered the science dealing with the application of knowledge for practical purposes but also that technology may be regarded as a method employed for the achievement of a practical purpose i.e. technology as a technical (and systematic) procedure used for the attainment of an objective. The latter meaning of technology corresponds with the meaning of technique according to von Wright. Thus technology may be given (at least) two slightly different meanings. The former emphasizes the practical interpretation of scientific knowledge and the meaning of technology application. The latter is more directed towards the ordering and structuring of

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1 With reference to Appadurai’s (1990) ‘imagined worlds’ Lash and Urry (1994) mediate five dimensions of global cultural flows, i.e. ethnoscapes, technoscapes, finanscapes, mediascapes and ideascapes. Technoscapes are defined as “the movement of technologies, high and low, mechanical and informational, across all kinds of boundaries” (Lash & Urry, 1994, p.307).

2 The quotations are translations from Swedish to English made by the author of this thesis.
operations. Technology as method has to do with action and performance. Its destiny is both practical and normative. When technology is elaborated in an industrial context the latter connotation of the word is probably more often the one referred to and then technology is synonymous with the concept of technique or manufacturing method. Broadly defined technology is knowledge and skills applied for a practical purpose either science-based or not. “Organizational competencies refer to the fundamental knowledge owned by the firm” whereas “organizational capabilities refer to the firm’s ability to use its competencies” (Métais et al 1998, p.298). It follows then that a firm’s set of technologies consists of the purposeful combination of its competencies and capabilities.

3.1.3 Knowledge and skills

Knowledge may be divided into ‘objective knowledge’ and ‘experience’ (Penrose, [1959] 1995). The former “can be learned from other people or from the written word, and can, if necessary, be expressed and transmitted to others. … Experience produces increased knowledge about things and contributes to ‘objective knowledge’ in so far as its results can be transmitted to others. But experience itself can never be transmitted; it produces a change … in individuals and cannot be separated from them” (p.53). Polanyi ([1966] 1983) starting out from Ryle’s (1949) expressions “knowing what” and “knowing how” identifies two aspects of knowledge: ‘explicit’ and ‘tacit’. ‘Explicit knowledge’ in Polanyi’s vocabulary is equivalent with Penrose’s concept ‘objective knowledge’. It is “knowledge as object” or “knowing what”, which is different from ‘tacit knowledge’, which is proposed to be “knowing as action or enactment”, i.e. “knowing how” (Nahapiet & Ghoshal, 1998). The latter is similar to what Penrose denotes ‘experience’, i.e. “knowledge acquired by doing”, which is interrelated with ‘skill’. “By a ‘skill’ we mean a capability for a smooth sequence of coordinated behavior that is ordinarily effective relative to its objectives, given the context in which it normally occurs” (Nelson & Winter, 1982, p.73). The degree to which knowledge is teachable and/or articulable determines its level of tacitness (Winter, 1987). Knowledge then could be considered as tacit to the extent that it cannot be codified and abstracted.

Skills commonly involve a certain (often large) portion of tacitness. ‘Experience’ closely relates to action, as does ‘skill’ - the capability to smoothly coordinate behavior – but there is an important difference between the two as regards their relationship to action and time. Experience is knowledge acquired by doing, which implies experience follows on doing. Thus, action precedes experience. ‘Skill’ on the other hand is the capability to smoothly coordinate behavior, which implies skill influences behavior. Thus, skill precedes action. Experiencing is learning by doing, which is synonymous with knowledge development, whereas practicing a skill is smoothly coordinating behavior (usually for a purpose), which appears to be a very common way of utilizing knowledge. Conceptually ‘experience’ refers to past action
whereas ‘skill’ refers to future action. However, from a process point of view the two are closely intertwined. On the one hand gaining experience is akin to developing skills and an adequate definition of ‘skill development’ would be ‘reification of experiential knowledge into routine behavior’. It is a process characterized by gradual adjustment based on the principle of ‘trial and error’ “continuously building out from the current situation, step by step and by small degrees” (Lindblom, 1959, p.241). But on the other hand it seems clear that skill utilization also implies acquisition of experience. The crossroads between experience and skill is a most interesting point where the entrepreneurial mind might have a good chance to prosper.

Both ‘tacit’ and ‘explicit knowledge’ occur at the level of the individual human being and at the level of the social collective, i.e. at group level. Four combinations have been proposed: ‘individual explicit knowledge’, ‘individual tacit knowledge’, ‘social explicit knowledge’, and ‘social tacit knowledge’ (Spender, 1996; Nahapiet & Ghoshal, 1998). At the level of the individual human being knowledge, skills and capabilities have been referred to as ‘human capital’ (Coleman, 1988). It follows that ‘human capital’ involves both ‘explicit’ and ‘tacit knowledge’. ‘Social explicit knowledge’ is the kind of knowledge that is abstracted, communicated and shared by human beings making up a social collectivity. ‘Social tacit knowledge’ “represents the knowledge that is fundamentally embedded in the forms of social and institutional practice and that resides in the tacit experiences and enactment of the collective” (Nahapiet & Ghoshal, 1998, p.247). But socially formed clusters of people enclose ‘explicit’ as well as ‘tacit knowledge’ both at the level of the individual and the collectivity. Nahapiet and Ghoshal (1998) write: “[w]e use the term ‘intellectual capital’ to refer to the knowledge and knowing capability of a social collectivity, such as an organization, intellectual community, or professional practice” (p.245).

3.2 Technology as material artifact

Products are the most obvious physical manifestation of technology. Products become visible through matter, energy, space and time. They are conceived of as real and many products are also tangible – they can be touched. Products are intended for use. Use might be private, professional or industrial. Irrespective of use category, in contemporary society it is unusual that the user is also the producer of the product implying that before being used products are subject to exchange. It follows that products are produced for sale. Exchange is the outcome of a combined evaluation and negotiation process in which the buyer and the seller participating end up reasonably convinced that with realized exchange they would both be better off.1

1 When formulating the division of labor mechanism Adam Smith (1776) left an early contribution to the understanding of the interrelationship between enterprising and market exchange. In brief his thesis proposes that the dedication of an individual to only one employment positively impacts upon productivity and dexterity with an implication on the output quantity, which becomes larger than is needed for own consumption, which in turn implies the surplus may be sold to others. Smith argues...
3.2.1 Products, consumables and production facilities

Products intended for private consumption are consumer goods whereas products intended for industrial use are industrial goods. The latter are divided into equipment and consumables. Equipment is intended for long-term use in the buying firm’s production system where it becomes an integral part of the firm’s production facilities.1 Consumables are intended for short-term use in the production processes of the buying firm.2 Thus, a product is an item produced for sale. When in use position, if intended for long-term use the same item has become a production facility, while if the item is aiming at short-term consumption it is a consumable. The conclusion is that one same item is given different definitions and labels as well depending on which is its contextually determined function, i.e. whether its function is ‘production for sale’ or ‘employment for use’.3 Hopefully the conceptual confusion as regards the concepts products, equipment, production facilities and the like is now cleared. For reason of simplicity in the following paragraph the denotation product will be used for a technological item that is produced and used for a particular purpose although in the use position an employment of ‘production facility’ or even ‘use (or service) facility’ would have been more appropriate.

3.2.2 Knowledge and skills reified into physical objects

Consider a vacuum cleaner. It is real and it can be touched. It is an artificial object produced for a particular purpose. It is intended for use. It involves the appropriate knowledge and skills because them without it could not have been developed and manufactured for the use intended. But operating a vacuum cleaner also requires a certain amount of knowledge and (maybe more importantly) skills for satisfactory results to materialize. The vacuum cleaner holds a particular activity structure preserved physically as an inscription in matter and space. The inscription is fixed and thus resists the influence of time. The thing can be activated at will by connecting the plug and turning the switch. Basically it constitutes a rule set, which, when activated, commands the various programmed steps associated with the function of a vacuum cleaner. It is carefully programmed involving “the idea of software as frozen

that “it is the power of exchanging that gives occasion to the division of labor, so the extent of this division must always be limited by the extent of that power, or in other words, by the extent of the market” (ibid. p.8). His was also the idea that through market exchange ”an invisible hand” guides society for the mutual benefit of both private and community interests (ibid. p.456). But market exchange was not unproblematic according to Smith. Rather it was an activity involving ”haggling and bargaining” (ibid. p.48). The market was something real but of limited analytical interest, since the price settled by the market was often influenced by accidental events. The formulation of the division of labor mechanism with its focus on manufacturing specialization, skill development and exchange in a market is an early description of the enterprise phenomenon.

1 In the accounting system of the firm production facilities are reported as fixed assets.
2 In the accounting system of the firm consumables are reported as liquid assets.
3 From a value point of view it is not a given that the sales value coincides with the use value as the use value is contemplated individually by each potential buyer whereas the sales value is contemplated collectively by potential buyers.
[organizational] discourse … which resists change and displays properties of irreversibility” (Walsham, 1997, p.469). The rules make up an operational formula relying on scientific knowledge about rational principals (natural laws). Not only the rules but also the supporting knowledge are constituent parts of the artificial object. But such a rule set is nothing but an institution constraining behavior, both that of the artificial object as such, the vacuum cleaner, but also to a certain degree that of the user striving to perform the weekly cleaning at home. Scott (1995) points out that institutions “are embedded in various types of repositories or ‘carriers’” (p.52). He proposes cultures, social structures, and routines to be such carriers. Technologies may also be an appropriate category to consider according to Scott. With reference to Barley (1986) and Orlikowski (1992) he writes:

A fourth candidate as a carrier of institutions is technology, defined narrowly as material artifacts within which are embedded knowledge and skills. Like other modalities of action-structure, technology is … socially constructed by the actions of designers, technologists, investors, and others (Scott, 1995, p.61, footnote 5).

Viewing technologies as material artifacts is appreciating the reification of knowledge and skills, i.e. the physical inscription of rules, which underpins some activities while making other activities difficult or impossible to perform. Products are material artifacts frequently observed and used by ordinary people as they live their everyday lives, be they private or professional. Products typically involve knowledge and skills embedded in matter, energy, space and time. The point is not new. Penrose ([1959] 1995) writes “[m]any developments in technological knowledge become available to firms not simply as new knowledge, but physically embodied in the form of the capital equipment they buy” (p.79). Basically material artifacts are past thoughts inscribed into physical objects and as such they continue to exist independently of their originators.

Once developed and deployed, technology tends to become reified and institutionalized, losing its connection with the human agents that constructed it or gave it meaning, and it appears to be part of the objective, structural properties of the organization (Orlikowski 1992, p.406).

The meaning given to technology in this definition is tantamount to von Wright’s (1986) understanding of the term “technics” as discussed above. It is technology appearing as material artifacts or otherwise expressed, knowledge and skills reified into physical objects. Most product use in contemporary society is based on the ‘black box principle’. The user learns how to use the product (usually by following the supplier’s instructions) but only seldom he learns what’s inside the box. The black box mechanism has been described in detail by Haberstroh (1965, p.1174).

The black box … is characterized by its inputs and outputs and the relationship between them. An input is any measurable event or series of events occurring outside the black box that influences the outputs (a dial setting or other stimulus). The outputs are any measurable event or series of events that are immediately determined by the inner mechanism of the box (a pointer reading or other behavior). The relationship between them specifies how inputs are transformed into outputs and is usually
determined by experimentation, although any potentially useful source of hypotheses for test is admitted (including design specifications accompanying the box). The relationship that transforms input into output is usually referred to as the transfer function.¹

Research in the area of actor-network theory and information systems holds the black box as a key concept. The black box is described as “a frozen network element, often with properties of irreversibility” (Walsham, 1997, p.468).² The description fits in with the phenomenon discussed here, i.e. the material artifact, and the vacuum cleaner serves as an illustration. To the everyday user the vacuum cleaner is a black box³ requiring a certain input while offering a certain output, the mechanism at work in between, the particular set of “frozen internal rules” simultaneously enabling and constraining behavior, being of subordinate interest to the user. This view harmonizes with that of Scott (1995), who argues that institutions “are embedded in various types of repositories or ‘carriers’” (p.52), one of those being technology (p.61). Orlikowski (1992) offers a detailed elaboration of technology as material artifact in which the institutional aspect of technology becomes particularly salient. Both Scott and Orlikowski draw on Giddens’s (1984) theory of structuration maintaining that structure is the result of past action, a social product, but also that structure is the starting-point for future action. Structure then is the more institutionalized aspect of behavior. “For its part, action operates to produce – to reproduce (perpetuate) or alter – structure” (Scott 1995, p.52). Structure incorporates institutional elements in the form of coded rules and belief systems. The vacuum cleaner is such a carrier of coded rules irreversibly organized to simultaneously enable and constrain behavior in accordance with a preplanned inscription. Material artifacts are important resources in contemporary society but if not activated for a purpose technology as material artifact is “dead tissue”. Activating a material artifact involves, one way or the other, human action. The knowledge of the user and the properties of the material artifact involve in interaction while constituting a productive process the outcome of which manifests as technological service.

¹ Since long system analysts have frequently applied the black box principle when relating parts into wholes and reverse.
² Actor-network theory distinguishes between the concepts ‘black box’ and ‘immutable mobile’. Walsham (1997, p.468) defines the former as “a frozen network element, often with properties of irreversibility” and the latter as “network element with strong properties of irreversibility, and effects which transcend time and place, e.g. software standards”. It follows from the definitions that the difference between the two regards degree rather than nature. At this instance the notification might be considered less important. It should be recognized, however, that sometimes irreversibility makes up an important variable to consider. Whether the irreversibility properties of an element are conceived of as strong or weak might be the crucial point to consider when choosing direction in a particular business situation.
³ Whether the vacuum cleaner should be considered a ‘black box’ or an ‘immutable mobile’ is a matter of estimate. Maybe the latter is the better as the “inside” of the vacuum cleaner displays strong properties of irreversibility.
3.2.3 Utilizing material artifacts – Three commonplace illustrations

‘The vacuum cleaner’

Assume a person that is ignorant about vacuum cleaners except for having a basic knowledge about how to use them. To this individual the vacuum cleaner is a ‘black-box’ (independent of the color of the envelope). Such a user knows nothing about what’s inside the envelope. He just knows how to assemble the pipes and the nozzle and how to connect the plug and turn on the switch. A somewhat less ignorant user will, besides using the device, when necessary open the envelope and exchange the collecting bag and the filters. A reasonably informed user may as well perform maintenance and take care of minor technical problems like cable malfunction and the like whereas a well-informed user may carry out advanced repair in case the cleaner is subject to major breakdown. Suppose a vacuum cleaner is delivered fresh and new. In the short run any user will gain good service from it. When the collecting bag has got full the ignorant user will recognize the vacuum cleaner is out of service. The less ignorant user will exchange the bag and go on cleaning. A minor technical problem leaves the vacuum cleaner inactive in the hands of the less ignorant user but the reasonably informed user will find out about the cable breakdown and finally ends up with a tidy house. The breakdown of the electric motor will stop all users except for the well-informed one, who takes action and gets the motor going again.

From this simple example can be drawn a few interesting insights. First, elementary user knowledge may suffice to obtain good service from a material artifact. Second, using a material artifact normally brings with it wear or other material deterioration, a circumstance closely interconnecting use and maintenance/repair. Third, an increased level of user knowledge, including knowledge about the “inside” of the material artifact, i.e. the rules that are inscribed into the physical object, may aid the sustentation of good service.

‘The hammer’

The second illustration involves a common carpenter tool, the hammer, frequently used also in private by many people; seemingly the late offspring of the Stone Age axe. But today’s hammer is not just one uniform piece of equipment. Different tasks enjoy hammers with different design. Focus in the current illustrative example is on the “carpenter’s hammer” used professionally as well as in private to drive nails into wood products by pounding. Using a hammer with success requires a certain amount of operator skill. For example, to drive small tacks into hard wood products, like for example toughened Masonite, without hurting oneself might be a challenge for the inexperienced non-professional. And everyone who ever hit his thumb hard while practicing knows it hurts. To wainscot a ceiling while practicing under-up pounding is another difficult task to carry out requiring certain skills. There are good hammers and bad hammers. A good hammer has properties making it suitable for pounding. It is neither too heavy nor too light; it is properly designed, e.g. displays a good balance; the driver head has been given the right toughness and the handle the right strength; etc. If the hammer is good and the operator is skilled the nails will properly and efficiently be driven into the wood products without any difficulty. If the operator is less skilled more time will probably be needed to complete the task and there is also an obvious risk that the end result will be less good. A bad hammer in the hands of the skilled professional and the inexperienced amateur alike will slow down the rate of work and will probably also impact negatively on the end result. The quality level of the hammer is established by the external evaluation of the rules inscribed into it and
those rules are imprints of the knowledge and skills once mobilized when the hammer was designed and manufactured.

The example highlights how operator skill translates into use efficiency and outcome quality but also how the rules inscribed into the physical object, i.e. the material artifact, to a certain degree impacts upon the behavior of the operator and the outcome of the process, i.e. the properties of the material artifact at the same time enable and constrain user behavior. A skilled professional operating a top quality hammer prepares for a good result whereas an inexperienced user making use of a poor hammer is a risky project. The outcome of the other two possible combinations is more uncertain but it is likely they will end up somewhere in the middle. To conclude, the skill of the user and the properties of the material artifact interrelate in a productive process the outcome of which depends on the constitution of each process component as well as their reciprocal orientation.

‘The rally car’

In Sweden motor rally makes up a popular branch of today’s motor sports. It involves driving on public roads while using (fairly) ordinary cars. Spectators find the various speed sections of a rally particularly attractive and they invade the usually brushy woods in large numbers to look at their favorite team struggling to run off with the maximum number of points. Now, let us have a look at an automobile rally team when in action on one of those speed sections. The task outline is to drive as fast as possible from point A to point B. The core of an automobile rally team comprises a car, a driver, and a co-driver (“map-reader”). The properties of the car, reflecting the knowledge embedded in it, enable certain behavior while constraining other behavior. A car may be better or worse at coping with constraints imposed by the surrounding physical world, e.g. inertia, gravity, and friction, to mention a few measurable variables. A good rally car carries with it built-in knowledge that to a certain extent buffers contextual constraints, but still, without a driver a car is nothing. A good driver is one that gets the very best out of his car and it is obvious that driver skills are a crucial factor when it comes to maintaining a high speed over a certain distance. Such skills comprise the ability to simultaneously interact with the car and the surrounding environment. The perfect driver-car establishment superiorly copes with contextual constraints by involving the driver and the car in instant and non-biased two-way communication the effect of which is flawless, streamlined action and reaction. It is an establishment facing the driver and the car united into one integrated whole. The more suitable for the purpose the inscribed-rules of the black box, i.e. the car, and the more developed the knowledge and skills of the driver, the higher the leveraging effect when interconnecting the two. It is obvious that a large portion of the driver’s contribution to the establishment is made up of tacit knowledge. However, a good car and a skilled driver do not suffice to complete a good rally team. As the route of a speed section is more or less unknown both to the driver and the co-driver before take off the latter’s role becomes particularly important. His is the responsibility to read the map during the run and to continuously inform the driver about what to expect beyond the next bend. The task involves reading, interpreting, and verbally communicating coded information (the map) to the driver while at the same time physically being thrown back and forth in a noisy “black box” rushing along at furious velocity on narrow and twisty bypaths. This is not the situation where an extensive academic style dialogue would be the effective choice. On the contrary, communication suitable for the purpose would involve a wide array of communication tools such as words, signs and unspoken thoughts.
This third example appreciates, similarly to the previous two examples, the user-artifact interaction but it adds to the system the interaction between the driver and the co-driver, the character of which involves explicit as well as tacit knowledge at the level of the collectivity. And, indeed, the nature of the process in which rally teams involve is both complex and complicated.

The three examples show some typical patterns of interaction between a few well-known material artifacts and the various user knowledge categories discussed above in section 3.1.3. Table 3:1 summarizes the patterns identified.

<table>
<thead>
<tr>
<th>Material artifact</th>
<th>User knowledge</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Individual</td>
<td>Social</td>
<td>Explicit</td>
<td>Tacit</td>
<td>Explicit</td>
</tr>
<tr>
<td>‘the vacuum cleaner’</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘the hammer’</td>
<td>(X)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘the rally car’</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Table 3:1 Some typical combinations of ‘user knowledge - material artifact’.

It should be noticed that the picture mediated is not aiming at precision or accuracy. It is rather fairly rough. A lot more can be contended about the way user knowledge and artifact profile may interconnect, but it seems plausible already to conclude that one particular artifact has to be combined with a certain type of knowledge for its effective utilization, whereas another artifact may require some other knowledge. Using the vacuum cleaner requires a small portion of elementary individual explicit knowledge only, whereas successfully exploiting the hammer raises demand for a certain amount of skills, or otherwise expressed an appropriate portion of individual tacit knowledge (although some individual explicit knowledge may also be of help). The rally car to be successfully utilized has to be run by a closely united driving team employing cooperative behavior beyond articulation. But to make a successful rally team not just one knowledge category has to be in place – all four categories have to involve in a sophisticated pattern of interaction. Now, in the next section services emanating from material artifacts will be further discussed while relating to user knowledge.

3.3 Technological services and user knowledge

3.3.1 Productive services and material artifacts

The illustrations above show that it is not the material artifact as such that is of interest but the service it generates when activated. The vacuum cleaner when used keeps the house tidy, the hammer when operated makes the wainscot attach to the sealing, and the rally car when activated races speedily from A to B (and may end up as the winner of the contest). Edith Penrose outlined the interconnection between service and resource in her seminal work on the growth of firms:
Strictly speaking, it is never resources themselves that are the ‘inputs’ in the production process, but only the services that the resources can render. The services yielded by resources are a function of the way in which they are used – exactly the same resource when used for different purposes or in different ways and in combination with different types or amounts of other resources provides a different service or set of services. The important distinction between resources and services is not their relative durability; rather it lies in the fact that resources consist of a bundle of potential services and can, for the most part, be defined independently of their use, while services cannot be so defined, the very word ‘service’ implying a function, an activity. As we shall see, it is largely in this distinction that we find the source of the uniqueness of each individual firm. (Penrose, [1959] 1995, p.25.)

The significance of ‘resource heterogeneity’, a key concept in Penrose’s writing, is that one particular resource may be used for different purposes, i.e. what matters is not the resource as such but the various services the resource is capable of bringing. When it comes to physical resources the service potential links to the knowledge and skills of the user. The three examples above illustrate the connection between technology as material artifact and the user of it although each one of the examples contains just one way of using the actual resource. But it is easy to think about alternative uses, e.g. the vacuum cleaner can be used for paint-spraying, the hammer can become a weapon when chasing burglars at night, and the rally car can transport food from the supermarket. These alternative uses still relate fairly closely to the original ones as outlined in the examples – paint-spraying builds on the blowing function of the vacuum cleaner (the fan), the hammer-weapon utilizes the pounding capacity of the hammer, and the food transporting task makes use of the mobile function of the car. More “distant” uses, i.e. uses not intended by the artifact designer, can also be thought of but such uses do not utilize the specific properties of the material artifact. They rather activate more general and fundamental features of the artifact such as shape, weight, and size – the vacuum cleaner put in up-right position may be a hat-peg, the hammer may serve as a weight preventing papers from blowing away in the wind, and the rally car may be used as blockage to prevent other cars from passing an entrance.

Material artifacts, being important resources of the firm, have no meaning if not used for a purpose. In Penrose’s vocabulary resources render the firm ‘productive services’. Idle resources house ‘unused productive services’. Such unused services constitute the most pertinent driver of the growth of the firm because they are immediately available and using them is cheap and sometimes even free (Penrose, [1959] 1995, p.66ff, p.78ff). Although one particular material artifact can be used in different ways and for the fulfillment of different purposes the rules inscribed into it simultaneously enable and constrain its effective utilization (Giddens, 1984, p.25). If in a particular application the specialized properties of the artifact are not fully exploited a certain

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1 I am avoiding the use of the term ‘factor of production’ precisely because it makes no distinction between resources and services, sometimes meaning the one and sometimes the other in economic literature. [The footnote is part of Penrose’s original text; author’s comment.]

2 Material artifacts constitute a certain type of material resource.
portion of its built-in service capability remains idle, which represents a use situation involving waste. Consider for example the rally car. Using it for food transportation is not fully utilizing its built-in specialized properties - a much simpler car could be used - and when using it to block an entrance none of its built-in specialized properties are actually activated - using a log would be equally effective and certainly much more efficient.

3.3.2 The quantitative and qualitative aspects of material artifact utilization

Material artifact utilization can be considered along two dimensions, i.e. the quantitative dimension and the qualitative dimension. Basically the quantitative dimension measures whether or not an artifact is engaged in an activity. If already occupied it cannot be used in an alternative activity unless its previous employment is terminated. The “on-off issue” involves two aspects. Is the entire thing or only part of it busy (measured quantitatively)? Is the thing employed full time or on a temporary basis? If the artifact is fully activated quantitatively it may still be under-utilized qualitatively, i.e. the knowledge and skills inscribed into it may not be fully utilized. Full utilization quantitatively and qualitatively equates optimal use of the material artifact. Should one of the two or both amount to zero the result will be no use at all. It is obvious that an artifact can be under-utilized qualitatively though fully employed quantitatively. Using the rally car as a log, for example, is wasteful use (although it may be highly rational in a given situation). From a quantitative point of view the issue of full resource utilization in an industry has been extensively elaborated in microeconomics analysis where quantity and price are supposed to strike a balance in market equilibrium. But as such theories assume competitors in an industry to employ equivalent production technologies, which are used in a uniform way, the qualitative aspect is not considered (e.g. Lancaster [1969] 1974).

However, the qualitative service aspect has been approached by Penrose ([1959] 1995), who offers an insightful discussion of the subject in relation to the concept of resource indivisibility. Her illustration musters a skilled chemist in a small firm, who, due to shortage of work, fills up his laboratory part-time work with tasks for which he was never trained and for which he is apparently overqualified, tasks like checking inventories or sending out accounts. She concludes that “he is not ‘idle’, but neither are his most valuable services fully used because the firm’s output is to small to permit their use” (p.71). Although Penrose’s illustration concerns the employment of a human resource the logic is perfectly transferable to material artifacts as discussed here. The two words ‘idleness’ and ‘utilization’ make up the starting point. Idleness is the inversion of utilization. Full utilization implies idleness is zero and vice versa. Thus, the service level achieved depends on whether the material artifact stays more or less idle or is more or less utilized. The degree of utilization ($S_{du}$) appears as the ratio between the amount of service factually gained from it ($S_{fg}$) in a particular use
situation and the potential (maximum) amount of service latently residing in it \( (S_{pg}) \), thus the formula \( S_{du} = S_{fg}/S_{pg} \) applies. The degree of idleness \( (S_{di}) \) appears as the balance, i.e. \( S_{di} = (S_{pg} - S_{fg})/S_{pg} \). It follows that \( S_{du} + S_{di} = 1 \). The degree of utilization may be divided up into its two constituting dimensions, the degree of quantitative utilization \( S_{du-quant} \) and the degree of qualitative utilization \( S_{du-qual} \). If one of those or both amounts to zero the artifact is unutilized. It is obvious that an artifact that is completely inactive from a quantitative point of view is unutilized but an artifact that is fully employed quantitatively may still be unutilized qualitatively if the knowledge and skills inscribed into it are not activated for service generation.

Position 1 in Figure 3:1 represents an artifact that scores high on the quantitative axis whereas it scores low on the qualitative axis. It is a qualitatively under-utilized artifact that could possibly be better exploited if used for other purposes (partly or in its entirety). An example is using the vacuum cleaner as a hat-peg full time. Position 2 represents an artifact where the properties are well exploited in the actual application but where the artifact is strongly under-utilized quantitatively. Again the vacuum cleaner serves as a good example when used for the purpose of hoovering at home, as most of the time it is left idle in the broom cupboard. Position 3 shows a well-exploited artifact scoring high on both axes – around 80 \% of its capacity (the quantitative dimension) as well as 80 \% of its capability (the qualitative dimension) are utilized. The professional use of a vacuum cleaner in the operations of a cleaning company exemplifies the position. Position 4, finally, shows an artifact that is poorly utilized both quantitatively and qualitatively. A good illustration is the vacuum cleaner relaxing on a shelf in the garage except for once every third year when used for paint-spraying – the resource stays idle most of the time and when activated its specific properties are not fully exploited. A discussion about material artifact utilization could as well employ ‘the hammer’ or ‘the rally car’ or any other “rule-inscribed” physical object.

The degree to which a material artifact is utilized, i.e. the service that is factually gained in relation to the service that is latently available, can theoretically be calculated as the measure on the quantitative axis multiplied by the measure on the qualitative axis, i.e. \( S_{du} = S_{du-quant} \times S_{du-qual} \). If both score high the product approaches ‘1’ and the artifact is well utilized. If one or both score low there is room and certainly

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1 The degree of idleness may be divided up analogously into its quantitative and qualitative components.
also need for improvement. This particular analysis sketches an “artifact-internal” view of ‘technology as material artifact’ akin to operational efficiency (Pfeffer & Salancik, 1978). An “artifact-external” view raises questions about whether or not – or rather to which degree – the service factually delivered suits the receiver, and that is a view concerned with evaluating operational effectiveness (ibid.). Another comment to make in this context is that the above analysis takes into account only one single material artifact, which is usually far from realistic and especially so in industrial environments where large numbers of resources combine into more or less efficient and effective industrial systems.

3.3.3 User knowledge and the utilization of material artifacts

Now, in order for a firm to fully utilize its material artifacts from a quantitative point of view certain knowledge and skills are needed, no doubt. It is an endeavor aiming at maintaining reliable factor supply, balanced production, efficient planning, stable order inflow, etc. The qualitative utilization of material artifacts may raise demands for some other types of knowledge and skills. If reflecting for a moment upon the three opening examples it is clear that the elementary use of a vacuum cleaner requires rudimentary user knowledge and skills only, whereas the successful use of a hammer raises demands for developed user skills about how to use the hammer but limited knowledge only about hammer related design and manufacturing. Whether the driver of the rally car needs a deep and thorough knowledge about the various technologies making up the car might be an issue of debate, but successful driving may at least partly depend upon having such knowledge in place, as materials and components when activated in a racing situation are often used at their limit. Insufficient knowledge about the technologies of the car may be the source of insensible driving, which in turn may lead to engine breakdown. However, the driver’s most pertinent contribution to the team is his immediate driving skills, i.e. his ability to fast and safely drive the car from point A to point B, and those are skills primarily of tacit nature. They comprise a sophisticated pattern of learned rules making the driver able to read and handle the car and the physical environment. The knowledge and skills of the co-driver are of a somewhat different nature as they largely concern the ability to read and communicate codified information while continuously checking against the factual situation, a situation that is rapidly changing. The knowledge and skills of the co-driver are certainly both explicit and tacit. But to the knowledge and skills available at the level of the individual member the rally team adds also knowledge and skills, explicit as well as tacit, at the level of the collectivity. When explicit any relevant subject or theme that can be articulated and codified may be included. When tacit any matter that doesn’t lend itself to articulation or codification may be contained. The driver and the co-driver communicate during the race, no doubt, but there is reason to believe that an ordinary language built on words and sentences is too coarse and too slow to meet the need for accuracy and speed. There is need for a more precise and direct language.
Analyzing the language of a rally team in action would probably attract cross-disciplinary interest. First and foremost the fields of semantics and semiotics would apply, but also other disciplines would have a role in the play. Words would be important, signs would be even more important, but most important would be such carriers of meaning that exist beyond words and signs. It is activating the “knowing how” at the level of the social collectivity where words and signs do not suffice as carriers of meaning. For a rally team to be successful the quality of the car is important, the skills of the driver are important, the ability of the co-driver to read and interpret the map is important but most important is how the various qualities are combined into one coordinated whole, the rally team, capable of moving from A to B faster than all other teams. The type of knowledge that might tip the scales is the “the knowledge that is fundamentally embedded in the forms of social and institutional practice and that resides in the tacit experience and enactment of the collective” (Nahapiet & Ghoshal, 1998, p.247). That type of knowledge has been denoted ‘social tacit knowledge’ but it could as well be called ‘collective skills’ because although it cannot be codified or articulated it strongly enhances collective coordinated action.

3.3.4 The team effect

It is obvious that social tacit knowledge is an important teamwork ingredient, maybe the most significant one, although other knowledge categories certainly also matter when individuals work together in teams. But a team is above all a social structure implying that relationship and network mechanisms in general also apply for individuals organized in teams. Albeit supposed to closely interrelate with the phenomenon of technology and technological change for the moment the social aspect will not be further elaborated. ¹ From an economist’s point of view Penrose ([1959] 1995) contributes to the discussion by describing the particular qualities that make the managerial group of a firm a ‘team’.

Businessmen commonly refer to the managerial group as a ‘team’, and the use of this word implies that management in some sense works as a unit. An administrative group is something more than a collection of individuals; it is a collection of individuals who have had experience in working together, for only in this way can ‘teamwork’ be developed. Existing managerial personnel provide services that cannot be provided by personnel newly hired from outside the firm, not only because they make up the administrative organization which cannot be expanded except by their own actions, but also because the experience they gain from working within the firm and with each other enables them to provide services that are uniquely valuable for the operations of the particular group with which they are associated. These are services which make possible a working relationship between particular individuals making decisions and taking action in a particular environment, and they

¹ The aspect is touched upon at the margin in this chapter but a more comprehensive discussion about organizations and social structure is presented in chapter 6 and used in chapter 7 for the purpose of analysis.
determine the efficiency and confidence with which action can be taken by the group as a whole. Unless such services are provided by its members, the group cannot function as a unit. (Ibid., p. 46.)

Productive services generated by human resources and particularly services emanating from the managerial group are crucial to the performance of the firm according to Penrose. She maintains that “an administrative group is something more than a collection of individuals; it is a collection of individuals who have had experience in working together”. It stands to reason that individuals, that have been working together closely for quite some time, share a certain portion of knowledge, the nature of which is to some extent explicit and to some extent tacit. Penrose argues: “experience itself can never be transmitted; it produces a change … in individuals and cannot be separated from them” (p. 53). Although experience cannot be transmitted from one individual to another, individuals involving in interaction with one another more than accidentally over time develop a stock of collective experience. Thus, data, norms and values at the level of the collectivity intertwine into shared meaning guiding future behavior.

The Penrosian view of teamwork as the activation of shared knowledge is somewhat different from that advanced by Alchian and Demsetz (1972), who focuses upon ‘team production’ as a route to improved productivity. In the tradition of transaction cost economics they focus upon the production function while considering the principal-agent problem of coordination. They start out from the possibility to produce $Z$ by separately producing $Z_i$ and $Z_j$ so that $Z = Z_i + Z_j$. They add the possibility to produce $Z$ by performing team production, which, according to the authors, is characterized by a production function, $Z$, which is not separable into the two functions, $Z_i$ and $Z_j$, each involving only inputs $X_i$ or inputs $X_j$. Whether to carry out separable production or team production of $Z$ is a matter of cost. “Team production will be used if it yields an output enough larger than the sum of separable production of $Z$ to cover the costs of organizing and disciplining team members” (ibid., p. 121). The team effect as discussed by Alchian and Demsetz is closely tied to production related economic efficiency whereas that of Penrose displays a wider scope, which may involve various effectiveness variables including those of creativity and technological change.

Material artifacts are “dead tissue” if not activated. Activation requires the involvement of user knowledge. From a service point of view there is an obvious interrelationship between the competence and capability of the user and the rules inscribed into the material artifact. “Structure has no existence independent of the knowledge that agents have about what they do in their day-to-day activity” (Giddens, 1984, p. 26). Single individuals in isolation as well as individuals operating in teams utilize material artifacts. Teamwork seems to enhance both efficiency and effectiveness. The stock of knowledge available to an individual utilizing a material artifact comprises his stock of human capital, i.e. his individual knowledge, explicit as well as tacit. The stock of knowledge available to a “Penrosian working team” utilizing material artifacts comprises the stock of intellectual capital available in the
social structure of the team, i.e. the individual and the social knowledge inherent in the 
team, explicit as well as tacit. It seems reasonable to conclude that the knowledge base 
of a team is usually superior to that residing in the mind of one single person. It ought 
to be more wide-ranging and more dynamic but it probably also involves an obvious 
element of conflict as various team members may strive for different achievements.

3.4 Technology as organized process

In the previous sections the appearances of technology as material artifact and 
technological services emanating from such objects have been discussed. The 
importance of user knowledge was emphasized and the conclusion was made that 
technological services for their coming into being rely on the combined activation of 
physical and non-physical resources. This section further elaborates the organization 
of resources into technological processes.

3.4.1 Natural and technological processes

There is an important difference between natural processes and technological 
processes. Natural processes evolve and operate without the influence of man whereas 
technological processes are man-created. At best the latter are also run and controlled 
by man. The ever-ongoing raining and evaporation process driven by natural forces 
spreading water into various places on earth is an example of the former. The latter is 
illustrated by the modern irrigation plant consisting of tubes, pumps, valves, nozzles, 
etc distributing water from the small inland river into the cultivated territory located 
close to the river. In this particular case there is an obvious interrelationship between 
the two processes. If there is no water in the river there is no water to distribute 
implying the irrigation plant will be left inactive, i.e. the operations of the 
technological process will not be initiated. It is obvious that this is a situation where 
the natural process constrains the operations of the technological process. However, 
should the technological process collapse the operations of the natural process would 
stay unaffected. In this particular case influence goes one way only but in many other 
cases influence goes in both directions. Consider for example the propagation of desert 
land in Northern Africa being the result of keeping heavy implanted cattle on the frail 
soil. The technological process influences the natural process but the reverse is also 
true. The two processes are intertwined. If reflecting for a while upon various 
processes appearing in a business context not much fantasy is needed to infer that most 
such processes are intertwined, i.e. involving at the same time sequences referable to 
as natural process and sequences referable to as technological process.¹ Some

¹ The entire field of applied natural science, involving both the academia and the business world, is 
deeply committed to increasing the knowledge about natural processes as a means to enhancing 
the development of technological processes. Ever since the scientific revolution in the 17th century, 
associated with such figures as René Descartes and Francis Bacon, natural scientists have strived to 
conquer and control the physical universe and the secrets it is hiding. The previous image of Mother
technological processes impact detrimentally on natural processes\textsuperscript{1}, while other such processes support the recovery of natural processes in situations where ruthless exploitation threatens the very existence of the natural process. In contemporary society various movements and organizations strive to influence business companies and others to think “eco-efficiently” and “socio-efficiently”, i.e. to influence them to take responsibility not only for the economic aspect of enterprising but also for the ecological and social aspects.\textsuperscript{2} The account made in this section focusing on technology as organized process refrains from explicitly discussing the impact of natural processes on technological processes and vice versa. However, as natural processes are assumed to interlock (often closely) with technological processes implicitly they are part of the discussion. But as humans did not create them they are not referable to as technology.

3.4.2 The manufacturing process

When asked to think about technology people often think about some sort of manufacturing process and such processes are certainly common manifestations of ‘technology as organized process’. “Modern Times”, Charlie Chaplin’s famous movie from 1936, constitutes an animated illustration of the phenomenon. It is a film leaving the average audience in an ambiguous mood of laughter and worry. A core sequence of the film shows Chaplin defeated and captured in an automated manufacturing process. The situation is funny because of Chaplin’s extraordinary talent as an actor, but it is also frightening because of the victim being caught in a huge machine operating, as it seems, beyond the control of any human being. Large interlocking cogwheels like jaws of a gigantic creature are about to tear the poor victim up to pieces. Another sequence shows Chaplin working at an assembly line. The work task completely absorbs him and with continuously increasing line speed he works faster...
and faster. Finally he works at a pace beyond what is practically possible. The operator is entirely controlled by the machine. But the movie also comprises some other elements, among those fascination and rationality. The gigantic creature, the manufacturing machine, is man-created, which is also a confirmation of man’s victory over nature. The construction as such may fascinate people but so may also man’s ability to create it. So the picture is ambiguous and in the end it is all a question of who is controlling whom. Besides, it is certainly true that many material artifacts when utilized properly make society a better place to live in.

The process approach is palpable in Chaplin’s movie. Large turning cogwheels invite the viewer to an ongoing manufacturing process while Chaplin himself engages in drawing nuts at the assembly line. Albeit a caricature the film mediates a fairly pertinent view of industrial operations. Tools, machinery and equipment involve in a broad variety of activities all of them in need of coordination. The grouping of machines into production lines coordinates activities more or less permanently. The establishment of working departments involving several production lines implies further coordination. Input reception and output dispatch located at comfortable distance adds to the structure of activity coordination. Tools, consumables, and complementary equipment situated close at hand make simpler the coordination of activities. Taken altogether these arrangements make up the firm’s industrial setting, which is basically a pre-coordinated structure enabling and constraining future action. Each machine, tool and equipment carries with it a particular rule set originally inscribed into it at the time of design and manufacture. The physical combination of material artifacts into production lines links various rule sets together into larger structures. It follows that a structure of the kind includes a certain number of rule set interfaces. A ‘rule set interface’ is an “area-between-events”, a place where an output is redefined into an input. For a manufacturing process to function smoothly rule sets approaching each other in the “area-between-events” have to match. Or to be more precise, the outcome of rule set activation, the services generated have to match in the interface area and if they do the output-input redefinition will pass by without friction. This is the “well-greased” manufacturing process carried into effect, a cherished dream for many a production manager, but as this way of evaluating process quality is strictly technical-instrumental it doesn’t tell anything about the economic consequences of performing manufacturing. ‘The manufacturing process’ as a special case of ‘technology as organized process’ builds on the idea of matching in the various rule set interfaces of an activity chain. Good matching is equivalent with frictionless output-input redefinition. Recognized interface friction calls for adjustment or even new development.

An artifact may be more or less complex. A hot rolling mill operating in the stainless steel industry, for example, may be considered a complex singular artifact but it may as well be looked upon as the combination of a large number of lower level artifacts. For the hot rolling mill to function well the various lower level artifacts have to be
designed, manufactured and assembled properly. They have also to be properly coordinated during operation. Each artifact has to supply services securing the smooth redefinition of output into input in the “areas-between-events”. Otherwise the mill might not start or the output produced will arrive out of specification. A complex artifact integrates several “areas-between-events” within its outward boundary. These interfaces may be more or less permanently settled, i.e. the various combinations of services flowing out from the lower level artifacts may be more or less permanently tied to each other ex ante. The degree of pernancy basically refers to whether, or to which extent, interrelated artifacts can be individually manipulated from the outside.

The issue may be shed light over by returning for a while to the modern vacuum cleaner (although the vacuum cleaner is certainly not a typical artifact representative of manufacturing). The electric motor constituting a particular rule set of the modern vacuum cleaner can usually be manipulated from the outside while affecting two specific functions - impacting upon the supply of two specific services – i.e. the on-off function and the speed function (older versions had usually only the on-off function). The fan, another rule set of the modern vacuum cleaner, cannot be directly manipulated from the outside. However, it can be manipulated indirectly by manipulating the electric motor. The rule set interface where the services of the fan meet those of the electric motor is permanently settled, which means the services generated are permanently tied to each other. Under the prevailing standard conditions the two rule sets cannot be independently manipulated. Dismounting this permanency calls for rule set revision. Moreover, it is interesting to note that the technological process of the vacuum cleaner operates also in the opposite direction. When the collecting bag is fully packed the fan cannot pass on enough cooling air to the electric motor. As a result the temperature inside the cleaner will rise higher than is allowed by the rule set inscribed into the electric motor. The automatic fuse will release and the vacuum cleaner will stop. The vacuum cleaner incorporates two main processes going in opposite directions - the electric motor is driving the fan and the fan is cooling the electric motor - and it is obvious that in both processes the designer has introduced permanency in interface area between the rule set of the fan and that of the electric motor. However, the user can indirectly manipulate the electric motor by directly manipulating the fan, which is done by exchanging the collecting bag. And then the fan will give proper service again and the electric motor will be back in operation.

The user of a complex artifact cannot manipulate a permanently settled interface from the outside. However, if the designer and the manufacturer have done a good job the user can trust the “function” of the permanently settled interface as the freedom given to the user to indirectly manipulate the downstream artifact (rule set) is constrained to services that are not hazardous to the “health” of the artifact. A rule set interface displaying a high level of permanency may be denoted a “black box” or even an “immutable mobile” (Walsham, 1997, p.468) and as such it adds to the rigidity of the complex artifact. If properly adjusted it simultaneously guarantees the frictionless
redefinition of output into input in this particular area and thus contributes to the smooth and reliable functioning of the complex artifact. The degree of permanency may as well be discussed by employing concepts such as flexibility and rigidity.

Industrial processes in general comprise large numbers of ‘permanently settled rule set interfaces’, some of them simple, others extremely complex, but there is no difference in kind between them just a difference in degree. Basically the two concepts ‘degree of interface permanency’ and ‘degree of automation’ address the same issue, that of activity control where the vital point to consider is whether or not a service generated in present time can also be controlled in present time by manipulating directly from the outside the rule set generating the service. An automated service comes from a rule set that cannot be manipulated by any means. A semi-automated service comes from a rule set that can be manipulated to a certain extent. A non-automated service comes from a rule set that can be fully manipulated in all details. One may question, however, whether there exists any service generating material artifact that is lacking every element of automation. Even an artifact as simple as a hammer is in fact a moderately complex rule system involving some permanently settled interfaces, e.g. the one interlocking the driver and the handle. It follows that industrial services are automated or semi-automated. The appearance of automated and upper-end semi-automated services is the outcome of artifact activation involving a high level of rule set interface permanency. Such artifact combinations are highly rigid entities leaving little room for user manipulation, the most rigid ones leaving for the user only to choose between the modes “operating” or “not operating”, i.e. to manipulate the on-off function. Such entities are simple to use but as rule set interfaces involved are fixed once and for all they leave no room for manipulation except for playing with the on-off function. Services generated from such artifact combinations are repeated uniformly each time a combination is activated.

Manufacturing processes display different levels of automation. They also measure differently on the efficiency scale and it is a broadly accepted “truth” that automation and efficiency are positively correlated variables. Increasing automation commonly implies manufacturing operations become more standardized. The overall effect on process characteristics is that rigidity goes up while flexibility goes down. It usually follows from such changes that standard product programs are favored at the sacrifice of special product programs and customized product specifications. The development in the stainless steel industry over the years is a good example. Consider a hot rolling mill. It represents a highly automated technological process. Whether the final output of the mill, i.e. the hot rolled plate, by a particular user is conceived of as desirable or not addresses the core of the issue of output-input redefinition. A hot rolling mill is an integrated production system offering a mixture of automated and semi-automated services. Many interface areas are permanently settled while others to a greater or lesser degree are left open for manipulation from the outside. Thus as part of normal operation it is possible to perform procedural adjustments. The various rule set
combinations making up the hot rolling mill allow the operator to specify various patterns of interrelated services involving speed, temperature, pressure, set-up time, or any other variable available for manipulation. Theoretically it would be possible to manipulate each variable individually while running the process. In practice, however, a computer program created beforehand controls the entire hot rolling process leaving to the operator only to initiate and monitor the process. The various rule set combinations making up the hot rolling mill including the computer programs controlling the various patterns of interrelated services available manifest as a most rigid technological artifact capable of efficiently producing a fairly broad albeit standardized output repertoire. Now, this is exactly what a frictionless output-input redefinition is all about. Does the standardized output repertoire of the hot rolling mill match the customer’s input requirements everything is just fine, because in the interface area where the rule sets of the hot rolling mill and those of the customer “intake artifacts” meet the customer prefers the occurrence of a smooth and “frictionless” redefinition of output into input.

3.4.3 Repetitive patterns of human behavior

The view of technology as material artifact as described above, and the grouping of artifacts into technological systems, add to the understanding of Jay Barney’s (1991, pp.110-111) somewhat dull description of ‘physical technology’. The discussion supports a definition proposal: ‘Physical technology’ may be defined as knowledge and skills reified into physical objects destined for future purposeful utilization. It is thoughts reified into physical structure, a collection of rules frozen into matter manifesting in space through time, and it is knowledge and skills preserved for future utilization. Such physical technology is “dead tissue” if not activated from the outside. It may be triggered by human force, natural force, or force emanating from an artifact. The level of automation of a manufacturing system measures the extent to which the various artifacts involved in the system are indirectly manipulated by an (human) operator, i.e. to which extent artifacts control other artifacts through permanently settled rule set interfaces, the higher the proportion of indirect manipulation the higher the level of automation. At a first glance it seems that natural forces trigger many technological systems, e.g. lightning systems, air-conditioning systems, pump stations, etc. but closer inspection reveals that all such systems contain inscribed rules signaling when to operate and when to stay idle. Light sensors, thermostats, altitude measures, etc. are designed to start the various processes when conditions are apt. When all is said and done it seems reasonable to contend that from the very beginning it is human force that is activating physical technology. Activation may be direct or indirect and it may be conditioned as well. Moreover, activation may appear in present time or it may be delayed to a future point in time.

Activation of technologies usually requires some knowledge and skills on the part of the operator. Here Nelson and Winter’s (1982) definition of ‘skill’ is referred to. “By a
‘skill’ we mean a capability for a smooth sequence of coordinated behavior that is ordinarily effective relative to its objectives, given the context in which it normally occurs” (ibid., p.73). It is clear that skills grow out of experience and that skills are usually acquired as a consequence of repetitive action. Depending on context and circumstances activation of physical technology may require more or less operator knowledge and skills, i.e. explicit and/or tacit knowledge at the level of the individual and/or the level of the collectivity. As explicit knowledge can be codified it is suitable for transfer by teaching. Tacit knowledge is experience acquired through action. It doesn’t render itself to codification. To some degree it can be “transferred” from one individual to another through extensive training under supervision. It is doubtful, however, whether that should be considered a process of ‘knowledge transfer’. Maybe it should rather be looked upon as a process of ‘knowledge translation’ or ‘guided experience gathering’. No matter which is the appropriate notification the successful activation of physical technology always requires a certain amount of operator knowledge and skills. In an article published in 1946 Fritz Machlup illustrates the relationship between repetitive action, experience gathering and skill development and utilization.

What sort of considerations are behind the routine decision of the driver of an automobile to overtake a truck proceeding ahead of him at slower speed? What factors influence his decision? Assume that he is faced with the alternative of either slowing down and staying behind the truck or of passing it before a car which is approaching from the opposite direction will have reached the spot. As an experienced driver he somehow takes into account (a) the speed at which the truck is going, (b) the remaining distance between himself and the truck, (c) the speed at which he is proceeding, (d) the possible acceleration of his speed, (e) the distance between him and the car approaching from the opposite direction, (f) the speed at which that car is approaching, and probably also the condition of the road (concrete or dirt, wet or dry, straight or winding, level or uphill), the degree of visibility (light or dark, clear or foggy), and the condition of the tires and brakes of his car, and – let us hope – his own condition (fresh or tired, sober or alcoholized) permitting him to judge the enumerated factors. Clearly, the driver of the automobile will not “measure” the variables; he will not “calculate” the time needed for the vehicles to cover the estimated distances at the estimated rates of speed; and, of course, none of the “estimates” will be expressed in numerical values. Even so, without measurements, numerical estimates or calculation, he will in a routine way do the indicated “sizing-up” of the total situation. He will not break it down into its elements. Yet a “theory of overtaking” would have to include all these elements (and perhaps others besides) and would have to state how changes in any of the factors were likely to affect the decisions or actions of the driver. The “extreme difficulty of calculating”, the fact that “it would be utterly impractical” to attempt to work out and ascertain the exact magnitudes of the variables which the theorist alleges to be significant, show merely that the explanation of an action must often include steps of reasoning which the acting individual himself does not consciously perform (because the action has become routine) and which perhaps he would never be able to perform in scientific exactness (because such exactness is not necessary in everyday life). (Machlup, 1946, pp.534-535.)
Machlup does not explicitly use the term ‘skills’ but his experienced driver, who routinely makes the right decisions in highly complex situations while mobilizing some sort of subconscious intelligence, fits in with our understanding of the highly skilled driver. It is the driver that has been in business many times before, that has gathered a lot of experience, and that has gradually developed his driving skills. It is the driver that knows in his fingers, hands, and feet what to do in an acute situation. It is not a matter of rational calculation involving complicated and complex physical formulas. It is ‘knowing how’ rather than ‘knowing what’. When Machlup’s article was originally published in 1946 it was as part of the marginalist controversy of the forties, which implies its focus was very much different from the one addressed here. The behavior of the experienced driver was used by Machlup as an analogy to the behavior of the experienced businessman. His text continues as follows:

The businessman who equates marginal net revenue productivity and marginal factor cost when he decides how many to employ need not engage in higher mathematics, geometry, or clairvoyance. Ordinarily he would not even consult with his accountant or efficiency expert in order to arrive at his decision; he would not make any tests or formal calculations; he would simply rely on his sense or his “feel” of the situation. There is nothing very exact about this sort of estimate. On the basis of hundreds of previous experiences of a similar nature the businessman would “just know”, in a vague and rough way, whether or not it would pay him to hire more men. (Ibid.)

Besides the obvious component of tacit knowledge appearing in the two examples another most interesting component is worth considering. “On the basis of hundreds of previous experiences of a similar nature the businessman would ‘just know’, …, whether or not … to … .” The manifold of previous experiences similar in nature constitutes the basis for taking action in present time. From his rich base of experiences “the businessman would ‘just know’” how to act. Such “knowing how” emanating from past business experiences may be denoted “business skills”. While considering the skill of the driver and that of the businessman it seems obvious that neither does the driver nor does the businessman need to literally repeat a previous behavior of his in order to make the “right” decision in present time. The “knowing how” comprises the ability to skillfully utilize previous experiences for decision-making in present time. Although activities are not literally repeated they link to a repetitive pattern of behavior.

3.4.4 Skills and routines

Skills and routines are both considered repetitive patterns of behavior although the former has been supposed to refer to the level of the individual, whereas the latter has been supposed to refer to the level of the organization. Nelson and Winter (1982, p.73) write:

We propose that individual skills are the analogue of organizational routines, and that an understanding of the role that routinization plays in organizational functioning is therefore obtainable by considering the role of skills in individual functioning.
The authors continue by listing three interrelated aspects of skilled behavior (ibid.):

In the first place skills are programmatic, in that they involve a sequence of steps with each successive step triggered by and following closely on the completion of the preceding one.

Second, the knowledge that underlies a skillful performance is in large measure tacit knowledge, …

Third, the exercise of a skill often involves the making of numerous “choices” – but to a considerable extent the options are selected automatically and without awareness that a choice is being made.

By introducing the two concepts ‘individual skills’ and ‘organizational routines’, accepting a proposed kinship between the two, and assuming that both concepts share the three aspects listed above, i.e. are programmatic, depend largely on the activation of tacit knowledge, and are run by automatic choice to a considerable extent, the authors outline a model set of repetitive human behavior. If focusing on technology for a while, i.e. one of the key concepts of the thesis, with few exceptions technological action is repetitive. It is unusual that technologies are developed for one time use only. Somebody may object to that statement while arguing that in contemporary society many products are designed as disposables, which means after being used once they are thrown away, and of course that is true. But that doesn’t imply that the technologies used when manufacturing disposables are also thrown away after one time use. On the contrary, and maybe particularly when it comes to mass production of disposables, the technologies employed are used again and again while producing large volumes of “cloned” products.

Although obvious differences may be identified between individual repetitive behavior and organizational repetitive behavior, both patterns of behavior will be referred to as ‘routines’ following the position taken by Nelson and Winter (1982).

We use “routine” in a highly flexible way, much as “program” (or, indeed, “routine”) is used in discussion of computer programming. It may refer to a repetitive pattern of activity in an entire organization, to an individual skill, or, as an adjective, to the smooth uneventful effectiveness of such organizational or individual performance. (p.97)

Repetitive activity patterns constitute a phenomenon that has been approached by several scholars in the field of organization theory, and particularly by scholars belonging to the Carnegie School (Simon, [1945] 1997; March & Simon, 1958; Cyert & March [1963] 1994), but also by others drawing upon their ideas, as for instance evolutionary theorists Nelson and Winter (1982). Institutionalized behavior relates to certain procedural structures as ‘value assumptions’, ‘cognitive frames’, ‘(standard operating) procedures’, ‘programs’, ‘routines’ and ‘rules’. Such structures are an outcome of negotiations and conflict resolution (Cyert & March, [1963] 1994). They consist of stable, agreed upon rules organized into patterns in each instance determining a particular course of action. They constitute the foundation for institutionalized behavior.
Institutions can be ... defined as collections of stable rules and roles, and corresponding sets of meanings and interpretations (Czarniawska & Sevón, 1996, pp.3-4).

Institutions incorporate context-related meanings and interpretations reflecting the values and norms held by those contributing to the outcome of the negotiation or the conflict resolution. Furthermore, as part of their substance they carry the kind of knowledge that is abstracted, communicated and shared by human beings making up a social collectivity, i.e. social explicit knowledge, as well as “the knowledge that is fundamentally embedded in the forms of social and institutional practice and that resides in the tacit experiences and enactment of the collective”, i.e. social tacit knowledge (Nahapiet & Ghoshal, 1998, p.247). While relating to the thinking of early institutionalist scholars Scott (1995) summarizes the interrelationship between institutions and structured activities.

Institutions may also be embodied in – carried by – structured activities in the form of habitualized behavior and routines. Routines are carriers that rely on patterned actions that reflect the tacit knowledge of actors – deeply ingrained habits and procedures based on inarticulated knowledge and beliefs.

Rather than privileging cultural systems, many early institutionalists viewed habitualized action, routines, standard operating procedures, and similar patterned activities as the more central features of institutions (p.55).

Processes capable of generating products (material artifacts) employ knowledge and skills. Such processes have been referred to as techniques. Conceptually technique has been described as the “capability or skill (the ‘methods’) needed to bring about the artifacts” (von Wright, 1986, pp.33-34). Such ‘methods’ are commonly used repetitively at least when applied in a business context. Techniques then may be looked upon as “structured activities in the form of habitualized behavior and routines” (Scott, 1995, p.55), carrying stable rules, i.e. institutions, operating to bring about material artifacts (products).

Winter (1990) has referred to routines as the “genes” of organization while ranging them from “‘hard’ (technological)” to “‘soft’ (organizational)”. He emphasizes the following features: “repetitiveness, embodiment in human and physical assets, and ease of identification”, and “[t]he conjunction of these features will serve as a working definition of routine” (p.275-276). Although not precisely clear it seems that Winter views routines embodied in physical assets as “‘hard’ (technological)” and routines embodied in human assets as “‘soft’ (organizational)”. The notification is of particular interest as it supports the idea of repetitive patterned behavior resulting from the activation of humans as well as physical artifacts.
3.5 Dualities of technology

Two major dualities of technology will be discussed; (1) the physical and the non-physical aspect of technology, and (2) utilization and change of technology; the former focusing on structure, the latter on process.

3.5.1 Physical and non-physical resources

Irrespective of area of specialization business firms strive to do well enough to secure tomorrow’s operations. While aiming at performing well business firms use resources, many of which are closely related to the technologies of the firm, and firms that fail to strike a proper balance between resource creation and resource consumption will not be able to make it in the long run. The central importance of resources calls for an explicit exposition of the resource concept generating an appropriate set of effective resource categories. Resource-based theory, a recent development within the field of strategic management, seems to be an appropriate sourcing candidate. The connection between resources and strategies are conceived of as particularly interesting as technological change, the main study object of the thesis, is supposed to involve a portion of actor intention and actor intention by nature is assumed to incorporate strategic elements.

The resource concept as such and the establishment of resource categories are issues frequently addressed in academic literature, not the least in literature on economics and business administration. Within the emerging tradition of resource-based theory a broad stream of scientific articles have arrived during the last ten to fifteen years, the greater part of them in the vein of strategic management.\(^1\) Focus is put on firm resources and their utilization for strategic purposes. According to resource-based theory success is closely associated with the characteristics of the resources the firm controls and the way the resources are utilized. Barney (1991) divides firm resources into ‘physical capital resources’, ‘human capital resources’ and ‘organizational capital resources’, the meaning of which is given by some examples:

Physical capital resources include the physical technology used in a firm, a firm’s plant and equipment, its geographic location, and its access to raw materials. Human capital resources include the training, experience, judgement, intelligence, relationships, and insight of individual managers and workers in a firm. Organizational capital resources include a firm’s formal reporting structure, its formal and informal planning, controlling, and coordinating systems, as well as informal relations among groups within a firm and between a firm and those in its environment. (Barney, 1991, p.101.)

The listing is non-exhaustive and vague as well, not the least concerning Barney’s categorization of relationships. ‘Individual relationships’ are referred to as human

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\(^1\) See for example the special feature issue of Journal of Management, 27 (2001) focusing on resource-based theory.
capital whereas ‘informal relations among groups’ are referred to as organizational capital but as the relationship concept is not further clarified the categorization becomes empty in this part. Maybe other resource categories could or should be considered. By using the word ‘capital’ alongside the three resource categories Barney emphasizes his focus on strategic management. ‘Physical resources’, ‘human resources’, and ‘organizational resources’, all three of them are conceived of as capital to be invested in the firm’s strategic operations. Adding the term ‘capital’ to the respective resource category implies purposeful action is substituted for idleness.

However, if accepting Barney’s three categories it is obvious that ‘physical capital resources’ corresponds to what are denoted tangible assets on the balance sheet whereas ‘human capital resources’ and ‘organizational capital resources’ are both referable to as intangibles. There seems to be little dispute in the literature about the categorization of tangibles but more about the categorization of intangibles, most likely because intangibles, for obvious reasons, are more difficult to conceive and comprehend than tangibles.¹ In this thesis at an overall level resources will be divided into ‘physical resources’ and ‘non-physical resources’, or if emphasizing the strategic aspect of resources the categories will be denoted, ‘physical capital resources’ and ‘non-physical capital resources’ respectively. By conceptually choosing to dichotomize resources the system becomes exhaustive, i.e. if resources are not referred to as physical, per definition they will be referred to as non-physical. Implicitly ‘human capital resources’ and ‘organizational capital resources’ will both be classified as ‘non-physical resources’ because it would be difficult to conceive of them as physical. Knowledge and skills are proposed to be particularly important ‘non-physical resources’ appearing in the business process.

3.5.2 The physical and the non-physical aspect of technology

Barney (1991, p.110) illustrates the phenomenon of ‘physical technology’ by mentioning machine tools, robots in factories and complex information management systems, i.e. by pointing at various technical elements. That is technology as material artifact, in the following denoted ‘technological artifacts’, which make up the physical aspect of technology. By and large it coincides with the term ‘technics’ if using the vocabulary of von Wright (1986, p.33-34). Barney (1991) maintains that “[t]he exploitation of physical technology in a firm often involves the use of socially complex firm resources” (p.110) but he offers no clarification of the concept ‘socially complex firm resources’; as guideline he just mentions a few examples: social relations, culture and traditions. It ought to be clear to each and everyone, however, that ‘technological artifacts’ for their activation need some sort of external stimuli. Once started a technological artifact may, without any further manipulation from the

¹ Beyond the aim of this thesis it could be mentioned that during the 1990s scientific theorists (e.g. Kaplan & Norton, 1996) as well as more practically oriented authors (e.g. Edvinsson & Malone, 1997) have shown a growing interest in the categorization, evaluation and notification of intangibles.
outside, continue to operate “for ever” by responding to its inscribed rules, rules that may prescribe running a certain loop over and over again. But it ought to be equally clear to everybody that in the end some external force has to stop the activities from repeating themselves (should a shutdown command not be built into the program) or the “piece of machinery” – the technological artifact – will either run out of input supply or goes down on other grounds. The external force is commonly an offspring of some repetitive pattern of human activity making use of technological artifacts while concentrating on the generation of products and/or services. In the following such patterns of activity will be called ‘techno-human routines’. They represent the non-physical aspect of technology, which, if referring to von Wright (1986, p.33-34), displays similarities with the term ‘technique(s)’. The non-physical aspect of technology has usually been hidden in nice “black boxes” such as ‘human capital resources’, ‘organizational capital resources’ (Barney, 1991), ‘organizational competencies’, ‘organizational capabilities’ (Métais et al, 1998), ‘core competencies of the firm’ (Prahalad & Hamel, 1990), and the like, but it is a mistake to externalize ‘techno-human routines’ from the concept of technology.

Winter (1990) takes a step forward by appreciating routines as genes of the organization. He presents some examples of routines that are “diverse in the dimension ’hard’ (technological) versus ’soft’ (organizational)” (p.275) while maintaining that routines are repetitive patterns of activity requiring investment in routine-specific human and physical capital. The close connection between the two categories is obvious. The physical element – in our vocabulary ‘technological artifacts’ - needs the human element for manipulation and coordination to occur. The human element – ‘techno-human routines’ – brings to life “slumbering” knowledge and skills residing in the physical element. Thus in practice the two aspects of technology, the physical and the non-physical, are closely intertwined. Both are carriers of rules established in the past enabling and constraining current activities. They show up as inherited resources in present time (Penrose, [1959] 1995, p.82). As regards the former aspect rules are inscribed into physical objects, i.e. they are tied to matter and energy in space through time. Concerning the latter aspect rules are arranged into conceptional and/or cognitive patterns determining “how things are to be carried out”. Thus defined ‘technology’ is an institution in its own right. Techno-human routines simultaneously organize human behavior and the way technological artifacts are utilized. They appear as the interconnecting glue of any system of technology¹. For a technological system to operate satisfactorily the rules captured in the two aspects of technology have to match. Considering techno-human routines to be an integral part of technology is moving another step ahead in the establishment of a rich and consistent conceptualization of technology.

¹ Here a ‘system of technology’ (or ‘technological system’) may be defined as a coherent set of technological artifacts and techno-human routines suitable for the generation of a particular type of products or services.
The concepts ‘technological artifacts’ and ‘techno-human routines’ introduce evident boundary-fixing problems into the discussion. How distinguish between ‘techno-human routines’ and other types of routines, and how to separate ‘technological artifacts’ from material artifacts that are not conceived of as ‘technological’? There are no univocal answers to this kind of questions. Answering them is rather a matter of choice tracing back to a few basic assumptions made in relation to this thesis work. First, the thesis is restricted to study technological change as it appears in an industrial context, i.e. technological change appearing as part of the business process (see section 1.6.3 above). That implies, whether technological or not, artifacts appearing in other contexts are not considered. Second, per definition the business process comprises exchange of products (and/or services) between participants operating on different markets (see section 4.2.2 below). That implies each party involved has to contribute at least with a minimum of transformation activities as the business process is assumed to include both transformation and transaction activities. Now, ‘technological artifacts’ are described as those material artifacts that are directly manipulated in the business process. It is a fairly vague and slippery definition but it is still enough precise for the purpose of this work. Technology has been defined as “the science of the application of knowledge to practical purposes, applied science”, and “a technical method of achieving a practical purpose” (Webster’s Dictionary, [1961] 1993). It is clear that contemporary business firms apply knowledge to practical purposes when performing transformation and transaction activities. That is basically at the core of their interest and by sharpening their knowledge arguments they strive to be better off than their contestants on the competitive arena. Material artifacts mobilized in this process are referred to as ‘technological’. It is also beyond debate, most likely, that business firms commonly channel their application of knowledge through various routinized “methods”, here called ‘techno-human routines’, constituted by a mixture of procedures and practices. Such routines direct human behavior and implicitly also the manipulation and coordination of technological artifacts. The outcome manifests as transformation and transaction activities making up the business process. That implies ‘techno-human routines’ along with ‘technological artifacts’ make up the structural frame of the business process. Activating these elements means getting the business process going.

Distinguishing between techno-human routines and other routines is a delicate task, not possible, neither necessary, to univocally accomplish. Here techno-human routines are described as those routines that interconnect human behavior and the manipulation and coordination of technological artifacts in the business process. Techno-human routines frequently appear in functional areas such as logistics, manufacturing, repair and maintenance, and quality work but they also appear in marketing and sales, and even in R&D. In functions such as accounting, and human resource management they are largely conspicuous by their absence. With reference to Porter’s (1986, p.19 ff) ‘value chain’ concept, ‘techno-human routines’ are mostly supposed to comprise ‘primary activities’ (inbound logistics, operations, outbound logistics, marketing and
sales, and service), while ‘support activities’ (firm infrastructure, human resource management, technology development, procurement) are more rarely included. It is clear that another content could have been infused into the concept, but for the purpose of this thesis work, the significance given to ‘techno-human routines’ as well as that ascribed to ‘technological artifacts’ – the two constituting elements of technology – make technology, it is hoped, a viable concept for the study of technological change inside and between business organizations.

3.5.3 Utilization and change of technology

The relationship between structure and action has been frequently visited in the past (e.g. Penrose, [1959] 1995; Chandler, 1962; Giddens, 1984). The fundamental theme of inquiry underlying all these contributions has been (and is) whether structure determines action, action creates structure or influence goes in both directions. It is a particular variation on the classic theme: Which comes first, the hen or the egg? The issue, as presented here, focuses upon utilizing technology and changing the structure of existing technology. The former relates to “structure determines action” as existing technology at the same time enables and constrains action, i.e. the combination of rules making up existing technology sets the limits for technology utilization. The latter relates to “action creates structure” as technological change implies the modification of existing technology or the development of new technology.

Technology utilization means purposefully operating a system of technology, i.e. activating techno-human routines and manipulating technological artifacts. With rare exceptions activating techno-human routines results in the creation of both manual services and machine services. Human beings are the originators of manual services, which may directly transform matter, influence human beings, or manipulate technological artifacts. Machine services arise as technological artifacts are manipulated either directly by human beings or indirectly via other artifacts. Just like manual services machine services may transform matter, influence human beings or manipulate technological artifacts. Per definition machine services always involve an element of automation. Figure 3:2 mediates a simplified view of technology utilization involving the two components of technology structure, their relationship to technological services and the effect

![Figure 3:2 Technology utilization](image)
generated. The scheme also serves the purpose of illustrating the basic assumption that
technology structure is “dead tissue” if not activated. It is difficult to think of any
system of technology, no matter how simple, that does not generate any type of
machine service and it is equally difficult to think of any other system of technology,
no matter how sophisticated, that does not generate any type of manual service. Also a
“fully automated” technological system has to be activated (started) and deactivated
(stopped). Such activation and deactivation may of course be carried out by some kind
of machine service – the outcome of the manipulation of another artifact – but at some
level of aggregation a manual service has to activate and deactivate the aggregated
system of technology. Depending on which are the “repertoires” of the techno-human
routines and the technological artifacts – with “repertoire” is meant the standard
options built into the rule sets constituting the routines and the artifacts respectively –
the technological system is capable of offering a certain amount of technological
services each one of them generating a particular effect. Technology utilization then
means drawing services from the “standard service palette” of a system of technology.
It is obvious that it does not concern developing new technological artifacts, neither
does it comprise finding new ways to make use of existing artifacts by being inventive.
It is just repeating certain patterns of activity outlined in the past for the achievement
of predetermined results.

Taken altogether the physical technology and the non-physical technology available to
a firm at a particular point in time constitute its current base of technological
resources. In the short run it remains what it is, which implies in the short run it
represents all that the company has at its disposal when aiming at satisfying the needs
of its customers. Utilizing existing technology is a matter of activating existing
routines, which in turn govern the utilization of material artifacts and related
intellectual capital. It is largely a matter of sticking to standard operating procedures.
There is usually little room for improvisation or development. Depending on which is
the technological context material artifact manipulation may present some openings
for variation. The more automated the operation process the less the freedom of the
operator to improvise. It seems reasonable to maintain that a carpenter has more
freedom to choose an alternative route of action than does an operator in a chemical
plant, but then it should be taken into account that much of the operations of the
carpenter are also heavily routinized. Not only nailing is performed in a routine way.
After several years in business a carpenter probably performs most of his professional
activities in a routine way because it is both efficient and effective to do so. The
services emanating from combining craftsmanship and professional tools are the
outcome of routines and artifacts smoothly working together. It follows from the
discussion that the seemingly obvious difference between carpentry and process
production of chemicals might not be that obvious after all. Both involve material
artifacts designed and manufactured for the purpose of delivering predestined services
and both involve human operators adhering to established routines when carrying out
their work tasks. Technology utilization is reactivating inherited knowledge and skills,
i.e. knowledge and skills “frozen” into material artifacts and knowledge and skills captured in the repetitive pattern of activities here denoted techno-human routines.

But human beings not only utilize technology over time they also change it in various ways. “Technology is created and changed by human action, yet it is also used by humans to accomplish some action. This recursive notion of technology - … I call the duality of technology” (Orlikowski, 1992, p.405). Orlikowski’s view of technology builds directly on Anthony Giddens’ theory of structuration. Giddens (1984, p.374) describes the ‘duality of structure’ in the following way: ”Structure as the medium and outcome of the conduct it recursively organizes; the structural properties of social systems do not exist outside of action but are chronically implicated in its production and reproduction.” And Orlikowski (1992, p.404) summarizes the essence of Giddens’ theory: “Structuration is posited as a social process that involves the reciprocal interaction of human actors and structural features of organizations. The theory of structuration recognizes that human actions are enabled and constrained by structures, yet that these structures are the result of previous actions.” Basically the theory of structuration appreciates that the rules (structure) mediating action are reaffirmed at the time they are used by human beings. The idea is simple. According to structuration theory structure is basically an institutional phenomenon that is created by those performing human action in present time. Rule-based human action works to reaffirm the rules on which humans act. The result is structure enacted. Repetitive patterns of human activity, then, operate as the preserving agent of structure. Rules captured in technological artifacts (tied to matter, energy, space and time) are commonly reaffirmed over and over again as the artifacts are repeatedly utilized in a particular way. Utilization raises demand for user knowledge and the ‘knowing how’ of the user is commonly found embedded in techno-human routines, i.e. human task-oriented routines operating in connection with various technological artifacts. The duality of technology, a paraphrase on Giddens’ theory, maintains that human beings make use of, create and change technology as they go along performing their activities.

3.5.4 Dualities of technology matrix model

By interrelating the two technology aspects with technology utilization and technological change the ‘Dualities of technology matrix model’ establishes (see Figure 3:3). The model takes into account the two structural components of technology, (1) the physical aspect of technology – the technological artifact – which is defined as ‘material artifact or pre-coordinated set of material artifacts intended for the generation of products and/or services’, and (2) the non-physical aspect of technology – the techno-human routine – which is defined as ‘repetitive pattern of human activity concentrating on the generation of products and/or services while employing technological artifacts’. Across the structural components are projected the process views of technology, (a) utilization of technology, which comprises the manipulation of technological artifacts and the activation of techno-human routines,
The non-physical aspect of technology (techno-human routines)

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<th>Activation of ‘techno-human routines’</th>
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<tr>
<td>Manipulation of ‘technological artifacts’</td>
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<th>Utilization of technology</th>
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Figure 3:3 Dualities of technology matrix model

and (b) technological change, which concerns the modification or novel development of technological artifacts and techno-human routines. The ‘Dualities of technology matrix model’ and the thoughts and arguments underpinning the model offer an answer proposal to the question: “What is technological change?” And the answer goes that technological change is change in technological artifacts and techno-human routines. But change doesn’t arise out of nothing, and that particular consideration is articulated in the main research question of the thesis: “How does technological change come about in an international, industrial system?” Studying the process of technological change is not just studying what is changing but also looking for the sources of change that influence the structural alteration of technological artifacts and techno-human routines. And that is actually what the remainder of this thesis work is going to do.
4 INDUSTRIAL NETWORKS AND INTERNATIONAL BUSINESS (THEORY)

An introduction focusing different modes of coordination and control leads up to a clarifying discussion about the business concept and the business organization. An overall reflection upon the interaction between business organizations is followed by a presentation of the ‘markets-as-networks’ approach to industrial markets and a model outline of the industrial system. Internationalization in a network perspective uncovers a process involving successive learning and recurrent investments in which technological change constitutes an integral part. The development of a conceptual framework completes the chapter.

4.1 Different modes of coordination and control

It is assumed that any business operation involves activity coordination and resource allocation independently of which is the prevailing mode of control. The assumption assigns the business process an overarching function in relation to the firm and the market.

4.1.1 “Islands of conscious power”

While quoting D. H. Robertson (1932, p.85), Ronald H. Coase¹ in his famous article, “The nature of the firm” (1937), writes:

As D. H. Robertson points out, we find “islands of conscious power in this ocean of unconscious co-operation like lumps of butter coagulating in a pail of buttermilk” (p.388).

Coase’s message is that firms expand on the expense of markets and the underlying logic is that in any situation where activity coordination is an issue the most cost effective institution of the two – the firm or the market - will be chosen. Basically, the metaphor visualizes a fundamental problem encountered by any firm involving in business operations, i.e. the problem of “whether to make or to buy”, and independently of which will be the answer the matter is of particular interest and importance to the firm.

When formulating his “division of labor mechanism” Adam Smith (1776) ends up in a similar conclusion while following another line of thought. He contends that the dedication of an individual to one single employment positively impacts upon productivity and dexterity with an implication on the output quantity. The volume produced becomes larger than is needed for own consumption, which in turn implies the surplus may be sold to others. Smith argues ”it is the power of exchanging that

¹ In year 1991 Ronald Coase was awarded the Nobel Prize in economy.
gives occasion to the division of labor, so the extent of this division must always be limited by the extent of that power, or in other words, by the extent of the market” (ibid. p.8). His was also the idea that through market exchange "an invisible hand” guides society for the mutual benefit of both private and community interests (ibid. p.456). But market exchange was not seen as unproblematic. Rather it was an activity involving ”higgling and bargaining” (ibid. p.48). The market was something concrete but of limited analytical interest, since the market price was often influenced by accidental events. The formulation of the division of labor mechanism with its focus on manufacturing specialization, skill development and exchange in a market is an early description of the enterprise phenomenon.

Coase (1937) points at other explanation proposals to why firms exist: “Marshall introduces organization as a fourth factor of production; J.B. Clark gives the coordinating function to the entrepreneur; Professor Knight introduces managers who coordinate” (p.388). More recently Snehota (1990) considers “a business enterprise as a collection of resources committed to and organized for the pursuit of a business activity” (p.40). The definition traces back to Penrose’s ([1959] 1995) way of defining enterprise “as a psychological predisposition on the part of individuals to take a chance in the hope of gain, and, in particular, to commit effort and resources to speculative activity” (p.33). Penrose’s “business firm … is both an administrative organization and a collection of productive resources; its general purpose is to organize the use of its ‘own’ resources together with other resources acquired from outside the firm for the production and sale of goods and services at a profit” (ibid. p.31). It seems that the characteristics of Penrose’s business firm largely coincides with those of Snehota’s business enterprise.

Robertson’s “islands of conscious power in this ocean of unconscious co-operation” is a metaphor used to draw attention to a particularly important difference between the firm and the market. In the market coordination comes about as the result of unconscious cooperation, i.e. by activating the price mechanism, whereas in the firm conscious power is governing the coordination of activities. In the tradition of economics the firm is considered a production function. The firm manufactures commodities and goods. It involves in production and trade but selling is looked upon as subordinated to production. Focal attention is drawn to internal manufacturing efficiency, which is expressed along the cost dimension.

The firm is considered a unitary decision making structure, with a unitary goal of profit, to be achieved through economizing in the process of transformation of a given set of inputs to desired outputs. (Snehota, 1990, p.43.)

Penrose ([1959] 1995, p.11) offers some background information in relation to the development of the firm concept in economics.

The ‘theory of the firm’ – as it is called in the literature – was constructed for the purpose of assisting in the theoretical investigation of one of the central problems of economic analysis – the way in which prices and the allocation of resources among
different uses are determined. It is but a part of a wider theory of value, indeed one of its supporting pillars, and its vitality is derived almost exclusively from its connection with this highly developed, and still basically unchallenged general system for the economic analysis of the problem of price determination and resource allocation.

The basic significance of the firm in “the theory of the firm” is strictly economic. That factual firms are populated with people is not really considered. But if appreciating the human aspect of the “islands of conscious power” a different picture comes to light and we approach the concept of organization.

The concept of organization in sociology is more ambiguous than that of the firm in economics. In a broadest sense an organization is a group, a collectivity of actors related with one another through joint activities of some members. The concept of organization is centered around shared behavior and activity routines that emerge in a collectivity of individuals, regardless of the purpose of the collective. (Snehota, 1990, p.44)

An early contribution in the tradition of organization theory1 supports the idea of an organization as a group of persons.

[...]

As already indicated the organization concept is primarily referable to a social order. According to Webster’s Dictionary ([1961] 1993) an organization is ”a group of people that has a more or less constant membership”. Also Barnard ([1938] 1968, p.69) discusses group membership. He contends that membership is the result of cooperative interaction between persons. Ahrne (1994) offers a clarifying, although fairly wide description of the characteristics of an organization.

The power of attraction of the nodes of everyday life is generated through four conditions that characterize and determine forms of human interaction:

(a) affiliation
(b) collective resources
(c) substitutability of individuals
(d) recorded control

A central argument will be that these nodal principles together constitute common features in basic social units such as families, enterprises, clubs or states. They are combinations of forces that make people part of social entities. We will call these entities organizations, ... (p.2).

It is clear that “the lumps of butter” phenomenon has been given a variety of meaning in the literature and that some of these descriptions have got names of their own, although their meaning is not always unambiguous. Most commonly we meet denotations such as “firm”, “organization” and “enterprise” and quite often in

combination with the word “business” (Snehot a, 1990, pp.40-45). Two views, i.e. the managerial view of the firm and a general view of the institutionalized organization, will be further outlined in chapter 6. A clarifying conceptualization of the business organization is given below in this chapter.

4.1.2 The firm, the market, and intermediate forms of coordination

Conventional wisdom in the field of economics appreciates two different institutions for the coordination of activities, i.e. the firm and the market. In the firm activity coordination is secured by means of hierarchical power, whereas in the market activities are coordinated through the price mechanism (Coase, 1937; Williamson, 1971; Buckley & Casson, 1976; Hennart, 1982). Economic theorists Alchian and Demsetz (1972) propose that the firm is not necessarily that much different from the market, and Demsetz (1992, p.28) contends that the firm “is a nexus of contracts that is created within the market and that remains a part of it”.

Firm, firm-like organization, and market differ only in the nature of contractual agreements. The differences, however, are in the nature of continuous shadings not abrupt divisions. There are no stark boundaries. … Durability and directability of cooperative association, I believe, correlate with our notion of a firm.

If exchange involves contractual agreements and associations between traders that carry beyond the instant of exchange, or that stray away from price as the primary parameter of interaction, “the” market becomes less different from “the” firm. (Ibid.)

The quotation points at “the” firm and “the” market as opposite ends of a continuum while opening for intermediate forms of coordination. This is sympathetic with looking at D.H. Robertson’s “islands of conscious power in this ocean of unconscious co-operation” as being bridged by intermediary islets and rocks. While relying on formal contractual arrangements for inter-firm cooperation the view represents an extension of conventional wisdom in economics, but it still leaves out of account behavioral aspects of business operations. It is beyond debate, however, that factual business practice involves behavioral sentiments and appreciating the involvement of human and social elements when conceptualizing intermediate forms of coordination opens for richer analyses, it is argued. The business relationship as an institution for inter-firm coordination of business activities is such a conceptualization (e.g. Johanson, 1966; Håkansson, 1982). It complies with the notion that actors involving in interaction with one another more than accidentally develop relationships (Homans, 1951; Nadel, 1957). Individuals as well as collectivities may be considered actors. When collective actors involve in business exchange with one another on a repetitive basis business relationships arise. Such relationships involve a social dimension.

Ouchi (1980, p.137) distinguishes three modes of control, i.e. ‘the market’, ‘the bureaucracy’ and ‘the clan’, while contending that each mode operates from a basis of social agreement. For the market the normative requirement is reciprocity, for the bureaucracy it is reciprocity and legal authority, whereas for the clan it is reciprocity,
legal authority, and common values and norms. The corresponding informational requirements identified are prices, rules and traditions. In line with the tradition of transaction cost economics Ouchi maintains that the appropriate mode of control to make use of in a given situation is the one ending up in the lowest transaction cost. The clan mechanism as a mode of control (or activity coordination) is governed by implicit rules evolving over time as individuals, groups or organizations interact. Thus, the clan mode of control is based on the same coordinating principle that Barnard (1938, p.144 ff) identified as “informal organization” and Selznick (1957, p.5 ff) discussed in terms of “institution”. Martinez and Jarillo (1989) have inventoried the evolution of research on coordination mechanisms in multinational corporations and they conclude that “informal and subtle” mechanisms of coordination, which have often been denoted corporate culture, have gained ground over the second half of the 20th century.

Ouchi (1980, p.140) raises the question “What is an organization?” and his answer is:

An organization, in our sense, is any stable pattern of transactions between individuals or aggregations of individuals. Our framework can thus be applied to the analysis of relationships between individuals or between subunits within a corporation, or to transactions between firms in an economy.

And a second question goes “Why do organizations exist?” and the answer is:

In our sense, all patterned transactions are organized, and thus all stable exchanges in a society are organized. When we ask ‘why do organizations exist’, we usually mean to ask ‘why do bureaucratic organizations exist’, and then the answer is clear. Bureaucratic organizations exist because, under certain specifiable conditions, they are the most efficient means for an equitable mediation of transactions between parties. In a similar manner, market and clan organizations exist because each of them, under certain conditions, offers the lowest transactions cost.

The relationship – or clan if using the vocabulary of Ouchi - is an institution in its own right. Actors involving in exchange with each other more than accidentally become acquainted, develop agreements, establish common values and norms and so become tied together. They commit themselves to each other and fulfillment of commitments often includes some kind of adaptation. As parties adapt to each other trust emerges. Mutuality has been referred to as “the mirror of trust” (Ford et al, 1986, p.61). Hannerz (1996, p.110) proposes another description of trust, which goes: “I know, and I know that you know, and I know that you know that I know”. It is obvious that this description includes both familiarity and mutuality.

4.2 The business concept and the business organization

Nowadays not only the traditional business enterprise involves in business activities but also public agencies and even associations of various kinds increasingly apply the business logic (Forssell & Jansson, 1996). Besides, business has become a word of fashion. It is frequently used in various contexts and it is loaded with a variety of
meaning. “Business as usual”, “get down to business”, “back in business”, “business-minded”, etc. are all phrases and expressions widely spread and commonly used in every-day life. The word ‘business’ has traveled a long way until arriving in contemporary society and like many words and expressions of fashion it suffers from ambiguity.

As the business concept makes up an important point of departure for this dissertation there is need to load it with a precise meaning. A first step in that direction is to assume business to be a change process involving process dynamics. But how to characterize this particular process of change called business? Understanding the word is certainly not trivial. The dictionary offers a few slightly different definitions, among those:

Purposeful activity; activity directed toward some end; a usually commercial or mercantile activity customarily engaged in as a means of livelihood and typically involving some independence of judgment and power of decision and sometimes contrasted with the arts or professions or sport or other activity considered less practical, serious, respectable, or mundane; a commercial or industrial enterprise; transactions, dealings, or intercourse of any nature but now especially economic (as buying and selling); the procedures and techniques of such enterprises. (Webster’s Dictionary, [1961] 1993.)

The content and characteristics ascribed to a concept determines its usefulness for a particular purpose. Whatever the meaning of the word business in every-day life, when it comes to enterprise and enterprising the word appears as markedly problematic raising demand for conceptualization. In order to give business a precise meaning it is necessary to look behind the curtain of fashion. A productive approach when aiming at developing the meaning of a concept is sometimes to consult history.

4.2.1 Business as trade

Man has been concerned with exchange of goods since ancient times and before. “A variety of archaeological findings indicate that external trade existed at least 5000 B.C. Seashells and objects of obsidian from this period have, for example, been found hundreds of miles from their origins.” (Swedberg 1994, p.256). Business according to the Webster Dictionary (1993) may be defined as “a usually commercial or mercantile activity …” or “transactions, dealings, or intercourse of any nature but now especially economic (as buying and selling)”. This is business interpreted as trade, i.e. “the business of buying and selling or bartering commodities; exchange of goods for convenience or profit” (ibid.). Adam Smith’s frequently cited praising of the trade mechanism goes as follows:

The division of labor, from which so many advantages are derived, is not originally the effect of any planning. It is the necessary, though very slow and gradual, consequence of a certain propensity in human nature which has in view no such extensive utility; the propensity to truck, barter or exchange one thing for another. Whether this propensity be ingrained in human nature, or whether, as seems more
probable, it be the necessary consequence of the faculties of reason and speech, is not material. (Smith, 1776, book 1, chapter 2.)

The industrial revolution emerging in England during the latter part of the 18th century brought production into focus. Neo-classical microeconomics appearing about a century later appreciated the manufacturing firm as an important building block of society. However, in this tradition the firm is reduced to a simple production function, “… a strange bloodless creature without a balance sheet, without any visible capital structure, without debts, and engaged apparently in the simultaneous purchase of inputs and sale of outputs at constant rates” (Boulding, 1950, p.34). The mathematical models developed within the tradition of neo-classical microeconomics are based on the assumption that a large number of “representative firms” (Marshall, 1920), all of them utilizing the same technology, compete with each other on the supply side of the market while offering customers identical products. Also the number of buyers is supposed to be large and furthermore, every market actor has access to all existing information. No particular dependencies establish between the actors in the market, which implies every actor can freely choose from time to time which counterpart to deal with. According to neo-classical microeconomics this market structure called ‘perfect market’ or ‘perfect competition’ is the ideal one optimizing resource allocation in society. Chamberlin (1933) modified the theory by adding monopolistic elements to the perfect market but his contribution, entitled monopolistic competition, did not change the traditional view of the firm. The firm remains a “black box” performing trade in the market.

In the early 20th century institutional economist Thorstein Veblen (1904) paints a harsh and straightforward view of the business concept:

The motive of business is pecuniary gain, the method is essentially purchase and sale. The aim and usual outcome is an accumulation of wealth. Men whose aim is not increase of possessions do not go into business, particularly not on an independent footing. (p.20)

On the topic of business organizations organization theorist William Dill (1965) states:

Long the darling of economists, business organizations remain something between enigma and anathema to most historians, psychologists, sociologists, and political scientists. Even in economics, more attention has been given to describing the aggregated interactions of companies or to recommending strategies for businessmen to follow than to analyzing the internal development and operation of individual firms. (p.1071)

It seems to be beyond dispute that students of economics by and large stick to the conception of business as equivalent with trade. Early business practice as described in the tradition of economics puts equals sign between business and trade. The industrial revolution did not change that circumstance although sophisticated production systems were soon operating in firms. The dominant line in economic theory kept the firm, i.e. the production (transformation) system, separated from matters concerning sales and distribution (transaction). Optimal resource allocation was supposed to occur in the
market via the price mechanism. Such a scientific posture implied business activities did not really include production. Business followed on production (sales) or was performed prior to production (purchase). Business appeared before and after production. This conceptualization of business implies attention is directed towards questions of the kind: How to sell the goods we produce? How to organize the sales function and how to arrange supply? Thus, business was largely reduced to matters concerning transaction (purchase and sales) while missing out on transformation (production) activities.

4.2.2 Business as trade and production

A somewhat different understanding of the business concept appreciates the involvement of some kind of production or industrial activity complementary to the activities relating to pure buying and selling. This is a view of business that fits in with the connotation of the word as “a commercial or industrial enterprise” (Webster’s Dictionary, [1961] 1993). Snehota (1990) offers a clarification: “The notion of trade evokes activity of buying and selling consequent to production or industrial activity. Trade is done with existing commodities and goods. The notion of business appears to be somewhat broader than that of trade in so far as it embraces also some industrial or production activity, some creation of goods, while trade does not” (p.25). Weimer (1962) holds the same position as regards the business concept: “Business deals primarily with the economic aspects of life. … Business activities include the production and sale of goods and services, usually by privately owned firms or companies” (p.6).

But there is a particular implication following upon extending the business concept to involve both transaction and transformation activities: “The scope of trade is exploiting the opportunities of gain through buying and selling in one product market. … Business activity often implies buying and selling in separate product markets which requires, as a rule, some degree of transformation of inputs into outputs, or transformation of goods into other goods.” (Snehota, 1990, p.26.) Commercial activities performed across different product markets while aiming at exploiting exchange opportunities has been argued to be the core of entrepreneurial activity. “[t]he essence of entrepreneurial activity, … , involves simultaneous participation in more than one ‘market’ - in fact, this activity consists of linking up different markets.” (Kirzner, 1973, p.124.)

4.2.3 The business organization

Two conceptualizations of business have been extracted from the literature. Business may be looked upon as an exchange process involving transaction activities only. In this view business becomes a market phenomenon, a phenomenon of inter-
organizational concern only. It is clear that the inter-organizational approach appreciates business actors because them without the market would be an empty space. However, in this perspective the business organization appears more or less as a black box whose internal life is not really considered. Extending the business concept to comprise both transaction and transformation opens for a study taking into account an intra-organizational as well as an inter-organizational perspective. It becomes equally important to consider what goes on inside and between business organizations. This standpoint is sympathetic with the idea that business is an activity linking up different markets, which in turn invites entrepreneurial activity to be an integral part of the business process. Looking upon business as a change process carrying an entrepreneurial flavor involving both transformation and transaction activities is expanding the business concept beyond its everyday use, and, more importantly, it prepares for a study emphasizing process continuity and a dual approach to technological change. This is the view of business as applied in this thesis and the conceptualization implies that, while transforming input into output, the business organization\(^1\) aims at profit generation by involving in exchange with other entities. Companies dedicated to pure trading are not conceived of as business organizations. They may be denoted traders or trading companies. But should such companies involve in transformation activities that made them operate in different markets on the supply and the demand side, no matter the degree of transformation, they would qualify as business organizations.

### 4.3 Interaction between business organizations

Business organizations meet and interact on markets. Interaction may appear as cooperation or struggle. Although difficulties arise when aiming at drawing a distinct line between the market and the organization still many theories attempt to describe and explain what goes on between organizations operating on markets. Conceptually the market may be given different meanings. On the one hand it might be reduced to an impersonal price mechanism, an invisible hand assumed to optimally allocate resources in society. On the other hand it might be looked upon as a network of business organizations and relationships interconnected through various forms of interdependencies evolving and dissolving over time. The former view refers to the tradition of economics whereas the latter relates to behavioral science. The two perspectives emphasize different forms of interaction with influence on the way technological change is described and explained.

\(^1\) The expressions ‘business organization’, ‘business firm’, ‘business enterprise’, and ‘business company’ are used interchangeably as equivalents in this thesis.
4.3.1 Economic theories and interaction

Traditionally the study of business and business firms has been reserved to the field of economics. Neoclassical microeconomics, in particular, made a strong case a century ago with their static explanation of firms operating on perfect markets as well as those facing a monopoly situation. This line of thought maintains that perfect competition results in optimal resource allocation in society whereas monopolies hamper the development of societal wealth. With the introduction of monopolistic competition (Chamberlin, 1933) and the further development of the field into industrial organization economics (Bain, 1959; Caves, 1964) main attention was given to the struggle between competing firms operating on imperfect markets, i.e. markets exposing various elements of differentiation, and the nature of competition was better understood. Market structures such as oligopolies and oligopsonies characterized by fierce competition received increased attention. In this theoretical perspective interaction is synonymous with competition showing, but interaction is performed indirectly involving contending parties aiming at securing the business with an invisible third party.

The early 1950s was the time when orthodox neoclassical economics was challenged from the inside. “Managerial economics”, Joel Deans pioneering book from 1951, became a starting signal for an extensive production of popular management literature to be published over the 1950s and 1960s. And the message was strongly directed towards practitioners. “Close-to-reality-easy-to-use” models and solutions were developed and spread. Rooted in the tradition of economics but cross-fertilized with pertinent mechanisms adopted from a variety of sources managerial economics soon became the guiding principle of many business practitioners and it spread quickly throughout the business world. The managerial view of the firm was established and economics had finally got a language that could be understood and used by ordinary businessmen. With managerial economics practitioners got the ‘managerial school of marketing’, an interactive S-O-R (stimuli-organism-response) approach to marketing including a set of simple and powerful tools such as ‘the market concept’, ‘the product life cycle’, ‘market segmentation’, ‘product differentiation’, etc. ready for use in business practice. (Sheth, et al, 1988.) Lately management strategists Michael Porter (1980, 1985, 1990), Jay Barney (1986, 1991) and others have developed theories and models aiming at guiding the understanding and practice of business management while upholding concepts such as ‘entry barriers’, ‘core competence’, ‘competitive advantage’, and ‘sustained competitive advantage’. Indirect competitor interaction is still very much at the center of the original as well as the posterior ‘managerial school’ but concepts such as ‘customer satisfaction’, ‘customer retention’ imply that some attention, although rudimentary, is directed towards the customer.

In the tradition of neoclassical microeconomics, and theories linking to this vein, it seems that the prime mode of interaction is competition. Usually this type of interaction is effectively indirect. To be better than competitors in the eyes of a third
party is what matters, but little if anything is said about this third party. Focus is put on indirect horizontal interaction involving competitors or potential competitors whereas vertical interaction with customers and suppliers is usually conspicuous by its absence. However, it is a well-known fact that even severe competitors sometimes organize various types of direct collaborative agreements between themselves in order to gain benefits. Thus, strategic alliances may concern a broad range of interests, e.g. technological development or new market entry. Cartels and trusts aiming at supernormal rents based on reduced competition is another example of collaboration between competitors (although illegal in most countries).\(^1\)

The Austrian school of economics, a challenger to the neoclassical approach in the early 20\(^{th}\) century, proposed a process approach to economic studies but did not receive the same level of recognition at that time as did neoclassicism (Eliasson, 1987).\(^2\) It put strong emphasis on competition and entrepreneurship and with Joseph Schumpeter’s (1942) conceptualization of competition other descriptions of the term become fairly modest.\(^3\) While comparing with “the traditional conception of the modus operandi of competition” he writes:

> But in capitalist reality as distinguished from its textbook picture, it is not that kind of competition which counts but the competition from the new commodity, the new technology, the new source of supply, the new type of organization (the largest scale unit of control for instance) – competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives. (Schumpeter, 1942, chapter 7: “The process of creative destruction”.)

4.3.2 Behavioral theories and interaction

New problems and new opportunities appearing after the end of World War II raised demand for new and richer descriptions of the firm. The marginalist definition was judged ineffective allowing free scope for the advent of the managerial view of the firm. From the early 1950s, but increasingly during the 1960s and 1970s, behavioral aspects of human activity gradually entered into the field of business studies. American business schools started recruiting psychologists, sociologists and other behavioral scientists for the teaching of business students. In the field of marketing a few streams of thought appreciating and markedly building upon social and psychological elements grew into ‘the buyer behavior school’, ‘the social exchange school’, and ‘the organizational dynamics school’ (Sheth, et al, 1988, p.25 ff). Consumer oriented marketing schools like ‘buyer behavior’ emphasized the psychology of buying

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1. Most commonly cartels and trusts take the form of price fixing or division of markets between collaborators.
2. However, after the oil crisis in the 1970s the Austrians had their revenge when much of the old theories that governments previously had relied on to control the business cycle lost their immediate relevance and were jettisoned.
3. Schumpeter is usually considered a member of the Austrian school.
behavior, whereas ‘organizational dynamics’ directed attention towards the sociology of interorganizational exchange, while borrowing “heavily from works in organizational behavior, social psychology, and sociology by authors like French and Raven (1959), Emerson (1962), Aldrich (1979), and Pfeffer and Salancik (1978)” (ibid. p.29). As a founding element ‘organizational dynamics’ involved a richer and more socially oriented description of the firm commonly addressed to as the behavioral view of the firm.¹

Behavioral science exposes a long tradition of using concepts such as relationships and networks to describe and investigate various phenomena relating to human behavior and social structure, and particularly so in sociology, anthropology and psychology (Scott, 1991). The basic assumption embraces the idea that human beings involving in interaction with one another commonly develop social relations that interconnect into social networks (e.g. Homans, 1951; Nadel, 1957). If substituting groups or organizations for human beings, while upholding the same pattern of description, relationships and networks mustering collective actors arise. A special case of this particular outline identifies collective actors lending themselves to business exchange framed by relationships and networks. The appreciation of concepts such as ‘bounded rationality’, ‘contingency’ and ‘resource dependence’ makes interorganizational theory focusing relationships and networks closely akin to traditional organization theory², and the involvement of ‘commitment’, ‘adaptation’, ‘trust’ and other related concepts imported from social exchange theory (Blau, 1964) adds a solid social dimension to it. In the field of industrial marketing business relationships and networks have been valued as particularly useful constructs. “[I]ndustrial marketing is primarily an organizational problem that must be seen in an interorganizational perspective” Johanson and Mattsson (1994, p.329) claim, while making an account of the markets-as-networks tradition in Sweden.

Viewing industrial markets as networks of business relationships is acknowledging that interdependencies develop between parties involved in exchange. Implicitly the business network metaphor also includes the idea that business relationships are interconnected³, which renders the markets-as-networks approach a system character. Interdependencies imply advantages and disadvantages. Advantages may appear as

¹ It might be interesting to remind the reader about the marginalist controversy that stretched from the mid forties up to the mid sixties involving Fritz Machlup and Richard Lester as main combatants. In short the controversy concerned the appropriateness and the explanatory value of the theory of the firm as forwarded in neoclassical economics. Critics blamed the theory of the firm (the marginalist view) for being utterly unrealistic lacking workable applicability for business practitioners. See Machlup (1967) for a retrospective view of the controversy and for a comprehensive comparison of the three different theories of the firm: marginalist, behavioral, and managerial.

² For a thorough discussion on organization theory see chapter 6.

³ Commonly Cook and Emerson (1978) are referred to as regards the interconnectedness of relationships in exchange networks. Interestingly enough Nadel (1957) proposed exactly the same structural characteristics in regard of social relationships and networks.
reduction of manufacturing costs due to increased productivity, joint development of new or modified technology, safe supply or steady demand, and so on.

Disadvantages may show up in terms of decreased flexibility as a direct consequence of being dependent, slow development if a close counterpart is a low performer, increased risks if doing large investments in assets that can only be used to serve one particular customer (the liability of asset specificity), etc. Relationships and networks may involve different entities appearing at different levels of aggregation in various contexts, but in so far as human beings are part of such a system any attempt to understand the system and the exchange processes evolving within it (while successively changing its structure) has to take into consideration various behavioral aspects.

As regards interaction between collective actors it seems that behavioral science primarily focuses exchange. That is no surprise as much interest in the field is devoted to various social processes, and such processes frequently muster exchange between human beings, either people perform exchange on behalf of themselves or on behalf of one collective actor or another. But it is clear that also conflict may arise in such contexts because now and then different meanings emerge of how things are or should be. Theories addressing business relationships and networks appreciate combinations of exchange and conflict although most interest in the field has been devoted to studying exchange as it occurs in the business process.

4.3.3 Interaction and technological change

Interaction has been discussed in two perspectives – the economic and the behavioral perspective – and it was indicated that in the economic perspective interaction is primarily viewed as competition, whereas in the behavioral perspective it is frequently looked upon as exchange. Ahrne (1994) offers a pertinent four-position matrix categorizing various forms of interaction between organizations.

<table>
<thead>
<tr>
<th>Form of interaction</th>
<th>Position of resources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inside</td>
</tr>
<tr>
<td>Struggle</td>
<td>Conflict</td>
</tr>
<tr>
<td>Cooperation</td>
<td>Exchange</td>
</tr>
</tbody>
</table>

Figure 4:1 Forms of interaction between organizations. Source: Ahrne (1994, p.122)
A conflict between organizations is a struggle for resources that one or both of them have within their control. A competition is a struggle for resources that are outside their control. Cooperation may happen either as a collaboration to get hold of resources owned or controlled by neither of them, or as an exchange of resources between them. (Ahrne, 1994, p.122)

Ahrne’s categorization may guide a brief overview of theories addressing what goes on between business organizations. A distinct borderline is found between theories elaborating interaction in relation to resources located outside the control of the interacting parties and theories elaborating interaction in relation to resources owned or controlled by one of the interacting parties or both of them. The former theories discuss interaction in terms of competition and collaboration and are found predominantly within the field of economics, whereas the latter showing up mostly in the area of behavioral science discuss interaction in terms of exchange and conflict.

Neoclassical microeconomics and related theories focus on the struggle competitors give themselves up to (a form of indirect interaction), while aiming at getting hold of resources outside their control, but little if anything is said about interaction taking place vertically along the supply chain materializing as direct interaction with those parties claiming ownership or control over the resources. The more common view is that two parties compete to be in favor with a third party downstream, i.e. to land the customer’s business, but competition may as well work upstream, if, for example, only one source of supply is available, i.e. in situations characterized by monopoly. Traditional economics keep track on the competing firms and their relative positions but refrain from paying attention to what goes on vertically in the form of direct interaction along the supply chain.

In the vein of economics not only struggle described as competition has been recognized but also various forms of cooperation appearing between competitors or potential competitors. One form is collusive agreements implying that direct interaction in the form of collaboration is substituted for indirect interaction in the form of competition. It is neither accepted by the law nor by people in general as it impacts detrimentally on the wealth of all parties save the colluders. Through collusion some control over “outside resources” is transferred to the colluders leaving the sufferers from the collusion in a position of less control over their own resources. Strategic alliances represent another, more constructive type of cooperative agreement commonly developed by competitors. It could be put in question, however, whether

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1 It should be notified, however, that already a century ago sociologist Georg Simmel (1908) elaborated the sociology of competition by proposing the mechanism of Tertius Gaudens, i.e. the third who benefits from the discord of the two. Anders Liljenberg (2001) in his dissertation “Customer-gedared competition – a socio-Austrian explanation of Tertius Gaudens” thoroughly penetrates the mechanism of Tertius Gaudens with reference to Simmel (1908) and Burt (1992b). The approach combines social structure projected via the markets-as-networks approach with an entrepreneurial perspective rooted in the (neo-)Austrian school of economics. In this context competition has been signified as indirect conflict.
resources affected by the formation of strategic alliances should be thought of as positioned inside or outside the ownership or control of the alliance partners. If the alliance takes the form of an established joint ownership, a legal unit in its own right, the answer is clear. Looser alliances shaped as informal or formal cooperative ventures missing the legal dimension are certainly more problematic from the point of view of resource location. Strategic alliances aiming at the development of technologies or markets certainly include exchange of “inside resources”, but to the extent that collusion is involved interaction should rather be conceived of as collaboration.

In the vein of behavioral science both social exchange theory and the markets-as-networks approach pay particular attention to interaction appearing as exchange. Also conflict is recognized but is given much less attention. With few exceptions theories in the field concern exchange of resources owned or controlled by the interacting parties. It is supposed that interdependencies bind actors and relationships together into networks whether social or business-oriented. The network approach adopts a system view on observed business phenomena.

Technological change may be studied in an intra- or an interorganizational perspective. This chapter focuses on the latter. Studies approaching technological change in an interorganizational perspective should refer to theories appropriate for the purpose. The discussion performed above indicates that theories linking to the vein of economics have a fairly poor potential to offer a rich description of the business process and the sociology of technological change. Both the marginalist and the managerial definition of the firm assume competition to be the predominant mode of business firm interaction. That means that firms operating at the same horizontal level of the supply chain, i.e. in the same industry, are reasonably visible, whereas firms located vertically – downstream or upstream – are effectively invisible. If considered at all they are looked upon as aggregates to be treated in a particular standardized way within each homogenous market segment. In this perspective business organization interaction is assumed to be indirect with a strong focus on economic aspects. To secure state of the art capabilities learning is delimited to imitating “the best man in the class”, not the least as regards technologies. It follows that an interorganizational perspective relying on theories in the tradition of economics may at the best describe technological change as a process of diffusion, but certainly not as one of evolution, and, as claimed elsewhere, economics doesn’t really take into account the social aspect of business. Granovetter (1985), for example, contends that economics is a strongly undersocialized field of science.

A behavioral view on business appreciates vertically oriented business firm interaction involving exchange of resources owned or controlled by one or both of the interacting parties. When performed in an industrial context interaction frequently involves problem solving focusing the firms’ needs and abilities (Håkansson et al, 1976). The perspective also takes into account the social aspect of business exchange. The
approach opens for a rich description of technological change as part of the business process, i.e. the process of transformation and transaction involving business parties. In this context the markets-as-networks approach is assumed to be a suitable body of knowledge.

4.4 The Markets-as-Networks Approach to industrial markets

Empirical research has shown that business actors involved in interaction with one another develop interdependencies conceived of as business relationships (Johanson, 1966; Håkansson (ed.), 1982). Interconnected business relationships may be seen as business networks (Cook & Emerson, 1978; Hägg & Johanson, 1982; Hammarkvist, et al, 1982). Literature of the kind usually considers the business actor a collective actor, more often it is supposed to be a business firm. The stream of research performed over the last few decades by Swedish scholars in collaboration with researchers from some other countries addressing business interaction between firms, the establishment of business relationships and the emergence of business networks has sometimes been called ‘the-markets-as-network approach’ (Johanson & Mattsson, 1994; Mattsson, 1997). To sum up: Interdependence is the most basic element in business network theory. Interdependence manifests as bonds. The interconnectedness of two companies through bonds is a business relationship. Interconnected business relationships constitute business networks. Comparing research along this tradition with contemporary mainstream research in marketing shows that “it is less quantitative and more qualitative, less deductive and more inductive, less theory testing and more theory developing, less specifically oriented to marketing management and more holistic, less prescriptive and more descriptive” (Johanson & Mattsson, 1994, p.336).

4.4.1 Nets and networks: some basic concepts

_Nets of companies and the industrial network_

The single firm is assumed to be interconnected with other companies; downstream with customers, upstream with suppliers and horizontally with companies producing complementary and/or competing products, i.e. substitutes. Companies that depend on each other make up a net of companies. Different nets of companies in various ways relating to each other make up a total industrial network. Such a total network may have a substantial reach. Its outward boundary is basically a matter of definition and choice. The constituting quality of a net or a network is a matter of which are the qualities and characteristics of its members and which is the interconnecting glue tying them together. An industrial network is a business network involving industrial actors.

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1 The clarification of basic concepts as mediated in this paragraph is based on chapter 3 in Hammarkvist et al (1982).
Bonds

As companies interact they develop interdependencies between themselves and those interdependencies have been conceived of as bonds. The bonds tie companies together. Bonds that are interconnecting two companies constitute a business relationship. Bonds are expressed along different dimensions. Thus, technical bonds, time-related bonds, knowledge bonds, social bonds, and economical and legal bonds have been identified. Where interdependencies concern technical matters technical bonds appear. Time-related interdependencies, e.g. just-in-time deliveries, show up as time-related bonds. Interaction implying that business parties become familiar with each other may be looked upon as an investment that is interconnecting the parties through knowledge bonds. Social bonds arise as trust is developed between individuals involving in interaction. Both economic interdependence and legal arrangements bind counterparts together.

Stability and change in networks

Nets and networks are more or less stable depending on which are the characteristics of the bonds keeping them in place. The very existence of bonds involves stability because intrinsically bonds show up as the manifestation of interdependence and interdependence involves mutual power and dependence, which in turn constrains company behavior. For at least two reasons bonds involve long-term commitment: bond development takes time and investment. Sometimes the investment required is substantial. That implies some relationships are old mustering counterparts that know each other well. However, stability does not preclude change. As the business process unfolds new ideas and new opportunities drive change within the network while challenging existing solutions and relations. New commitments and subsequent adaptations contribute to the reshaping of nets and network. The process of change is driven by forces and counter-forces striving to arrange the best position possible for each one of the parties concerned.

Close and loose relationships

Business actors take on certain arrangements and do particular things in favor of their counterparts as they involve in interaction. Talking is usually not enough. Action must follow. A commitment made commonly raises demand for subsequent action and sometimes also triggers adaptation. By reciprocally adapting to each other actors develop trust. They become increasingly interdependent and their relationship is getting closer. As one relationship is getting closer other related relationships may become looser as adaptation made in one relationship may detrimentally impact upon the status of other relationships. The close-loose dichotomy, or rather the continuum appearing between those two extremes, is a rough measure of relationship quality. A close relationship is tightly knitted whereas a loose relationship is weakly knitted. Adaptation re-orientates actors while repositioning relationships along the close-loose continuum leaving some relationships in a closer condition and other relationships in a looser condition. In the loose end of the continuum there is an open playground for
market forces. In the close end intense inter-organizational cooperation and struggle
are natural modes of interaction. Closeness is a projection of actor interdependence
that is measuring the level of interconnectedness between relationship counterparts.

Levels of network structuredness
Bond quality determines the level of structuredness of net and network. Companies
involving in tightly structured nets have clear and distinct roles in relation to each
other. The bonds that are linking the companies together are strongly knitted and
relationships of the companies are categorized as close. Loosely structured nets
involve companies whose positions are more blurred, bonds are weaker and
relationships are loose. Tightly knitted nets better resist attempts to invoke change than
do loosely knitted, but change realized in tightly knitted nets is usually more
comprehensive than change realized in loosely knitted nets. As nets are the building
blocks of networks the reasoning is equivalently valid for networks. The logic goes:

- The more structured the network, the more interdependent the companies in the
  network, and the more they have invested in the various relationships making up
  the network. Major changes in one relationship may have dramatic
  consequences for the entire network or at least for several relationships.
- The less structured the network, the less interdependent the companies in the
  network, and the less they have invested in the various relationships making up
  the network. Major changes in one relationship may have minor consequences
  only, if any, for a few relationships in the network. The network as a whole
  stays unaffected of the change.

Bonds that interconnect companies may be more or less strong, which implies that one
particular relationship more than not mix stronger and weaker bonds at the same
time, e.g. the social bonds of a particular relationship may be strong whereas the
technical bonds are weak. Nets and networks of companies involve relationships
positioned somewhere on the close-to-loose continuum. Although categorized as close
a relationship may comprise some weak bonds. Interconnectedness is not to be
considered a matter of “either-or” but rather a matter of degree.

4.4.2 Interaction and the business relationship
Håkansson (1982) forwards an illustration of the interaction model consisting of four
groups of variables describing “the parties involved, both as organizations and
individuals, .. the elements and process of interaction, … the environment within
which the interaction takes place, … [and] the atmosphere affecting and affected by
the interaction” (p.15). The parties are considered in terms of technology, structure and
strategy at the level of the organization, whereas at the level of the individual aims and
experience are highlighted. The process of interaction and the elements involved are
considered in two time perspectives. Short-term product/service, information,
financial, and social elements are addressed while relating to exchange episodes.
Long-term focus is put on relationship development while rendering particular interest to institutionalization and adaptation. The environment is operationalized while distinguishing between market structure, dynamism, internationalization, position in the manufacturing channel, and social system. The atmosphere, finally, is expressed in terms of power/dependence, cooperation, closeness, and expectations. The interaction model is framing business relationship content and development in context. It is an overall model guiding further investigations into dyadic business relationships but it is not informative about the way multiple dyads relate to each other or to elements making up the surrounding environment.

Interaction between companies often unfolds as a learning process in which the interacting parties learn about each other in different areas and at various levels. Thus, the parties socialize and become familiar at a personal level, but they also learn about each other at the level of the organization for example as regards technologies, goals, means of organization, etc. Interaction has been proposed to concern four aspects in relation to the counterpart, i.e. capability, mutuality, particularity, and inconsistency (Ford et al, 1986). Both interacting parties are interested in what they possibly can get from the other party. In many cases this is probably the most important aspect of interaction. It has to do with the capability of the counterpart and what services this capability can possibly bring forth. Mutuality is the “trust-aspect” of a relationship. The willingness of one party to do something for another party to a certain extent depends on whether the one party trusts the other party will do something in return. Mutuality has also been denoted “the mirror of trust” (ibid., p.34). Most actors, both individuals and collective actors, want special treatment now and then. Particularity refers to whether one party is willing to give a particular counterpart special service that is not given to any other party. Inconsistency, finally, refers to whether or not various individuals or groups of a company act in a consistent way when dealing with another party. Maybe the message given by the sales man is more positive and different from information received from the production manager of the company counterpart. This aspect also addresses the issue of side-changing referring to the situation when for example a sales person becomes more loyal with the customer than with his own company. A relationship that is scoring high on capability, mutuality, and particularity and low on inconsistency is probably fairly close. Whether it is productive or not, that is another issue.

4.4.3 The development and dissolution of business relationships

A business relationship is commonly understood to be an exchange relationship involving a buyer company and a seller company. Business relationships develop over time as a result of interaction. Stage models are frequently used to describe their development. Ford (1980) proposes a five-stages model starting with a pre-relationship stage ending with a final stage involving extensive institutionalization. Some authors add to the development stages a stage characterized by decline or dissolution (Dwyer
et al, 1987). Relationships may also become dormant in case counterpart interaction is down over a long period of time (Havila, 1996). It takes a lot of cooperation to develop business relationships, but relationships producing supernormal performance usually involve not only cooperation but also a substantial amount of conflict driving newness and change, while challenging the existing order (Wilkinson & Young, 1993). Relationships scoring high on cooperation and conflict simultaneously, may suffer less from the liability of monotonous routine, a condition rendering long-term cooperative relationships both inefficient and ineffective more often than not (Ford, 1980).

No matter which is the model referred to relationship development as all living tissue basically conforms to the birth-growth-decline sequence. Dwyer et al (1987, p.15) proposes “five general phases identified as (1) awareness, (2) exploration, (3) expansion, (4) commitment, and (5) dissolution” while following Scanzoni (1979). Ford (1980) proposes a similar five stages model although leaving out the decline stage: Stage 1: the pre-relationship stage; Stage 2: the early stage; Stage 3: the development stage; Stage 4: the long-term stage; Stage 5: the final stage. Both models describe relationship development as a gradual process. Dwyer et al elaborate five subprocesses, viz. attraction, communication and bargaining, development and exercise of power, norm development, and expectation development, whereas Ford discusses five variables, viz. experience, uncertainty, distance, commitment, and adaptations. The two models have much in common.

Typically relationship development starts out from a situation where two parties have only superficial knowledge about each other, but where one of the two (or both) nurtures an idea, although perhaps vague, about some potential benefit that may result should business exchange between them materialize. As the parties start to exchange information knowledge goes up and uncertainty goes down. If interest grows, and particularly if both parties find the other party interesting, intensified interaction follows involving further exchange of information, but also, at a certain point in time, negotiations about future exchange of goods or services. The parties go on learning about the other party’s needs and abilities, information that is computed into potential pros and cons should further involvement with the counterpart come about. In case both parties believe in advantages relationship development proceeds. Now possible commitments and adaptations may be discussed. Doing something special for another party usually means adapting to the other party in order to satisfy particular needs or desires. With few exceptions adaptation implicitly involves investment. Parties that are mutually adapting to each other also mutually invest in each other, and by that become mutually dependent (interdependent). Trust results from the fulfillment of commitments. Commitments made are fulfilled through adaptation. There is a connecting line beginning with interest and expectations ending in trust passing through commitment and adaptation:
Figure 4.2 The interest-commitment-adaptation-trust sequence.

Trust functions as an insurance against relationship breakdown in situations involving conflict or tension. The higher the level of trust between two parties the more difficulties can be handled within the frame of the relationship. But trust is a fragile asset. Cheating on a counterpart or acting opportunistically may quickly erase even a large amount of accumulated trust. Building trust is a time-consuming exercise but once established trust can be gone in a second.

By adapting to each other (investing in each other) parties develop trust but they also increase their interdependence as investments made usually have higher value when utilized in relation to the counterpart for whom the investment was done than when used in relation to some other party. At the worst an investment may suddenly turn into sunk costs should the counterpart for whom it was done close down or terminate business on other grounds. The liability of interdependency is a price relationship counterparts have to pay in order to attain increased efficiency and effectiveness. By mutually adapting to each other they can improve technical, administrative and organizational solutions with an impact on functionality and productivity. Particularly in industrial markets technological issues are of major importance and adaptations relating to technologies and technological matters are often crucial for the successful operation of the industrial firm. Increasing interdependence implies that relationships get closer, a condition constraining the freedom of the partaking firms.

So far the discussion of relationship development has focused on two sub-processes viz. trust development and the development of interdependencies. It is obvious that the two processes are intertwined. Relationship development as a learning process has also been touched upon. By involving in interaction the parties learn a lot about each other as regards operations, technologies, strategies, personnel, organization, goals, ambitions, etc. but also about the industry in which the counterpart is operating and about companies related to the counterpart. Increased learning about the other party reduces uncertainty. As uncertainty goes down the willingness to invest in the relationship may increase as the outcome of an investment becomes more predictable. By and large relationship development is a process of trial and error.

Interaction with a counterpart comprises a lot of information exchange but it also involves negotiations aiming at establishing – backed by commitments and adaptation – fair agreements about the exchange of goods and services. Learning about the needs and the abilities of a counterpart is important, but learning about which is the power-dependence balance between the parties might be crucial. Who is more and who is less dependent? In what dimensions do dependencies appear? Are there alternative sources
of supply or alternative customers to turn to should the current exchange partner drop out? Emerson (1962) is commonly referred to when power is discussed in relation to relationships and networks. His thesis comprises the proposition that party A has power over party B to the same extent that party B is dependent on party A for supply of resources or for a particular conduct. “[p]ower resides implicitly in the other’s dependency” (ibid. p.32). Thompson (1967, p.30) summarizes the logic in a simple two item structure: “an organization is dependent on some element of its task environment (1) in proportion to the organization’s need for resources or performances which that element can provide and (2) in inverse proportion to the ability of other elements to provide the same resource or performance”. It is obvious that negotiations performed by business counterparts involve considerations about the way power-dependence is balanced between the two.

As relationships develop the parties agree upon how to deal with each other. Goals are communicated. Some of them are shared. Common values evolve. Rules constraining future conduct are established. Sometimes manufacturing procedures are developed or adjusted to better serve the need or fit in with the constraints of a particular counterpart. A relationship may be considered a quasi-organization residing in the interface between two “parent organizations”, carrying its own history and operating according to its own inherent logic. Problems relating to belongingness may emerge in the form of loyalty conflict and “side-changing”. Institutionalization may reach a point where patterns of cooperation are taken for granted and established routines are left unchallenged (Ford, 1980). Relationships of the kind run an obvious risk to become less productive, i.e. to lose in efficiency and effectiveness. Inefficient and/or ineffective relationships sooner or later dissolve or the actors running them may lose out on competition. There are certainly also other reasons for relationship decline or dissolution, e.g. relationship counterparts may develop their respective interest in different directions, entrance of new technology may change the name of the game, new personnel on a crucial position may imply social malfeasance jeopardizing cooperation, and so on.

4.4.4 Actors at various level of organization

The ‘markets-as-networks approach’ holds the door open for different levels of aggregation as regards the actor concept. The following quotation serves as an illustration: “Actors control activities and/or resources. Individuals, groups of individuals, parts of firms, firms, and groups of firms can be actors. Thus, in an industrial network, there are actors at several organizational levels. Actors at lower levels can be part of actors at higher levels.” (Håkansson & Johansson, 1992, p.28)

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1 The concept ‘industrial network’ is used in the quotation. The concepts ‘industrial network’ and ‘business network’ are often used interchangeably in literature on business relationships and networks although it seems clear that the business network concept is likely to serve a broader area of application than that of the industrial network.
The notification is somewhat gratifying as it invites for studies on all possible levels of aggregation but a snap inventory reveals that most literature in the field pays prime attention to collective actors such as corporations, business units and departments. Although individuals and groups of individuals are appreciated as valid actor categories studies addressing such actors are strikingly few. Actors, irrespective of category, are supposed to cooperate and struggle with each other along horizontal as well as vertical lines of organization.

Thus, in a network, there are a number of conflicting and common interests as well as efforts to provide for those interests. In this struggle the actors use their knowledge of the network as well as their relationships with other actors in order to increase their control. Furthermore, as the actors are at different organizational levels this struggle takes place not only between actors but also within actors. (Ibid.)

The last sentence in the quotation is particularly interesting because it introduces an intra-organizational perspective to the discussion, i.e. it points at cooperation and struggle appearing within organizations. Ambiguity as regards the actor concept in this kind of literature makes the application of various theories and models difficult sometimes. When actors are discussed at the level of the individual it is more often done in a superficial way while reporting that so and so many people on each side of a relationship are in touch with each other so and so many times over a certain period of time. Little is said about the underlying social processes. Collective actors on the other hand are equipped with human features. They experience uncertainty, they get familiar with each other, they have expectations, and they develop feelings of trust. It is somewhat strange to notice the ease with which collective actors get humanized. Who are those perceiving uncertainty, becoming familiar, expecting things, or developing trust? When a specification is lacking, implicitly it seems that the feelings and reactions are experienced by management, but that might be of little help as in most cases management is also a collective actor.

4.5 The industrial system and technology

Technology, conceptually defined as the application of knowledge and skills for a practical purpose, manifest in business as material artifacts (products and production facilities) and organized processes (routines and procedures). Artifacts and organized processes combine into production systems. A production system along with a governance structure constitutes an industrial system (Johanson & Mattsson, 1992). The governance structure is supposed to control the production system. Technology utilization manifests as the purposeful activation of resources. A technology may be more or less effective in relation to the needs and desires for which it is operated. To be effective resources mobilized must fit to the purpose and their activation must be

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1 This seems to be particularly true for research performed on Scandinavian ground addressing business relationships and networks, but there are some exceptions, e.g. Turnbull (1979), Hamfelt and Lindberg (1987), Hallén (1992), and Johanson and Vahlne (2003).
2 See chapter 3 for a comprehensive exposition of ‘technology’ and ‘technological change’.
properly coordinated. The overall effectiveness of an industrial system is a reflection of the effectiveness of the various technologies involved and the way these technologies are interrelated and adapted to each other. Studying technology and technological change in a network perspective is appreciating the existence of interdependencies between various business actors and technologies (resources and activities). Interdependencies imply both opportunities and constraints to the parties involved.

4.5.1 Network governance in the industrial system

Penrose ([1959] 1995) defines the firm “as a collection of resources bound together in an administrative framework, the boundaries of which are determined by the ‘area of administrative coordination’ and ‘authoritative communication’.” Indeed, Penrose’s definition is both knowledgeable and vigorous. It captures resources, activities and a governance structure. Furthermore, it claims that resources and activities are controlled by the governance structure. If creating several Penrosian firms and linking those “clones” together we arrive at Johanson and Mattsson’s (1992) model of network governance in the industrial system (Figure 4:3). The authors differentiate between actors, resources and activities while referring the latter two elements to the production system. Actors, they claim, belong to the governance system because “the concept of strategic action presupposes actors. Actors have intentions, they make interpretations of conditions in the industrial system and they act” (p.176). Actors also involve in exchange relationships with one another and by way of their interaction activity coordination and resource orientation are influenced.

Figure 4:3 Network governance in the industrial system;

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In production systems, resources are employed, combined and transformed in industrial production. Coordination and direction of activities in the production systems take place through governance structures. The production system together with the governance structure constitutes the industrial system. The term production is taken in a wide sense to include all the different kinds of activities needed to create and use products and services (R&D, manufacturing, marketing, distribution, purchasing, etc.). (Ibid., p.177).

The model offers a simplified view of network governance in the industrial system. Resources make up the foundation of the production system. Industrial firms, the actors of the system, control resources. Such firms are collective actors. Resource control may be understood as the transformation of raw materials or semi-products from one shape to another. However, by including in the term ‘production’ also other business functions such as marketing, distribution and purchasing, the production system becomes something more than a pure manufacturing system, which means it also comprises transaction activities. The three arrows connecting the smaller “actor ellipses” with the larger “resources ellipses” in Figure 4:3 seem to indicate that each one actor controls just its “own” resources, but that is misinterpreting the model. One focal actor may control both its own resources, and, by way of interdependence, resources possessed by other actors. According to the same logic some other actor may control resources legally belonging to the focal actor. Actors involving in interaction develop interconnected exchange relationships taking on network shape. Such an aggregate of relationships constitutes an integrated governance structure exerting control over industrial system resources, some of which are interdependent. An industrial system may involve actors that do not involve in exchange with one another, actors that do not even know about each other, as well as actors that are competitors. Through the network structure of interconnected relationships they may still be interdependent either at the level of the governance structure or through interdependencies residing in the production system or both.

In the model the actor component is defined at the level of the firm and governance is meant to occur at the actor network level. It is notified in the article that “strategic actions are efforts by actors to influence (change or preserve) their position(s) in network(s)” (ibid., p.183). The term ‘position’ is conceptualized as follows:

To sum up, the position of an actor is described by the characteristics of its exchange relationships. A limited, basic definition is that the position is a matter of with which actors the focal actor has exchange relationships. An extended definition of a position also involves the role of the actors in the production system. The role comprises the function accorded by the industrial logic and the relative importance of the actors. (Ibid.)

Actor positions change as the character and content of relationships change. New relationships develop and old relationships are interrupted or become dormant. “But the ways in which positions change may differ depending on whether the changes take place on the actor (network) or on the resource (production system) level” (ibid.). Change may concern the posture of an actor vis-à-vis another actor or several actors in
the industrial system, the identity of an actor, i.e. the way another actor conceives of the actor, or the resource base and/or its utilization. But as interdependencies opposing change make up an integral part of the industrial system also inertness prevails in the system. Thus, the industrial system, a certain kind of business network, involves both stability and change. It is the place where decisions turn into forces and forces translate into action with an impact on resource orientation and activity coordination. It constitutes the habitat of business process evolution.

4.5.2 Industrial system cohesion

It has been found that business firms operating on industrial markets often develop interdependencies between themselves. Five bonding categories have been identified, i.e. the technical, time-related, knowledge, social, and economic/legal bond (Hammarkvist, et al, 1982, pp.23-24; Håkansson, 1989, pp.24-25). Another interpretation of interconnectedness proposes business actors to be bonded into actor networks, resources to be tied into resource networks, and activities to be interlinked in activity networks, and finally that the three sub-network categories are all intertwined (Håkansson (ed.), 1987, chapt.1; Håkansson & Johanson, 1992; Håkansson & Snehota, 1995). Interdependencies developing between counterparts along the various interconnecting “dimensions” may be more or less strong. The total constitutes the degree of relationship closeness, which at an aggregated level determines network density. This is in line with viewing an exchange network as a set of interconnected relationships (Cook & Emerson, 1978) \(^1\). By combining the two models into one a comprehensive scheme including fifteen potential analysis positions is offered (Table 4:1). Depending on which is the empirical case to be analyzed and what is the analysis task at hand some positions would be found more interesting than other.

<table>
<thead>
<tr>
<th>Cross-relating interdependencies</th>
<th>Actor bonds (relatedness)</th>
<th>Resource ties (orientation)</th>
<th>Activity links (coordination)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical bonds</td>
<td></td>
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<tr>
<td>Time-related bonds</td>
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<tr>
<td>Knowledge bonds</td>
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<tr>
<td>Social bonds</td>
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</tr>
<tr>
<td>Economic/legal bonds</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Table 4:1 A model of industrial system cohesion.

\(^1\) Already in the year 1957 psychologist and social anthropologist Siegfrid Frederick Nadel brought forward an analogous conceptualization of a social network: “I do not merely wish to indicate the ‘links’ between persons; this is adequately done by the word relationship. Rather, I wish to indicate the further linkage of the links themselves and the important consequence that, what happens so-to-speak between one pair of ‘knots’, must affect what happens between adjacent ones. It is in order to illustrate
The five vertical dimensions in Table 4:1 represent the five-bonds model previously discussed. The dimensions are certainly not perfectly heterogeneous between themselves. Technical bonds, for instance, could easily be claimed to involve both time-related and knowledge bonds. This is particularly true if expanding the term ‘technical’ into ‘technological’ in the model. And it seems clear that also social and economic/legal bonds involve time and knowledge. Other bonds than those incorporated in the model, e.g. administrative bonds, planning bonds, and cognitive bonds, could well have an explanatory value in certain analysis situations, and it is important to consider that a particular categorization of bonds is just a tool that may help understanding industrial system cohesion and the underlying interdependencies that constrain actor behavior.

Along the horizontal line of the table another categorization of interdependencies is presented, viz. actor bonds, activity links and resource ties. Håkansson and Snehota (1995, p.26) clarify the significance of the three concepts:

*Activity links* regard technical, administrative, commercial, and other activities of a company that can be connected in different ways to those of another company as a relationship develops.

*Resource ties* connect various resource elements (technological, material, knowledge resources and other intangibles) of two companies. Resource ties result from how the relationship has developed and represents in itself a resource for a company.2

*Actor bonds* connect actors and influence how the two actors perceive each other and form their identities in relation to each other. Bonds become established in interaction and reflect the interaction process.

The model of industrial system cohesion as presented in Table 4:1 becomes particularly interesting when projecting the vertical dimensions along the horizontal line. Technological interconnectedness, for instance, may be approached by asking questions about actor relatedness (identities, roles, objectives, etc., and how they are interconnected), resource orientation (e.g. adaptation of production facilities, or development of customized products), and activity coordination (unique procedural adaptation, customized logistics, etc) in regard of the various technologies involved in a certain relationship or net. The other vertical dimensions would also gain from being discussed along the horizontal line although it is clear that not always every matrix position will be proven productive. However, the scheme is assumed an excellent pointer guiding research into industrial system cohesion by systematically directing attention into various “could-be-interdependency-pockets”. By reducing the model into a nine-position matrix it gains in simplicity without losing much of its explanatory potency. The horizontal dimensions are still the same in the condensed model while

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1 The differences between technics, technique and technology are discussed in section 3.1.2.

2 The original text reads “represents in itself” which is grammatically incorrect. A better reading had been “represent in themselves”.

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the vertical dimensions are reduced into three, viz. technological bonds, social bonds and economic bonds. Discussing actor bonds, activity links, and resource ties along the technological, the social and the economic dimensions is certainly sufficient for achieving a comprehensive understanding of industrial system cohesion, it is argued.

Resource orientation and activity coordination occurring inside and between business organizations to a certain extent is the outcome of negotiations and adaptations performed by interacting counterparts involving in exchange. With few exceptions such negotiations and adaptations address two major issues viz. effectiveness and efficiency. To satisfy various demands calling for improved effectiveness and/or efficiency resources are given specific orientation and activities are linked into certain activity patterns in industrial systems. Effectiveness and efficiency are measures along which actors assess expectations, formulate goals and evaluate outcomes. The way resources are orientated both stimulates and constrains activity coordination. Technological functionality as such and the economic consequences of technology utilization are both to a large extent explained by the way resources are orientated and activities are coordinated. As resources and activities are spread over various actors (companies, units, departments, groups, individuals), and, as the power to control those resources and activities is dispersed as well, interdependencies arise in industrial systems, and those interdependencies are supposed to be heavily charged with technological, economic and social content.

4.5.3 Resources and activity interdependence

Interconnectedness of production systems is traceable to resource interdependence and activity interdependence. If the use of one resource depends on the output emanating from the use of another resource the former resource can be said to depend on the latter, but although that sounds convincing it is still the service offered by the latter resource – the service generating the outcome – that makes the difference. It is clear that resources may offer both opportunities and constraints to action. It is also clear that different resource combinations offer different opportunities and constraints to action, which means a particular combination of resources permits only a certain set of activities to be executed (although the versatile entrepreneur may be able to enlarge the number of activities\(^1\)). The long-linked technology as described by Thompson (1967) is an illustration of activity interdependence: “A long-linked technology involves serial interdependence in the sense that act Z can be performed only after successful completion of act Y, which in turn rests on act X, and so on” (pp.15-16).

Richardson (1972) identifies four attributes that distinguish activities. Activities can be similar, complementary, dissimilar and closely complementary. “[a]ctivities are complementary when they represent different phases of a process of production and

\(^1\) Confer Penrose ([1959] 1995). Basically it is the service that can be obtained from a resource that makes the difference and that opens for an entrepreneurial approach to resource utilization.
require in some way or another to be co-ordinated” and “it is clear that complementary activities have to be co-ordinated both quantitatively and qualitatively” (ibid., pp.889-890). The activities of Thompson’s long-linked technology are a good example of complementary activities. Much of industrial operation builds on this logic and for efficient production to materialize activities have to be properly coordinated. “Activities which require the same capability for their undertaking” (ibid., p.888) are denoted similar activities. Capability is understood as “knowledge, experience and skills” and it goes without saying that capabilities have to be appropriate for the task at hand. Similar activities are activities that can be performed while using the same capabilities.\(^1\) Similar activities, then, may benefit from economies of scale. As a firm diversifies into new areas of operation it usually starts out from its existing base of resources. It follows that growth commonly implies an extension of similar activities. Activities can be complementary and similar at the same time, but even more interestingly complementary activities can also be dissimilar. If there is much to gain from economies of scale firms may specialize in one particular area of operation leaving to other companies to perform complementary activities that are dissimilar. In case a focal company is not financially strong enough to invest sufficiently in order to secure that complementary activities that are also dissimilar can be executed in-house, the company will depend on some other party for execution of some of those complementary activities.

Dissimilar activities cannot benefit from economies of scale because they require different capabilities for their execution. In case the aggregate output of a certain activity (or a chain of activities) contains standardized products that are meeting the requirements of the general-purpose input of another, subsequently located activity, both as regards quantity and quality, coordination is easily secured through ordinary market transactions. Under these circumstances coordination refers to the matching of complementary activities at an aggregate level of supply and demand. For proper coordination to occur no special arrangements concerning investments or output plans ex ante in regard of one or more particular counterparts are required. If, on the other hand, feasible execution of a certain activity requires special execution of a preceding activity then the activities are mutually dependent. Activities thus specified have been called ‘closely complementary’ (Richardson, 1972, p.891) signifying that a condition of ‘close complementarity’ prevails. Coordination of such activities requires ex ante matching of plans.

Hence, close complementarity exists when an activity is directed to a certain counterpart. Another way to put it is that the results of closely complementary activities are restricted to a particular end product and, hence, cannot be used for other purposes (Dubois, 1994, p.31).

\(^1\) When left (partly) unused such capabilities hold opportunities for expansion to be uncovered and exploited by the entrepreneur (Penrose, [1959] 1995).
The more specialized a resource is, i.e. the narrower its scope of use, the greater is the probability of activity interdependence, and in case activities are closely complementary the market is not a suitable mechanism for coordination. Such activities are preferably coordinated within hierarchical structures by way of directives or through cooperative arrangements established by parties involving in business exchange, e.g. through the establishment of business relationships. Cooperation carried out within business relationships often concerns activities that are both closely complementary and dissimilar (ibid.). If returning to Thompson’s long-linked technology the activities described are not just complementary. As a downstream activity depends on the proper execution of a customized upstream activity they are also closely complementary.

In case a firm invests in a heavily customized resource capable of rendering valuable service to one single counterpart only, then the resource holder fully depends on the counterpart for productive utilization of the resource. If resource utilization explains a major share of the resource holder’s profitable business then the resource holder strongly depends on this particular counterpart. If the counterpart is unable to obtain the same service or an acceptable service substitute from another source of supply, and if the service is crucial for the counterpart’s profitable operations, then the counterpart’s dependence on the resource holder is also strong. Resource specialization then underpins interdependence in production systems. Such interdependence may be symmetric or asymmetric but it seems reasonable to assume that the special case of complete symmetry is a rare bird.

4.6 A network approach to international business

Studies in international business traditionally starts out with trade theories addressing the competitiveness of nations by elaborating upon issues such as absolute advantage, comparative advantage, the product life cycle and governmental interference. At the level of companies and industries theories relating to the tradition of economics addressing foreign direct investment (FDI) seem to be of particular interest. Indeed, the multinational enterprise has been defined as an enterprise that is performing direct investment abroad. In this vein of thought the internationalization of companies is assumed to be the result of rational decision-making concerning foreign investments including planning, implementation and monitoring. However, whether fierce competition between oligopolists, product development stages, or market failure in

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1 This is what Williamson (1985) refers to as ‘asset specificity’, which when combined with opportunistic behavior constitutes a risk for the resource holder.
2 See the discussion about power and dependence relations in section 4.4.3 above and in chapter 6.
3 See the discussion about interdependence and interconnectedness in chapter 6.
4 For a description of various theoretical explanations of company internationalization forwarded in the vein of economics see any comprehensive textbook addressing international business, e.g. Hill (2005).
regard of intangible assets should be referred to as the most effective ground for explaining company internationalization in this tradition is still a matter in debate. The omnipotent company performing internationalization by way of grand strategic decision-making is an understanding of company internationalization that has lately been challenged. Observations have shown that internationalization is rather to be conceived of as an evolutionary process than a strategically controlled event.

4.6.1 The internationalization process of the firm

Johanson and Vahlne (1977) propose a theoretical model describing company internationalization as an incremental process comprising “knowledge development and increasing foreign market commitments” (p.23). Previous research had shown that Swedish firms usually enter new markets successively and four typical development stages had been observed: “1. no regular export activities, 2. export via independent representatives (agent), 3. sales subsidiary, 4. production/manufacturing” (Johanson & Wiedersheim-Paul, 1975, p.306.). A major obstacle for firms going international is the psychic distance perceived between the home market and the foreign market (Hörnell et al, 1973). “The psychic distance is defined as the sum of factors preventing the flow of information from and to the market. Examples are differences in language, education, business practices, culture and industrial development.” (Johanson & Vahlne, 1977, p.2) As the range of differences vary between various markets companies tend first to turn to markets similar to their own home market and gradually expand into markets that are more different. The internationalization process is claimed to involve two fundamental sub-processes, i.e. a process of learning and an investment process. Through the learning process new knowledge is added to existing knowledge and through the investment process companies become increasingly committed to the markets that are receiving investments.

The meaning of commitment is “resources located in a particular market area” (ibid. p.27). The level of commitment is determined by the amount of resources that are located to the area and how closely those resources are captured in the area, i.e. how difficult it is to move them from the area for productive use in another area. With reference to Penrose ([1959] 1995) knowledge is divided into objective knowledge, which is knowledge that can be articulated, and implicitly, it can be taught to others, and experience, which is knowledge that can neither be articulated nor be taught to others. Objective knowledge may be gathered through education. Gaining experience (or experiential knowledge) is equivalent with learning by doing. Learning by doing implies activities are carried out. It usually involves a certain amount of ‘trial and error’. The development of skills comes from learning by doing.

The internationalization process model is circular or maybe it should rather be considered a spiral. It consists of two state aspects, market knowledge and market commitment, and two change aspects, current activities and commitment decisions. A
company that is operating on a foreign market, no matter in which development stage, encounters new problems and new opportunities as it goes on doing business. But performing activities on the market also implies gaining experience and with increasing knowledge uncertainty decreases (part of the uncertainty decrease consists of reduced psychic distance). As uncertainty goes down the outcome of decision-making becomes more predictable. Operating on the market implies that the awareness of opportunities and problems increases and uncertainty decreases. Both implications drive commitment decisions. Commonly resource allocation (investment) is needed both when aiming at solving problems and exploiting opportunities. Reduced uncertainty means increased willingness to invest, as the risk accompanying the investment has now become more predictable.

Conclusive summary: current activities drive knowledge development, by increasing knowledge the awareness about opportunities and problems increases and uncertainty decreases, increased awareness about opportunities and problems and decreased uncertainty drive commitment decisions, additional investments enlarge the commitment made to the market, enlarged commitment means extended operations, and extended operations implies more learning. This sequence is a quick outline of the internationalization process of the firm according to Johanson and Vahlne (1977).

### 4.6.2 Internationalization in networks

Over the last few decades the subject of internationalization in networks has attracted vast research interest and the original unilateral model of company internationalization (Johanson & Vahlne, 1977) was later extended to incorporate interacting firms while giving rise to a process model of internationalization in networks (Johanson & Vahlne, 1990). The extended model owes debt of gratitude to several publications issued in the meantime. An early seminal contribution, the article “Internationalisation in industrial systems – a network approach” (Johanson & Mattsson, 1988), inventories and synthesizes general network theory while linking it to the internationalization of companies. The article underpins the extension of the original unilateral process model of company internationalization to involve the multilateral aspect. Two interesting aspects of internationalization, one structural and one process oriented, are highlighted in the article. The aspects are presented and discussed below.

**The structural aspect of internationalization**

The structural aspect compares the degree of internationalization of the firm entering a new market and the degree of internationalization of the market to be entered by the firm. Through the two dimensions internationalizing companies may be divided into

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2. The ideas in the article were presented in a paper carrying the same title already in 1984 at the Prince Bertil Symposium at Stockholm School of Economics.
four archetypes: the early starter, the lonely international, the late starter and the international among others. The archetypes may be studied by discussing the positions a firm establishes and develops in relation to other firms in foreign networks. Firms hold and develop both micro-positions and macro-positions.

A micro-position refers to the relationships with a specific individual counterpart; a macro-position refers to the relations to a network as a whole or to a specific section of it.

A micro-position is characterized by:
1. the role the firm has for the other firm;
2. its importance to the other firm; and
3. the strength of the relationship with the other firm

A macro-position is characterized by:
1. the identity of the other firms with which the firm has direct relationships and indirect relations in the network;
2. the role of the firm in the network;
3. the importance of the firm in the network; and
4. the strength of the relationships with the other firms.

The macro-positions are also affected by the interdependencies in the whole network as well as by the complementarity of the micro-positions in the network. Thus, in the context of the whole network, the macro-position is not an aggregation of micro-positions. (Johanson & Mattsson, 1988, p.198)

Interdependencies (various sorts of bonds and their strength), roles and identities are essential dimensions making up positions but in the end it is the importance of a firm to its various counterparts and in the network as a whole that adds substance and value to the firm’s various positions. Firms ascribe identities to other firms. A firm’s identity comprises the essential characteristics ascribed to it by others (customers, suppliers, etc.). It follows that different viewers may conceive of a particular firm in different ways as they ascribe different characteristics to the firm, and it seems clear that the role a firm plays or may (is able and/or willing to) play in relation to a counterpart impacts upon the identity the counterpart is ascribing to it and vice versa (Håkansson & Snehota, 1995). Forsgren and Johansson (1992, pp. 23-24) give significance to the concept of ‘network identity’ for any business unit (firm, sales company, manufacturing unit, etc.) being part of a network.

Any business unit in the network has a network identity, which refers to the views – both inside and outside the unit – on the unit’s role and position in relation to other units in the network. The network identity is formed and developed over time through transactions with other units. The network identity in turn has strong implications for the development of the unit and its relations to other actors.

The perception of role and identity is influenced by the way interaction unfolds between related parties. It concerns the interpretation of answers given in response to questions such as: “What can you do for me? How do you see me? What are you prepared to do for me, compared to what you do for others? Which variations are there
in these ‘whats’ and ‘hows’?’ (Ford et al, 1986, p.29). The questions direct different interaction aspects viz. capability, mutuality, particularity, and inconsistency.¹

Basically, a micro-position concerns the effectiveness and commitment of a firm as conceived of by a particular counterpart, dimensions that are influenced by the way interaction unfolds and adaptation is carried out within the relationship, whereas a macro-position comprises the recognition of the firm in the network as a whole. Parties involving in exchange relationships run complementary strategies, as the output of the supplier becomes the input of the customer. If neither of them can find an alternative partner the parties are interdependent. The two run a symbiotic relationship involving outcome interdependence implying that both would benefit from growing business exchange (Pfeffer & Salancik, 1978, p.41). The company roles are clearly defined and the micro-positions involve complementary strategies.

The kind of system sketched, involving micro- and macro-positions related to interconnected business relationships, is what is commonly denoted an industrial or business network. Depending on which are the types of bond (technical, planning, knowledge, social, economic, legal, etc.) constituting the system and what is the strength of the bonds the system is more or less stable although continuously subject to change. Networks, and particularly those that are tightly structured, are usually well balanced. Each firm is important for the system as a whole and each firm also adopts a clear role in the network. Should a major change come about the system would easily go out of balance. For example, a vacancy appearing in the wake of a shut down or a merger would claim for urgent action to restore the balance (Forsgren & Olsson, 1992).

An industrial system may be partitioned in various ways for the purpose of description or analysis. Johanson and Mattsson (1988, p.199) propose ‘national net’ and ‘production net’ as industrial network subcategories.

We use the term “net” for specifically defined sections of the total network. When the grouping is made according to national borders we distinguish between different “national nets”. Correspondingly we refer to “production nets” when the grouping is made on the basis of product areas. A production net contains relationships between those firms whose activities are linked to a specific product area.

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Within the framework of a product area with its production nets, different national production nets can be distinguished.

As an industrial network in its entirety may comprise a very large structure the definition of various industrial network subcategories opens for directed analyses addressing selected areas and phenomena.

¹ See section 4.4.2 above for clarification.
The process aspect of internationalization

Johanson and Mattsson (1988) divide the process aspect of internationalization into three dimensions, i.e. extension, penetration, and integration, and discuss the three while referring to the concept of position.

The firm establishes and develops positions in relation to counterparts in foreign networks. This can be achieved (1) through establishment of positions in relation to counterparts in national nets that are new to the firm, i.e. international extension; (2) by developing the positions and increasing resource commitments in those nets abroad in which the firm already has positions, i.e. penetration; and (3) by increasing coordination between positions in different national nets, i.e. international integration.

(p.200)

In a process perspective positions are established, developed and connected to each other, and that is basically all that is to the phenomenon of internationalization. If referring to the structural model introduced above proposing four company archetypes, the degree of internationalization of a particular market is a matter of depth and level of interrelatedness of company positions (and relationships), within and between markets, for all companies, foreign as well as domestic, making up a particular net on a particular market. A far-reaching national net, thoroughly integrated with nets on other country markets, involving well-developed positions signifies a high degree of internationalization of the market. The degree of internationalization of the firm is a matter of how far the firm has extended its positions into foreign nets, the level of development of the firm’s existing positions with counterparts in foreign nets, and the level of coordination of the firm’s various positions in different country nets. ‘The early starter’ is a firm with low-level experience as regards international business that is entering into a foreign market characterized by few international contacts. ‘The late starter’ is a company with little international experience that is approaching a heavily internationalized market. ‘The lonely international’ is the internationally experienced company that operates on a market with a low level of internationalization. ‘The international among others’ combines substantial international experiences with a well-developed international market.

4.6.3 The internationalization process in a network perspective

The original model (Johanson & Vahlne, 1977) offers a unilateral description of company internationalization whereas the extended model (Johanson & Vahlne, 1990) includes also the multilateral aspect. A major difference is that “current business activities” is substituted for “current activities”. Business activities involve interaction between and within business organizations.

An extension of the internationalization process model to take into account the network aspect should consequently make the concepts “commitment, knowledge, current activities and commitment decisions” as multilateral rather than unilateral as in the original model. That is, the process is also inter-organisational and not just intra-organisational” (ibid., p.19).
The extended model appreciates the dyad and wider systems of interconnectedness between business firms. In such systems firms gain new experiences as they involve in business activities, experiences that add to the stock of knowledge of the various firms. Business activities, and not the least exchange activities, make firms encounter on opportunities and problems, which more often than not raise demand for investments. In many cases investments are carried through in order to better serve business counterparts and a firm adapting to a particular counterpart is further tying the parties together. It is obvious that general network theory applies perfectly well to the extended model of the internationalization process. Some main differences between the original model and the extended model are identified. The original model assumes knowledge development to be unilateral and commitments to be made in relation to a particular market, whereas the extended model considers both phenomena to appear within the frame of interconnected business relationships, i.e. firms develop an interest in each other; they interact while exchanging information and later they involve in exchange of goods and service; while so doing they commit themselves to the other party and they adapt to each other; as a result interdependencies and trust establish.

With reference to the four archetypes model as presented in the previous section, the original model of the internationalization process of the firm is still considered a valid explanation concerning ‘the early starter’. The original model may also reasonably well explain internationalization performed by ‘the late starter’, but it should be noticed then that the dimension ‘degree of internationalization of the market’ is not considered in the model, a circumstance making the model less useful in this particular setting. When it comes to explaining the further internationalization of companies that have already attained a markedly high level of internationalization the original model lose in validity. Neither do such companies suffer much from foreignness nor from psychic distance as defined in the original model, as they are already widely experienced internationally. Whether investments performed by them on various country markets should be conceived of as foreign or not is a matter of viewpoint, because most of those companies have become multinationals already. Large multinationals operating in many countries might not even be thought of as having a distinctly defined home market anymore. In the four archetypes model the current discussion applies to the ‘the lonely international’ and ‘the international among others’. Although those two company categories do not lend themselves to sensible analyses using the original model, projected via the extended model high quality analyses would materialize. The extended model directs three process aspects viz. international extension, penetration, and international integration, which all three of them apply perfectly well to any multinational company no matter its size or pattern of dispersion. While considering the mechanism of internationalization as outlined above, in this view the internationalization process comprises the development of new
positions, the further development of existing positions, and the coordination of positions in various country nets.¹

4.6.4 The modern multinational: at the crossing between command and dependency

Whether the coordination of activities in a particular situation are better performed (at lower costs) through hierarchical control within the firm or by utilizing the price mechanism in the market is an issue that has attracted a lot of research interest over the years. It was once given prominence by Ronald Coase (1937) and later it became the leading principle of transaction cost economics (Williamson, 1975) and internalization theory (Buckley & Casson, 1976; Hennart, 1982). However, in time the strict “market-firm dichotomy” has been found too rough a model for the comprehensive explanation of activity coordination in contemporary business life, and particularly so in an industrial context. If considering the operations of the large multinational company² (MNC) the inadequacy of the model becomes even more apparent.

As a company expands sooner or later it finds itself standing in front of a country border and if the company transcends the border, i.e. if it starts making business abroad, it becomes an international company. If the company proceeds by making direct investments abroad it turns into becoming a multinational company (e.g. Hill, 2005). Some multinationals grow into extremely large organizations employing hundreds of thousands of people worldwide, while performing operations on many country markets. Controlling the activities of large multinational companies goes beyond the reach of traditional structural and formal control mechanisms. With the arrival of large multi-unit firms partaking in business exchange both within themselves and with companies external to the focal multinational, and with increasing cooperation occurring within and between firms or parts of firms intermediate forms of coordination have become important means to link business activities.³ Commonly such intermediate forms of coordination involve more informal and subtle control mechanisms taking into account shared values and corporate culture (Martinez & Jarillo, 1989; Nohria & Ghoshal, 1994).

Over the last few decades the large multinational company has often been conceptualized as an inter-organizational network (Ghoshal & Bartlett, 1990) carrying an obvious political dimension (Forsgren & Johanson, 1992).

¹ The points of criticism in regard of the original model as touched upon here are further discussed in Johanson and Vahlne, 1990, pp.14-15.
² Commonly the denotations ‘multinational’, ‘multinational company’, ‘multinational corporation’, and ‘multinational enterprise’ (MNE) are used interchangeably.
³ See the discussion about the firm and the market in section 4.1.2 above.
The political view of the firm is based on the idea of power as a relational concept derived from social exchange theory, and the assumption that resource dependence between actors is an important basis of power (ibid. p.24). Business units of the large MNC commonly expand while specializing into various directions. Growth also implies the build-up of resources in various parts of the system making some units develop positions of a kind making other units of the company, and external counterparts as well, increasingly dependent on them. Even headquarters and manufacturing units on the home market previously holding dominant positions vis-à-vis foreign subsidiaries may find themselves dependent on some large and powerful business units located abroad. At this stage of development the multinational corporation has attained a multi-center structure constituted by several power centers that are strongly influencing the operations of other units within the corporate system and external actors as well (Forsgren et al, 1992; Sölvell & Zander, 1995). Sometimes called “internationalization of the second degree” (Forsgren et al, 1992) this stage of development differs from “internationalization of the first degree” (ibid.) where the headquarters is still supposed to control the operations of the MNC by and large. In the multi-center structure the headquarters is certainly considered an important part of the system, but other units, sometimes as powerful as the headquarters, may significantly influence the further development of the company.

“Who controls international business activities?” (Engwall & Johanson, 1980). Raised some 25 years ago the question has triggered a lot of research interest since. Control may be divided into “formal control, the power base of which is legitimacy and non-formal control, the power base of which is access to scarce, and essential resources” (ibid., p.64).¹ Thus control seems to emanate from two power bases, and both categories of control, i.e. formal and non-formal control, may originate from internal as well as external sources. The origin of formal external control refers to e.g. ownership, laws and contractual relations with various counterparts, whereas the origin of formal internal control refers to the formal organization of the company, i.e. its hierarchical structure. Should legitimacy not prevail formal control suffers. Non-formal control is supposed to connect to the “access to scarce, and essential resources”. Thompson (1967, p.30) summarizes the logic: “an organization is dependent on some element of its task environment (1) in proportion to the organization’s need for resources or performances which that element can provide and (2) in inverse proportion to the ability of other elements to provide the same resource or performance”. Most resources and performances needed by a company are provided by suppliers and customers located inside and outside the MNC, although other counterparts may contribute to the company’s resource provision as well. Whether to

¹ Already in the early 20th century Weber ([1922, 1924] 1978) discussed the matter while referring to domination based on legitimacy and interest respectively. Emerson (1962) elaborated upon the interest aspect while claiming: “power resides implicitly in the other’s dependency” (p.32). See chapter 6 for a more thorough discussion on domination and power.
refer to non-formal control as internal or external in a particular situation goes back to which is the location of the resource provider.

The two power bases, i.e. power based on legitimacy and power based on access to scarce, and essential resources, are central in discussions on control in international business. Forsgren and Pahlberg (1992), for example, discuss network position in terms of structural or systemic power while claiming that “structural power or systemic power … is related to the degree of involvement in a system and stresses the functional interdependence between units of a firm including indirect relationships as they are embedded in a wider system of interdependencies including units outside the firm” (p.42). The discussion fits in nicely with the discussion performed previously addressing a firm’s micro- and macro-positions. It seems reasonable to assume that systemic power of the kind combines legitimacy-based authority and power relating to resource dependence, and in this context is seems appropriate also to put forward the conviction that business reality is much more complex than theoretical models will ever be able to show. As a variation on the theme of access to resources and company control, several studies have addressed the flow of information and development of knowledge in the large MNC (e.g. Holm et al, 1995; Forsgren et al, 1997), an area of particular importance as information and knowledge are both considered particularly valuable resources on which to build control.

Pfeffer and Salancik (1978, p.32) state:

The organization ends where its discretion ends and another’s begins.

.....

The boundary is where the discretion of the organization to control an activity is less than the discretion of another organization or individual to control that activity.

Their message is certainly clear but applying it to a large, contextually embedded MNC – an interorganizational network in its own right – would certainly pose a major challenge. At an overall level the MNC may be taken for one coherent entity but such a view would not produce much valuable information about its nature. A closer look uncovers an organizational hybrid mixing hierarchical control based on legitimacy (firm) with control based on access to (and exchange of) scarce, and essential resources involving internal as well as external units (market). And somewhere at the crossing between command and dependency, beyond the control of one omnipotent power source, the MNC wends its way towards the future. The issue of firm boundary suddenly becomes less interesting as firm and market amalgamate into one common playground, a network of interrelated relationships appearing at various levels of organization, posing opportunities and constraints for actors to act upon no matter which are the bases of power they may draw on. The view sketched is certainly not inappropriate if assuming that power is unevenly dispersed over the set of viable coalitions that are populating the playground, and that those coalitions are bound together inside and between themselves through various sorts of relationships making

4.7 Conceptual framework

It is assumed that business organizations (firms, units, etc) operating in industrial systems involve in interaction. Interaction may take on the form of exchange, conflict, collaboration or competition. Mixed forms of interaction may occur between business actors. The conceptual framework as outlined here puts exchange in focus although the other three forms of interaction are also appreciated. Exchange activities involve at least two parties but commonly those two parties also involve in exchange with other parties making exchange activities go in many directions.

4.7.1 Carving manageable units of analysis out of an industrial system

An industrial system is a specific kind of business network populated by collective actors performing industrial operations commonly involving manufacturing. In such systems actors embark upon various positions in relation to each other and the system as a whole. Such positions reflect actor role(s), actor importance(s), and relationship strength(s). As – per definition – any business network is constituted by interrelated business relationships it is much obvious that such a system might be comprehensive and far-reaching. It follows then that drawing the boundaries of a business network or an industrial system is a most delicate task. The boundaries may be drawn arbitrarily but for the purpose of analysis they should be drawn neither too wide nor to narrow. If drawn too wide the analysis would be encumbered with irrelevant information. If drawn too narrow essential information would be left out. Johanson and Mattsson (1988) propose partitioning the industrial system into ‘national nets’ and ‘production nets’ depending on which is the basis for distinguishing various parts of an industrial system. The proposal is found much supportive and will be applied in the analysis in chapter 5. It should be noted, however, that a production net involves both a certain part of the production system and a certain part of the governance structure, the two together making up the industrial system (Johanson & Mattsson, 1992, p.206 ff). Thus, the approach appreciates actors, activities and resources judged as relevant for the analysis of the process of technological change as appearing in an international network perspective.

4.7.2 The gap reducing mechanism

Exchange implies bridging a gap. The gap may be larger or smaller. It may also be more or less difficult to overcome. The gap is constituted by elements such as ‘not knowing’, ‘not fitting’, ‘not reaching’, ‘not liking’, ‘not understanding’, ‘not controlling’, and so on, all of them bringing uncertainty to the exchange process as
perceived by the interacting parties. Parties involving in business exchange often perceive of a gap between the need of the customer and the ability of the supplier. The gap may be apparent or factual. An apparent gap is a manifestation of ‘not knowing’ or ‘not understanding’ and it is usually overcome by information exchange and learning about the other party. A factual gap refers to a mismatch as to resources and/or activities involved and is a manifestation of elements such as ‘not fitting’, ‘not reaching’, ‘not controlling’, etc. The bridging of a factual gap requires adaptation, which may be performed by one or both of the interacting parties.

In some literature on international business the gap phenomenon has been discussed in terms of ‘psychic distance’, a concept originally “defined as the sum of factors preventing the flow of information from and to the market” where “differences in language, education, business practices, culture and industrial development” are given as examples of such factors (Johanson & Vahlne, 1977, p.2). Challenged by others the authors have later divided the concept into two parts, viz. ‘relationship-specific psychic distance’ and ‘country-specific psychic distance’. The former relates to ”direct business-related managerial problems that are relationship-specific”, whereas the latter concerns “country-specific institutional and cultural barriers” (Johanson & Vahlne, 2003, p.96). It is clear that the ‘need-ability gap’ as discussed above interlinks with the concept of ‘relationship-specific psychic distance’, but it is of limited interest here to thoroughly clear the relationship between the two. It might be sufficient to conclude that a ‘need-ability gap’ may sometimes show up as a ‘relationship-specific psychic distance’ and the reverse.

The gap or distance, as perceived by parties involved in interaction, hampers the flow of information and/or goods between them. Some parties have good reason to make easier or more productive the exchange of information and/or goods and this circumstance may motivate them to endeavor reducing the gap. That may be particularly urgent in case the business process involves a desire or need for technological change emanating from some kind of misfit or mismatch in regard to ideas, resources and/or activities. In such situations gap reduction is at the core of business development. The mechanism of gap reduction has been an often visited theme in business research, and the literature review performed in this thesis chapter makes no exception. But why are gaps and gap reduction of interest for a study of technological change? Because it is assumed that an important variety of technological change takes the interaction of two or more business actors to materialize, and in this particular process existing gaps are assumed to impede both interaction and technological change. The gap reducing mechanism recognized in the literature can be summarized as follows:

At the start there is a gap between parties (or as in the early version of ‘the internationalization process of the firm’ between one party and a particular market). Interaction underpins (experiential) learning. As knowledge increases uncertainty
decreases. Increased knowledge and reduced uncertainty makes future risk more predictable and the outcome of risk calculation more reliable. As uncertainty decreases and future risk becomes more predictable room is created for the making of extended commitments (investments) either to the market or to a particular relationship or both. Commitments carried into effect are supposed to take place in the form of investments that are market-specific and/or relationship-specific, which means adapting to the needs or desires of a “receiving” party. Adapting is demonstrating commitment and commitment demonstrated is the source of trust. But out of adaptation comes also dependency and interdependency as an adapting party surrenders part of its freedom to act. The sequence Figure 4:4 shows a much simplified view of the mechanism of increased learning and commitment (the mechanism of gap reduction) being the core logic of relationship development (Ford, 1980) and company internationalization according to the Uppsala school (Johanson & Vahlne, 1977, 1990, 2003). The mechanism is iterative implying that the sequence is repeated again and again as the business process proceeds, and in this context learning, commitment, trust and dependency are considered cumulative entities.

<table>
<thead>
<tr>
<th>learning up</th>
<th>uncertainty down</th>
<th>commitment up</th>
<th>adaptation up</th>
<th>trust up</th>
<th>dependency up</th>
</tr>
</thead>
</table>

**Figure 4:4** A schematic model of the ‘gap reducing mechanism’

Learning about, committing to, and adapting to another party (or market) is a viable way to reduce an existing gap, whether be it a ‘need-ability gap’ or ‘psychic distance’.

4.7.3 Needs and abilities – Resources and activities – Interconnectedness

To make sense in a context where two or more than two parties involve in business exchange the ‘gap reducing mechanism’, as sketched in Figure 4:4 above, has to relate to some kind of asymmetric distribution of needs and abilities. Commonly it is customer need and supplier ability that come into focus but in business contexts also supplier need and customer ability are appropriate elements to consider (Ford et al, 1998). Typically the customer aims at getting access to certain resources or services the supplier is supposed to be able to supply, whereas the supplier aims at making those resources or services available for the customer. As long as the supplier ability fits the customer need everything is just fine and exchange occurs without friction. Sometimes (and probably quite often) this ideal situation doesn’t exist and exchange counterparts face a situation where needs and abilities are not matching. Business settings characterized by mismatch carry a certain portion of uncertainty and it is when uncertainty prevails that the gap reducing mechanism may come into operation.
Considerations about needs and abilities involve the interest and expectations of the parties concerned. A customer needing certain resources or services will assess whether a particular supplier would be able to deliver what the customer is aiming for, and in the same vein the supplier will judge whether its competences and capabilities will suffice to satisfy the needs of the customer. The interest to involve in exchange with another party has to do, to a certain extent, with expectations about what will be the direct outcome of exchange, but beyond short-term considerations about the need-ability complex as such also long-term strategic aspects are usually taken into account. In case the need-ability gap is conceived of as small or nonexistent it might be possible to achieve instant satisfaction from exchange without performing any activities deviating from “normal operation”. If the gap is large but the parties have strong interest and great expectations the propensity to perform gap reducing activities may involve a certain trait of urgency. Thus, it seems that interest and expectations are activating the gap reducing mechanism, and, as the mechanism is on the move, commitments and adaptations follow. Such commitments and adaptations frequently influence resource orientation and activity coordination but may impact upon the formulation of goals and strategies as well. What an actor is able and willing to do, and what the actor is actually doing for a particular counterpart, by and large defines the position of the actor in the eyes of the counterpart (Ford et al, 1986), because by that the actor role and the importance of the actor for the counterpart are determined (Johanson & Mattson, 1988). As the gap reducing mechanism goes on operating the bonds that are tying the interacting parties together gradually grow stronger.

Those bonds may be discussed in terms of actor bonds (agreements about goals and strategies), resource ties (resources that are orientated towards each other for a particular purpose and lose in significance if re-orientated), and activity links (interdependent activities that are productive only in the context where they operate) (Håkansson & Snehota, 1995). Such interconnectedness may concern technological, social, economic, legal, time-related, or knowledge aspects (Hammarkvist et al, 1982). To propose an exhaustive listing of bond dimensions is probably of little interest as it is the bonding principle as such that is of interest not the particular as conceived of type of bonding dimension. But basically interconnectedness is rooted in the distribution of power-dependency in a relationship or in a larger system (Emerson, 1962; Thompson, 1967). Resource and activity interdependencies, though, seem to be central for an understanding of technological change as such interdependencies show up as elements constraining change from occurring. Though available resources certainly constrain what can be done, if given the attention of an entrepreneurial mind sometimes they come into flower, while offering new productive services that nobody ever thought of before (Penrose, [1959] 1995).
4.7.4 Extending the framework by introducing ‘proximity’

The gap reducing mechanism shown in Figure 4:4 summarizes the ideas forwarded in Ford (1980) and Johanson and Vahlne (1977, 1990, and 2003) as to the mechanism of relationship development and company internationalization. The model logic is based on the idea of reducing an existing gap by way of learning by doing (uncertainty goes down, risk becomes manageable) and to utilize the room thus created for increasing the commitment to the market /counterpart. The model is based on the idea of continuous change emanating from the interplay between experiential learning and growing commitment. It doesn’t lend itself particularly well to the analysis of discontinuous or disruptive change. The strength of the model refers to its ability to follow change patterns driven by actor involvement in exchange processes where learning and growing commitment (and adaptation) are central elements. As to static situations and situations characterized by discontinuous change the model has little to say. The former situation may concern parties that are interrelated more or less closely in various dimensions although they have never involved in exchange with one another and they probably never will. Companies encountering discontinuous change as a result of mergers or acquisitions exemplify the latter situation (Melin, 1992, pp.111-112).

The gap reducing mechanism emphasizes ‘gaps’ and ‘distances’ but leaves little room for ‘nearness’ or whatever the opposite to (substantial) distance may be called. Sudden shifts caused by mergers, acquisitions or other disruptive changes (often created beyond the reach of those commonly involving in business interaction) re-position actors vis-à-vis each other. Former competitors might become sister units in a new structure. Actors previously involving in business exchange may have to terminate interaction for political reasons. A buying company, for example, may have to internalize procurement after having been acquired by another company. Major discontinuous change like that resulting from a merger may reshape the business landscape in such a way that a focal actor (e.g. a business unit) by the merger suddenly finds itself situated closer to some actors whereas other actors have become more distant (Havila & Salmi, 2002). When studying situations of the kind it might be more productive to start out from a perspective focusing on “nearness” rather than “remoteness”, as nearness can be considered akin to certainty whereas remoteness is akin to uncertainty. It follows that a situation characterized by nearness paves the way for acting on opportunities, whereas remoteness is hampering the flow of information and goods. A sudden reshaping of the business arena is an effect of discontinuous change. As new positions and conditions are created new opportunities arise for actors to take advantage of, and “nearnesses” appearing in the new setting will make easier the exploitation of those opportunities.

After having discussed “nearness” and “remoteness” at some length it is reasonable to take a standpoint by choosing a suitable word for “small gap” and by rendering the word a distinct meaning, i.e. to embark upon and run the process of conceptualization.
Here the word ‘proximity’ is selected to represent the phenomenon of “small gap” or “short distance”. By proximity is meant “the quality or state of being proximate, near or very near (as in time, place, relationship)” where the significance of proximate is “very near, immediately adjoining” (Webster’s Dictionary, [1961] 1993). Proximity may appear in various dimensions, e.g. the spatial, relational (social or business), legal, technological, cultural, knowledge, temporal, preferential, industrial, and so on, and when proximity is attendant information and goods are supposed to flow easier in industrial systems. Different proximities relate actors, activities and resources in different ways. In some business settings proximity appearing in one particular dimension is critical whereas proximities in other dimensions are less significant. In general it seems reasonable to assume that the more a particular business setting is saturated by proximity, i.e. the more dimensions that involve proximity and the closer the proximity in each dimension, the easier information and goods will flow through the system. It follows that proximity may show up as an important prerequisite for the successful utilization of opportunities in relation to technological change (or any other type of change) given that somebody is there to make use of the opportunities. The concept of proximity should be looked upon as a complement to distance or gap. When the gap reducing mechanism is operating “effectively” relational proximity would result. However, proximity is not a concept primarily meant for use in connection with the gap reducing mechanism. It has a somewhat different field of application as it is rather to be employed as a mapping device for use in the wake of disruptive change where the overall questions searching for answers go: Well, what does it all look like now? Which opportunities do we have and what can we do about them? By identifying proximities appearing in the new setting and compare them with those existing in the old setting the inquirer may get answers that reach halfway through or more.

4.7.5 Possible sources of technological change

Technological change may result from work performed in isolation by an ingenious industry researcher or by work carried out by experienced R&D teams or similar, and this is probably the most common view there is of how technological change comes into being. This view departs from the assumption that skilled scientists come up with an idea that they develop into manifest technology. Another most common view equates technological change with technological diffusion, i.e. the transfer of existing technology into a new setting where it is conceived of as new. It is a view comprising business exchange involving discussions about performance and price. Both views presuppose that technological change is the result of rational decisionmaking driven by strategic intention. The course of events is traceable. The actors involved can be identified as can the resources and activities. Although much of technological change is referable to either of those two views the scope of technological change offers still further room for other pictures to be painted. There is more to say about technological
change and this void is supposed to be filled – at least to a certain extent – by this thesis work.

The business process is a certain type of change process. The process of technological change and the internationalization process of the firm both appear as sub-processes to the business process. As part of the business process technological change and the process of internationalization frequently overlap. The overlap occurs when the gap reducing mechanism is activated in an international environment while addressing dynamic technological matters, i.e. matters that are open for negotiation between parties involved in business exchange. In case the business process links to an international industrial system the overlap is supposed to be extensive and the two sub-processes are supposed to be heavily intertwined. It follows that factors influencing the process of company internationalization ought to influence also the process of technological change and vice versa. Perhaps the two processes would benefit from being conceived of as one single process (the business process), which is studied from two angles, i.e. that of internationalization and that of technological change. The idea renders some support from Johanson and Vahlne (1990), who write:

We suggest that researchers should investigate how firm internationalisation processes are related to surrounding processes, i.e. market or network internationalisation, industry internationalisation, technical development, concentration as well as deconcentration processes. It is important to remember that firm internationalisation is embedded in an ever-changing world. (p.22)

The authors proceed by referring to internationalization strategies as another field of study deserving attention, and as they do they propose a set of possible sources of company internationalization.

[w]e think that internationalisation processes are the result of a mixture of strategic thinking, strategic action, emergent developments, chance and necessity. We believe it is worthwhile to analyse the internationalization of firms with regard to these factors. (ibid.)

It seems reasonable to assume that the factors that Johanson and Vahlne (1990) propose as suitable to explain internationalization processes, i.e. strategic thinking, strategic action, emergent developments, chance and necessity, could also qualify as potential sources of technological change. If relating each one of the factors to a scale that is measuring ‘actor power of choice’ strategic thinking and strategic action would hit the top end of the scale, because together they would represent pure intention-based action. Chance and necessity on the other hand would hit the bottom end of the scale. As per definition chance shows up at random beyond the will of any intentionally operating actor, and necessity usually makes actors do things they never intended to do, or at the worst, things that they are not at all willing to do. Table 4:2 is ranking the ‘possible sources of technological change’ along the scale of ‘actor power of choice’. As it is hard to motivate using both strategy factors the two are brought together into
one factor, i.e. ‘strategic intention’. Strategic intention may come to an observer both in the form of communication and “tangible action”.¹

<table>
<thead>
<tr>
<th>Possible sources of technological change</th>
<th>Actor power of choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic intention</td>
<td>High</td>
</tr>
<tr>
<td>Emergent developments</td>
<td>Medium/Low</td>
</tr>
<tr>
<td>Chance</td>
<td>None</td>
</tr>
<tr>
<td>Necessity</td>
<td>None (Negative)</td>
</tr>
</tbody>
</table>

Table 4:2 Possible sources of technological change related to actor power of choice

Change occurring as an effect of strategic intention is a theme discussed at length in the literature on strategic management and business strategy. Change occurring as a result of emergent developments has been thoroughly described above with reference to the gap reducing mechanism. Change emanating from chance or coincidence has not been discussed at all so far but is supposed to be an important source of change in the world of business. It seems reasonable to contend that a lot of activities going on in a certain business area happen beyond the awareness boundary of many people active in that area (Dubois, 1994), or otherwise expressed, each and every individual working in a company (or in an industry) have access just to a small portion of all information that is potentially available (Lawrence & Lorsch, 1967). Commonly people have to take decisions from a tiny base of information and they have to act although many things they know little about are simultaneously going on around them (Simon, [1945] 1997). Necessity, finally, enforces actors to do things that they have not intended to do, or as the course of events unfolds an actor may find that all ways are closed except for one. Business actors depend on the environment for survival. They have to get hold of input resources and they have to dispose of output products, and sometimes there is little room left to make a choice (Pfeffer & Salancik, 1978). An actor facing total necessity has lost all power of choice. The power of choice of the actor is actually negative as external factors are fully controlling the actor’s activities.

¹ The main problem with strategic thinking from an analysis point of view, if keeping to it as a separate factor, would be the gathering of data in case nothing was said and nothing was done.
5 BUSINESS EVOLUTION AND TECHNOLOGICAL CHANGE (ANALYSIS)

Technological change as appearing in the empirical case emerges as an integral part of the business process. It grows out of interaction, and, though industrial business operations are apparently intention-based, business network analysis shows that technological change is evolutionary rather than deterministic. Strategic intention appears to be a viable source of technological change but emergent developments, chance and necessity prove to be important sources of technological change as well.

The empirical case extends over a time period of fully two decades although the latter part of the period offers most detailed information for analysis. The case involves a large number of actors identified both at the level of the individual and at the level of the collectivity. The collective actors are firms, business units, and other organizational actors driven by profit motives. The actors attempt to fulfill their various goals by performing meaningful activities. The activities aim at transforming or coordinating physical and immaterial resources. Transformation means changing the shape or property of resources whereas coordination means moving resources geographically from one location to another or to combine or recombine resources. Thus, it is assumed that actors activating resources are goal-orientated, that activities performed are intention-driven, and that activity performance is ascribed meaning. As actors strive for goal achievement they interact with other actors, and as they do they develop interdependencies. Industrial settings are full of interdependencies. Actors are mutually dependent, activities are interrelated, and resources, as they orientate to other resources, are modified to fit into the resource puzzle. And when intersecting in the industrial system these three structures – the actor, the activity, and the resource structure – make up a playground, which at the same time facilitates and constrains the development and realization of new ideas. And some of those ideas relate to the phenomenon of technological change.

5.1 Analysis format and focus

The business story is at the same time comprehensive, penetrating and far reaching. Making sense out of such a large amount of data can be problematic, and the material can also be approached from different angles and in different ways. A structural approach pays attention to the way various entities relate to each other in a particular situation, whereas a dynamic approach focuses on change in one or a few dimensions over time. Guided by theory both approaches may appreciate the study of certain identified themes. Here a dynamic approach applies. The approach chosen divides the history of business evolution and technological change into four more or less distinct stages; the first stage commencing in the late 1970s, the last ending in the early 21st century. As the analysis proceeds through the four stages elaboration of various
themes reveals technological change as it appears in an international industrial system. The approach conforms to longitudinal case study research.¹ A few types of process model are employed to frame the analysis (Melin, 1992), viz. relatively short episodes (type B) spanning time periods from a few weeks to a few years, and longer epochs (type C) where long periods of evolutionary change are disrupted by episodes of revolutionary change. Maybe even biographic history (type D) could be considered. Table 5:1 summarizes the division of the business story into the four stages.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Major theme defining the stage</th>
<th>Time period</th>
<th>Process type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Technology development and diffusion</td>
<td>1978-1991</td>
<td>C (D)</td>
</tr>
<tr>
<td>2</td>
<td>Focal relationship start-up in the wake of a merger</td>
<td>1992-1993</td>
<td>B</td>
</tr>
<tr>
<td>3</td>
<td>Relationship development and technological change</td>
<td>1994-1998</td>
<td>C</td>
</tr>
<tr>
<td>4</td>
<td>The maturing of cathode plate business</td>
<td>1999-2001</td>
<td>B</td>
</tr>
</tbody>
</table>

Table 5:1 Division of the change process into four stages

As the table indicates the stages 1 and 3 take on the epoch character of process model constituted by reasonably long periods of evolutionary change (that may be) disrupted by shorter episodes of revolutionary change. The stages 2 and 4 constitute shorter episodes, each one of them comprising a few years. The division into the four stages is basically an artificial construct established in order to highlight certain themes of importance as to technological change. The theme identified takes precedence in the analysis of the respective stage. In this context it should be emphasized that technological change is assumed to be a sub-process to the business process and that technological change is supposed to be closely intertwined with the internationalization process of the firm as well as organizational change in general².

Each major theme links to a certain stage, a certain period of time, and a certain type of process. Each stage also involves a certain set of actors, certain resources and certain activities, and not to forget certain relationships. This circumstance makes it possible to identify an adequate sub-network suitable for analysis in each stage, be it a ‘production net’, a ‘national net’, a ‘national production net’, or any other definable ‘net’ that is underpinning meaningful analysis.

Another most important choice to be made concerns the actor concept. The chapter introduction gives a broad description of purposeful human action in an industrial context, but it doesn’t take a clear position as to the level of aggregation in regard to the actor concept. However, guided by business network theory this chapter will focus primarily on collective actors, i.e. firms, business units and the like, but also on their

¹ Also see section 1.7.3 for a more thorough discussion about longitudinal case study research.
² Confer section 1.6.3 above.
aggregation into industrial systems. Unless anything else is proclaimed the term ‘actor’ refers to ‘collective actor’ when used in the analysis.¹

The analysis aims at identifying and discussing technological change with reference to the ‘gap reducing mechanism’, and by that implicitly also other manifestations of the change process will be addressed, manifestations such as relationship development and the internationalization process of the firm. The analyses of the type C process stages, in particular, take advantage of the ‘gap reducing mechanism’, whereas ‘proximities’ become more central in the analyses of the type B process stages. The reason being that the former involve more of continuous change, whereas the latter display more of discontinuity. Each stage is scrutinized in pursuit of possible sources of technological change. Such sources may comprise strategic intention or force, emergent development or evolution, chance or coincidence, necessity or coercion, etc. Table 4:2 offers a simplified listing (though not exhaustive) of possible sources. It is assumed that actors striving to create change would face both opportunities and constraints linking to other actors’ operations as well as environmental conditions in general.

5.2 Technology development and diffusion

Scarce resources might trigger the development of new technology or new technical solutions and that was actually what happened during the mid 1970s as Domestic Mining Ltd (DML), one of the world’s largest mining companies, ran out of cathode starter plates for their metal refinery operations. Previous trials performed by DML to recycle starter plates produced from titanium in their refinery system had failed. Now the idea of using reusable starter plates was revisited by a young engineer at DML, a person with an entrepreneurial mind, who raised the inquiry “hey, why don’t we use stainless?” The man was obviously in possession of a certain amount of entrepreneurial versatility (Penrose, [1959] 1995) enabling him to look beyond traditional solutions and he was also alert enough to see opportunities that others were unable to see (Kirzner, 1973). The idea of using reusable starter plates fabricated out of stainless steel was now raised as a priority item on the research agenda of DML. Thus, in the case of DML it was actually the need of the customer that triggered technological change at a point in time when the market was short on disposable starter plates. Whether the need grew out of necessity is not perfectly clear. There is too little information available to make a credible judgment, but it seems that some options were left open to act upon although the procurement situation was difficult. If so, strategic intention determined the course of action to a certain extent though constrained by market conditions. In this particular case the solution to the problem was developed internally by the entrepreneurial-minded young engineer, but up to this point in time it was all just an idea, an image picture in the mind of the inventor. To

¹ See also the discussion performed in section 4.4.4 above.
make the idea materialize, i.e. making it convert into physical structure, should take both effort and resources.

5.2.1 From idea to manifest technology in a domestic actor circle

The idea to develop a modified refining technology grew out of customer need and an invention originating from a young engineer working at DML. As the project proceeded and the results obtained were found promising Metal Extraction Ltd (MEL), a fully owned subsidiary company of DML, was formed around the new technology. The core element of the new technology, the cathode starter plate, was supplied by Domestic Steel Ltd (DSL), the only stainless steel supplier running the entire route of stainless steel manufacturing on X-land ground, from steel smelting to finishing, all other X-land suppliers of stainless being traders importing material from abroad.

Already the need for a customized product may drive counterparts to establish a business relationship, and in case there is just one supplier and one customer operating on a particular market, and both of them depend on the other for success, it goes without saying that they are likely to involve in close cooperation while developing a strong relationship (Håkansson, 1982; Campbell & Cunningham, 1983; Campbell, 1985), and that was actually what happened when it comes to MEL and DSL. Had it been possible to satisfy the need of MEL by offering a fully standardized product also traders active on the X-land market could have been effective competitors. But the traders would still have faced an obvious disadvantage vis-à-vis DSL, because geographical proximity in itself facilitates corrective action and problem solving should material defects or other deficiencies appear.

Thus, choosing DSL for supply of cathode plate was not really a choice, as MEL needed a customized product adapted to the process in which it was meant to make service. As the need for adaptation raised demand for cooperation, and proximity made cooperation easier, DSL was the natural choice. The alternative, i.e. trying to develop new technology while involving in cooperation with a manufacturer located abroad at a large distance, whether spatial, psychic\(^1\) or both, was probably not even considered by MEL in the early days. As people at DML already involved in business exchange with DSL concerning other products (most likely), MEL found no reason to turn to any other source of supply regarding cathode starter plate. By choosing DSL the DML group could benefit from already existing proximities in several dimensions, viz. the spatial, cultural, relational (probably both business relational and social relational), and temporal dimension, and the flow of information and goods could move smoothly

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\(^1\) “Considering the extension of activities to new markets, the concept of psychic distance may well prove useful. This concept is defined as factors preventing or disturbing the flows of information between firm and market. Such factors include differences in language, culture, political systems, level of education, level of industrial development, etc. For obvious reasons, psychic distance is correlated with geographic distance. But exceptions are easy to find.” (Johanson & Wiedersheim-Paul, 1975, p.307.)
between the various units constituting the domestic actor circle, i.e. the triad made up of DML, MEL and DSL. Concurrent proximity in several dimensions facilitated information exchange and learning in regard of dimensions where the gap had still to be closed (or at least reduced). And as the interaction between DML, MEL and DSL immediately put focus on technology issues, and particularly on issues addressing resource and activity coordination (and adaptation), the ‘gap reducing mechanism’ was early on the move and favorable conditions for new technology development were soon in place.

The actors working on the development of the MEL refinery process back in the 1970s obviously succeeded in creating a workable “reification window” determining the way the idea was reified into manifest technology. The solution was probably not optimal but it was certainly viable (Cyert & March, [1963] 1994, p.93 ff). Given the manufacturing equipment available at DSL and the level of technological know-how residing in the national production net the “reification window” was established and by that the standard of how to produce the stainless steel starter plate. The resources at hand and their particular qualities along with the concurrent use knowledge, i.e. knowledge about how to combine and activate the resources to make them generate productive services appropriate for the application, at the same time constrained and facilitated technology development (Penrose, 1959). It is assumed that misfit appeared now and then at various interfaces between the product under development, existing production facilities, existing use facilities, and the knowledge and expectations of those involved in interaction and that such misfit was a source of disturbance and negotiation in the development process (Cyert & March, [1963] 1994). From the very beginning surface finish and material flatness were the crucial parameters of the stainless cathode plate. However, DSL’s capabilities to control the manufacturing operations back in the 1970s were not all in place and the empirical case tells about material that was so heavily over-pickled that the grain boundaries were strongly hollowed out. This was not deliberately created, but it was a good thing after all, because the hollowed-out grain boundaries functioned as a “toe-hold” for the deposit to “grab” as the cathode plate was employed in the metal refining process. And this “toe-hold” was coarse enough to offer appropriate service also in case the material had to pass through heavy posterior roller leveling in order to arrive at a level of flatness suitable for the application. Most likely, material with a less rough surface would have become too fine for the application after such harsh treatment. By chance an intended strategy had resulted in unanticipated consequences\(^1\), which, in this particular case, were later found to be an advantage.

In the early days MEL, DSL and DML established a tight triadic relationship, a ‘national production net’ in its own right, where DML brought the expertise in mining and refinery technology to the setting, DSL contributed by activating facilities and skills as to stainless steel manufacturing, and MEL shouldered the responsibility of

\(^1\) Cf. Merton (1936)
running the technology development project while putting all the pieces together, pieces that should finally result in the ‘MEL refinery process’. DML shouldered the specifier and test center role as well as the end user role in the system, DSL took on the role of the adaptive supplier willing to cooperate in order to end up with a customized product fitting in with the need of the customer, and MEL, finally, had the coordinating role making things come out right. The three actors ran complementary roles triggering business exchange in the system and all three were also much important for the success of the system as a whole, which made them become strongly interdependent within the format of a triadic relationship (Johanson & Mattson, 1988).

Through ownership bonds MEL was closely tied to DML but also knowledge bonds and resource dependence on the hand of MEL tied the two together, not to forget about all the social connections that had evolved over time between people working for the two companies as MEL was a late offspring of DML. Thus, DML was a most important counterpart of MEL and certainly the reverse was also true as the technological development performed by MEL had bearing on the operations of DML. The further the MEL refinery process was developed and refined the more efficiently DML could perform their metal refining operations. The discussion shows that the bonds interconnecting MEL and DML were both strong and multidimensional (Hammarkvist et al, 1982).

During the initial part of the development process DML and DSL frequently and intensively involved in interaction with one another, but after MEL had become a legally established corporation DML’s everyday contacts with DSL were soon transferred to MEL. DSL, being the only supplier of stainless steel operating a steel mill on X-land ground, was the only viable choice for MEL, who needed a supplier that was both willing and able to adapt to their needs and wants (Ford, 1980). Consequently, MEL strongly depended on DSL for the development of the ‘MEL refinery process’ because DSL involved in the process of trial and error run by MEL aiming at improving the existing refining technology (Emerson, 1962; Thompson, 1967). It is not at all peculiar that DSL had a strong interest in doing business with MEL and DML as the DML Group was a major steel consumer on the X-land market.

The technical solution, i.e. the MEL refinery process, offered adequate services in those refinery plants where it was brought into service, and it seems that it scored high on the effectiveness scale at least from a functional point of view. It is uncertain, though, whether cathode plate manufactured in these early days rendered the user the highest level of productivity. In comparison with conventional electrolytic refining of metals the MEL refinery process certainly granted the operator strongly increased efficiency, but the full efficiency potential of the new technology was probably not yet utilized. (Pfeffer & Salancik, 1978, p.11.)

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1 For many years DSL manufactured and supplied both mild steel and stainless steel for the X-land market.
In the DSL works it seems that productivity suffered a great deal as to the manufacturing of cathode plate for MEL. Product quality had to be sorted out as the requirements concerning both surface finish and flatness were particularly demanding. A certain amount of material was rejected because the surface arrived at didn’t meet specification or the material was not flat enough to be suitable for use in the refinery process. Material thus withdrawn had to be sold at reduced price on the market for seconds, as it didn’t comply with standard dimensions. Lower yield numbers, extra handling operations, and an extended posterior roller leveling left the cathode plate product with costs high above the normal for standard material. As a consequence the price for stainless steel cathode plate, as supplied by DSL to MEL, carried quite a high premium. In this context it might be worth underlining that the piece-mal roller leveling performed by DSL involved a lot of manual work. In comparison with production of standard material the cathode plate produced for MEL scored low on the efficiency scale but thanks to a high price the business was still much profitable for DSL. (Ibid.)

DML’s experiences in regard of the MEL refinery process turned out to be so good that the MEL people contemplated: “Well, it’s so successful. Who are we in [X-land] that can prevent someone in America or wherever from copying our system. We can’t stop it. So…, well, why aren’t we making money out of it, we are going to sell it to our competitors.”¹ Up to this point in time the development project that had generated the MEL refinery process had altogether been a domestic affair involving actors operating on X-land ground only, but soon the conditions should change. The new technology, originally meant for use in the refinery operations of the DML group only, should soon conquer the world as it was made available to DML’s competitors through license agreements.

It is clear that the triadic ‘national production net’ constituted by MEL, DML and DSL had been able to mobilize and coordinate sufficient physical resources, knowledge, and development skills for the development of a most successful modified version of the metal refinery process utilizing reusable stainless steel cathode starter plates, and that the development to a great extent had arrived as a result of interaction and adaptation in an environment characterized by proximity in several dimensions.² Necessity and chance had been supportive in the process as well, no doubt, and parties outside the triad had also contributed to the project in various ways, e.g. by performing common workshop operations, but the core of the development work had revolved around the three actors making up the triad. To conclude, it seems that several concurrent sources of technological change made the ‘stainless steel cathode starter plate idea’ reify into physical state. The example is a viable illustration of

¹ Interview with Hank Kennyson on November 22, 2001.
² Also compare with the discussion performed in connection with Figure 4:3 above (see section 4.5.1) about how resources, activities, and actors combine into an industrial system.
technological change as the ‘novel development or modification of technological artifacts’ (see Figure 3.3 above), because the stainless cathode starter plate brings with it certain rule set inscriptions that closely control the performance of the artifact when brought into service. It is obvious that the ‘MEL refinery process’ also comprises a set of novel ‘techno-human routines’, but, as sufficient information is lacking about these routines in the case (no matter how interesting they might be), they are paid no further notice to in this analysis.

5.2.2 Technology expansion into the international arena

After a couple of years the MEL refinery process had been adopted as the standard operating procedure in the refineries operated by DML, and based on the experiences of using the new technology two conclusions were drawn within the DML Group, 1) the new technology was very successful, and 2) it would be difficult to prevent competitors from copying the new technology. The two came together into a strategic decision: “So…, well, why aren’t we making money out of it, we are going to sell it to our competitors.”¹ Thus, the DML Group found that they possessed an asset that would render them competitive advantage if exploited on overseas markets.² Motives of the kind for international expansion are not at odds with the stages model of company internationalization (Johanson & Vahlne, 1977). The model claims that first the firm establishes viable business operations on its home market and later it expands internationally in several steps. And when deciding to go abroad the firm usually refers to an asset supposed to render it competitive advantage on the new market, at least in the initial phase of the process.

At the time ‘the MEL refinery process’ had become amenable to sales the DML Group was certainly most experienced already in the area of international business, but the experience of the Group mainly derived from operations on markets for raw materials, and to perform international sales of a sophisticated process technology, i.e. ‘the MEL refinery process’, was something different. The Group could basically go in two directions. Either they could exploit the new technology by performing own large scale investments on a global basis in new refinery capacity, or they could sell the technology to others.³ As each such investment by necessity had to link to an ore deposit, and as most known deposits were already controlled by other mining companies (competitors of DML), little expansion potential was left for the DML Group to act upon if choosing a strategy based on internalization. Thus, the ownership structure of the mining industry certainly influenced the choice of strategy of the Group, but another factor was probably even more influential. The new technology

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¹ Interview with Hank Kennyson on November 22, 2001.
² According to traditional foreign direct investment theory (FDI) this is the strongest single theoretical argument for company internationalization whether the advantage is gained by exploiting monopolistic benefits on an imperfect market (Bain, 1959; Kindleberger, 1969; Hymer, 1976), or by internalizing activities in order to avoid market failure (Buckley & Casson, 1976; Hennart, 1982).
³ Doing nothing about it, of course, could be a third alternative.
was suitable for incorporation in existing refineries using conventional technology, and this circumstance made all refinery plants around the world a potential target for the new technology. Implicitly the customer need was specified in detail and the ability to satisfy the need with an adapted solution was already in place (Håkansson et al, 1976). Thus, a huge market waited for DML to conquer, and the market for the new technology was with DML’s competitors, a circumstance that might have triggered some skepticism within the DML Group. However, as the proprietors of the new technology saw no realistic possibility to protect it from encroachment, and as nobody within the Group had effectively questioned the proposal to sell it to competitors, the strategic direction was settled. To a certain degree the decision was fatalistic as the fight for property rights was already abandoned before it had even started – the reason being that the MEL people saw no way to prevent the technology from being copied. Thus, why involving in a fight you think you can never win?¹ Instead of giving the technology away for free the DML Group chose to make money out of it.

Now, at least two strategies could be applied regarding the selling of the new technology. It could be sold by way of licensing or it could be presented as a turnkey solution where MEL offered the customer a complete refinery plant ready for use. It is interesting to note that the new technology entered the European market via a license agreement. The buyer was Continental European Refinery Ltd (CER), a company connected to DML through joint ownership (see Figure 5:1). Thus, in this particular case DML used ownership bonds (or legal proximity) as the bridge to Europe for the new technology. The DML Group further developed an already existing position on the European market by way of penetration (Johanson & Mattsson, 1988). The role of DML as part-owner of CER was now complemented by DML’s role as supplier of new refining technology², which strengthened DML’s position at CER, but CER also grew more important to DML as they became the first reference for the MEL refinery process’ on European ground. DML (and MEL) and CER now involved in a pattern of multi-strand interaction comprising exchange of technology, competition as regards the output products of the mining and metal refinery industry, and probably also (although there is no information available on this point) some kind of collaboration concerning price. To think of relationships as single-stranded from an interaction point of view, implying that two interrelated parties involve either in exchange, competition, collaboration or conflict with each other, is sketching a much too narrow (and most naive) picture of international business as it appears in today’s internationalized world, where the large multinational corporation takes on the format of a far-reaching inter-

¹ It is clear that the DML Group didn’t anticipate they would win a case on property rights in regard of ‘the MEL refinery process’, should they go to court with it, or at least they thought it wouldn’t be worth the candle. Outcome expectations certainly impact upon decisions made in regard of future action. “When interaction between organizations is adjusted to their relations of power it usually only rests on how the interacting parties perceive the resources of power involved in the interaction.” (Ahrne, 1994, p.120.)

² It is likely to assume that DML sold the license to CER although MEL later physically delivered the cathode plate to CER.
organizational network linking activities between large numbers of entities both inside and outside the legal boundaries of the corporation (Ghoshal & Bartlett, 1990). By CER’s investment in the MEL refinery process the new technology got an initial foothold on European ground, and it is likely that the decision of CER to take on the new technology had not come out of the blue. It had rather emerged as a result of information exchange between managers at different levels linked together through ownership bonds, and it is a given that parties sharing common ownership are guided at the same time by informal agreement at various organizational levels and by formal control emanating from the top of the organizations concerned (Ghoshal & Bartlett, 1990; Forsgren & Pahlberg, 1992). By that not said that social bonds at the level of the individual are not effective bridges to the internationalization of companies and technologies (Johanson & Vahlne, 2003). The empirical case doesn’t tell about social or personal bonds in the relationship between DML and CER but it is probably unwise to repudiate the explanatory value of such bonds in relation to the early diffusion of the MEL refinery process.

If looked upon in retrospect the license agreement that was established between DML and CER back in the early 1980s was an exception. Later on, as MEL had grown into a well established business firm, the new technology was sold no more by way of licensing. Instead manufacturing and assembly activities were now fully internalized and the ‘MEL refinery process’ was sold embedded in refinery plants and refinery equipment. There might have been several reasons to why the activities were internalized, but one of the more probable ones concerns the quality control aspect. As the proper functioning of ‘the MEL refinery process’ relates closely to the flatness and

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1 The circumstance that relationships commonly involve both cooperation and competition has been discussed by several authors, e.g. Axelsson (1992, pp.199-200), Ahrne (1994, p.121 ff), Wilkinson and Young (1994).
the surface finish of the cathode plate, the monitoring and control of manufacturing and assembly activities become crucial. Licensing the technology to others implies giving up on these issues. Most likely, internalization also meant increased profitability for MEL and the DML Group, as well as a more safe protection from the encroachment of others (Buckley & Casson, 1976). Thus, the final solution to the exploitation of ‘the MEL refinery process’ was inscribing it into matter – i.e. embedding technology in technological (material) artifacts carrying precise knowledge-based inscriptions, which, when properly activated, perform efficient and flawless electrolytic metal refining – and then selling the process to the market in the form of refinery plants and equipment. The strategy applied relates to technology diffusion, which is the category of technological change where technology is transferred from one location to another.

The self-contained “domestic actor circle” constituted by DML, MEL and DSL was subject to a major change in 1988 as DSL decided to close down their metallurgy operations of stainless steel production. The change meant that steel smelting and hot rolling had to be performed elsewhere, but as DSL was the only steel producer in X-land hot coil had to be procured from foreign sources. DSL chose to buy hot coil from England, which implied that the business performed in regard of the MEL refinery process now became international in both ends of the value chain (Porter, 1986). The reason why DSL chose British Steel Stainless (BSS) as their feedstock supplier is not clearly known, but the existence of old cultural bonds interconnecting X-land and England might serve as one possible explanation (or maybe there were some ownership bonds interlinking the two companies). If that is true it is relevant also here to discuss the impact of proximity on the development process. The more precise concept of psychic distance, as discussed by Johanson and Vahlne (1977), is certainly also relevant to refer to in this context, although the network extension into another country in this particular case concerned procurement and not sales.

5.2.3 Stage 1: Summary discussion

As the original version of ‘the MEL refinery process’ is developed the actors involved face a most limited market. Contrary to the view depicted by literature on neoclassical microeconomics (see e.g. Lancaster, 1974) the observation indicates that not always there is a broad market to turn to for exchange. Sometimes there is just one single counterpart to rely on for supply or one single counterpart to turn to for sales. In such settings the parties involved often become extremely important to each other and that is actually what happens in the empirical case during the early years of technology development. The triadic relationship of DML, MEL and DSL forms a tightly structured national production net where each party is running its own distinct role(s) in the system. Within the triad interaction takes on the form of harmonious cooperation with the parties involving in exchange. Activities are complementary giving little room for conflict or competition. The triadic business setting may be considered a more or
less closed system (Thompson, 1967) characterized by obvious proximity in several dimensions. The development project is performed in one single country and it is populated by engineers and technicians operating in the same cultural zone, using the same language, exhibiting a similar business conduct, and so on. Each party brings specific knowledge and physical resources to the development project making the domestic triad a self-contained system capable of creating a “reification window” for the new idea to pass through on its route to manifest technology.

The production facilities residing in the production net and the operating procedures in place to control the facilities at the same time underpin and constrain change. Resources inherited from the past involve inertness constraining change – you have what you have and what you have to a certain extent determines what you can do – while resource heterogeneity, the circumstance that one particular resource can be used in more than one way (sometimes many different ways), is underpinning resource adaptation and recombination (Penrose, 1959). Products and production facilities are technological artifacts. Technological artifacts are inert because they contain certain rules once inscribed into them, rules that constrain the operations of the artifact when activated, and commonly such inscribed rules cannot easily be changed. Resource heterogeneity refers to the “flexible use” of resources, which in turn refers to user creativity. A technological artifact, though inert, may still be used in different ways depending on which are the services that the user is capable to draw out of it, and if that is not sufficient the user may be able to modify the artifact in such a way that the aimed at services can be obtained. Back to the empirical case; as a result of resource adaptation and resource recombination a new viable refining technology emerges at the crossing between conventional metal refining technology and standard technologies relating to stainless steel production. It seems that most of the mismatch appearing at various resource interfaces in the course of stage 1 of the case is sufficiently negotiated and resolved as DSL is obviously developing capability suitable for the production of well-performing cathode starter plate. Not much of disturbing mismatch seems to remain as the quality of the output product is markedly high and fairly stable.

However, as the production route includes piece-mal roller leveling, which is utilized as a posterior corrective operation, it might be that the combined production system of stainless steel manufacturing and electrolytic metal refining involves a certain portion of dormant residual friction (not recognized in the first place) in the “area between events” where the output product of stainless steel manufacturing is redefined into an input production facility of the metal refining process.¹ The manual roller leveler functions as a “corrective device” rendering each plate particular attention and treatment. Plates meeting the product specification in the first place are let through. Plates that are not meeting the specification in the first place are subjected to corrective action and after the posterior processing has been performed some of them

¹ Cf. the discussion in section 3.4.2 about the manufacturing process.
are allowed through, whereas others are rejected and reallocated. The piece-mal roller leveling appears as a controlling and bridging operation concentrating on the sorting out of quality. The handling is rather an art than a technological procedure, at least if uniform repetitive action (and outcome) is supposed to be a distinctive technological feature. As there is frequent need for posterior corrective action some kind of friction seems to remain in the interface area between the industrial processes of stainless steel manufacturing and electrolytic metal refining. Should the inconsistency not be masked by handicraft piece-mal roller leveling resource interface friction would certainly rise to the surface.

Industrial systems involve inertness constraining change. Rules, whether embedded in technological artifacts, industrial routines, or “taken-for-granted” agreements at large, are guiding future action along lines determined in the past. They are the “defenders of the existent”. Changing “what is” is changing the rules that are guiding action. A set of possible sources of change have been proposed, viz. ‘strategic intention’, ‘emerging developments’, ‘chance’, and ‘necessity’. The analysis performed above underpins the proposition that technological change is a continuous process closely relating to the interaction of business counterparts (Håkansson, 1987). The process proceeds in accordance with the ‘gap reducing mechanism’ and change takes on the form of incremental development. Actors are acting and reacting in relation to each other (Håkansson & Snehota, 1990). Each new situation is the starting point for renewed evaluation and a new decision, and the result arrived at in the end more often than not differs from what was anticipated in the beginning. This view on business strategy has been labeled the ‘branch method’ (Lindblom, 1959). It is the method of “successive limited comparisons. … continually building out from the current situation, step by step, and by small degrees” (p.241). It seems that the description fits in fairly well with the original development of ‘the MEL refinery process’ the way it emerges in the tight domestic triad constituted by DML, MEL and DSL.

The analysis of the empirical case shows that ‘the MEL refinery process’ grows out of ‘emerging developments’ by and large, but it also points at other possible sources of technological change. DML, for example, is driven by ‘necessity’ to find a solution making disposable cathode starter plates redundant as procuring them brings about a lot of problems, and particularly so at times when supply is short on the market. It is difficult to estimate the degree of necessity that is driving the search for an alternative solution in the case, because it seems that necessity is mixed with ‘strategic intention’. To DML the situation is precarious but not so bad that they cannot cope with it. It

1 To univocally distinguish between ‘art’ and ‘techno-human routine’ is probably impossible. Both involve and make use of knowledge and skills. A major difference, though, between the two is that activities referable to as ‘art’ are supposed to involve a substantial portion of creativity, whereas activities referable to as ‘techno-human routine’ are repetitive per definition, i.e. their utilization doesn’t involve creativity. Also see the discussion performed in chapter 3 about various manifestations of technology.
2 The items are examples of ‘institutions’. For a discussion about ‘institutions’ see section 6.2.
seems that they still have some power of choice left at their disposal. When deciding to support the idea of fabricating reusable cathode starter plate out of stainless steel the DML management is showing strategic intention. The idea to develop reusable starter plate was not new. It had been tried before but then titanium had been the material candidate and the trial had failed. When the young entrepreneurial-minded engineer comes up with the inquiry “hey, why don’t we use stainless?” the time was right and the idea was supported by the DML management. The consideration fits in with Barbara Czarniawska’s discussion about “an idea whose time/space has come” (1996, p.44). In the empirical case the entrepreneurial mind of the young engineer serves as an initiating force that is triggering the process of technological development, but hadn’t it been that the time/space had been “right” for the idea to flourish it is likely that nothing had happened. It is beyond debate, though, that the contribution of the young engineer played an important role in the formation of strategic intention in the case.\textsuperscript{1} In line with Penrose’s (1959) discussion about the interrelationship between entrepreneurial services and managerial services it is assumed that much of strategic intention involves a certain amount of entrepreneurial thinking. Strategic intention may or may not be based on entrepreneurial thinking, but when it is, entrepreneurial action will usually follow.

Another most obvious manifestation of strategic intention is shown when the DML Group (MEL) decides to exploit ‘the MEL refinery process’ on a global basis, but, as the case reveals, the decision is based not only on their own free choice. There is a certain amount of coercion involved. The MEL people express their view of the situation: “Who are we in [X-land] that can prevent someone in America or wherever from copying our system?” It is an implicit threat forcing MEL to act, although still they have some freedom to choose direction. To conclude, the internationalization of the ‘MEL refinery process’ appears in the form of technological diffusion driven partly by strategic intention and partly by necessity (coercion). The case also reveals certain conditions making ‘chance’ the source of technological change. The conditions refer to DSL’s inability to properly pickle the stainless steel material when running it through their annealing and pickling line. The material ends up severely over-pickled with the grain boundaries strongly hollowed out. The effect is unintentionally achieved, but it turns out to be a good thing as it renders the plate an adhesive capability suitable for the application also when heavy posterior roller leveling has to be performed in order to improve the flatness of the material.

\textsuperscript{1} The interrelationship between entrepreneurial thinking and strategic intention is an interesting field of study that has been frequently approached in the literature. “The Process of Creative Destruction” (Schumpeter, 1942, chapter 7) is an early, much interesting discussion interrelating the two areas. Penrose (1959) thoroughly elaborates the interrelationship between entrepreneurial and managerial services. Lately, concepts such as ‘strategic intent’ (Hamel & Prahalad, 1989), and ‘core competence’ (Prahalad & Hamel, 1990), have been developed and used in connection with entrepreneurial thinking and strategic intention.
The triadic relationship of DML, MEL and DSL involves close proximity in several dimensions already from start, i.e. the spatial (geographical), cultural and temporal dimensions. All three actors are located in X-land, they share one culture including one language and common rules guiding behavior, and they are attendant simultaneously in the same time unit. Besides, some of the “legs” in the triad involve also legal proximity and relational proximity (both business relational and social relational). As the development project addresses a technological matter it is densely populated by technicians and engineers making also collegial proximity an adequate dimension to consider. Thus, it seems that “the stage is well prepared for the show” and the apparent gap to be closed (or to be sufficiently reduced) consists primarily of uncertainties relating to the properties of the stainless steel cathode starter plate, its manufacturing and its utilization. Thus, there is an obvious gap in technology. As proximity in several dimensions makes the flow of information and goods smoother the domestic triadic setting is an ideal context in which to perform development work by way of interaction. The setting is dense and there is not much disturbance coming in from the outside impacting upon the interplay between the actors. At the same time the resources available in the system are setting a limit as external resources are not easily available due to X-land’s peripheral location.

At the time ‘the MEL refinery process’ goes international legal bonds are aiding the entrance into Europe. The large geographical distance between X-land and Europe is certainly a disadvantage but the ownership connection between DML and CER offers a channel for information exchange. The observation supports the model of internationalization developed by Johanson and Mattsson (1988) claiming that “the firm establishes and develops positions in relation to counterparts in foreign networks” (p.200). According to the model the internationalization of the firm is a cumulative process where existing positions make up the basis for further internationalization through international extension, penetration and international integration. When, in the late 1980s, DSL chooses to source hot band from England it might be that cultural proximity significantly influences the decision, as X-land and England to a certain extent share the same culture. If so, it is in line with the stages model of firm internationalization (Johanson & Vahlne, 1977) contending that psychic distance is a distinguishing factor when the firm is expanding abroad, i.e. a firm is inclined first to enter such countries that represent a small psychic distance in relation to the firm’s home country.

5.3 Focal relationship start-up in the wake of a merger

Metal Extraction Ltd (MEL), as part of the Domestic Mining Ltd (DML) Group, successively expands its business on a global basis during the 1980s as metal refineries around the world upgrade their plants with the new technology. Greenfield investments made in parallel add to the spread. Customers buying the MEL refinery process get knowledge embedded in refinery plants and refinery equipment (they
actually buy a set of technological artifacts). The downstream business of MEL will not be subject to any explicit analysis here as the type of technological change appearing in the episodes conforms to technological diffusion, i.e. the spread of “black boxed” technology from one place or location to another. Diffusion of technology is equivalent with technology transfer, an activity that doesn’t contribute to the content of the technological solution as such. The business between MEL and its customers concentrates on exchange of information in regard of technical and commercial matters, while issues concerning technological development and adaptation are conspicuous by their absence. It is so because MEL’s customers are buying just a sophisticated, ready-to-use, standardized technical solution. Relationships of the kind may involve both frequent and intensive interaction, and a lot of teaching and learning as well, but they do not involve much of adaptation (Håkansson, 1982). Upstream MEL enters into a new relationship during the first half of the 1990s when starting to do business with Unit Cold Rolled (UCR). The relationship between the two should soon come to involve an important element of technological change. It is the focal relationship of the empirical case and it will be analyzed in great detail. As the relationship interlinks with several other relationships it will be studied in a network context.

5.3.1 Entry into business by coincidence and enterprising

Avesta AB and British Steel Stainless (BSS) merged into the Avesta Sheffield Group in late 1992. The following summer Unit Cold Rolled (UCR), now a member of the Avesta Sheffield Group, offered stainless steel cathode starter plate to a North American company by name Refinery Plant Construction Ltd (RPC) for use in a metal refinery plant in Canada. The incident occurred almost one year before the first direct contact was established between UCR and MEL. The UCR-RPC relationship appears to be one of the least dramatic in the entire business story of the empirical case. In the mid 1993 RPC sends an inquiry to UCR for close to 2000 tons of stainless plate. An offer is made, the order follows, and during the autumn the material is dispatched. The connection between UCR and RPC may be denoted ‘business relationship’, but, if so, it certainly has to be characterized as “loose” (e.g. Ford, 1998). Maybe a more appropriate denotation is “ordinary market exchange performed at arm-length distance”, as RPC seems to approach any supplier on the market for supply. Still, the presence of RPC in the field of refinery plant construction is important to consider, as the company is a severe competitor of MEL. For the purpose of analysis UCR’s business exchange with RPC is of interest for two reasons, 1) the product specification of RPC was never scrutinized along UCR’s administrative routine for non-standard products, but an experienced employee willing to take the risk of a failure made an offer anyhow, and 2) by processing the RPC order people in the UCR organization attained some confidence as to the manufacturing of cathode plate for the electrolytic refining of metals.
RPC’s inquiry arrived in the sales department of UCR during the holiday period in the mid of the summer. Several functional managers of UCR were off for holidays, but RPC sought for an urgent offer. The product specification included some difficulties regarding product properties. An experienced product manager in the marketing department took on the responsibility for the inquiry, by-passed the administrative routine for the handling of non-standard products (the so-called FOG routine\textsuperscript{1}), and transmitted an offer. Soon the order arrived. Had the RPC inquiry arrived at UCR during a time period characterized by normal operation the difficult specification had been carefully scrutinized in accordance with the administrative routine for non-standard products, and it is most probable that the production and quality assurance managers had rejected it, while referring to all potential difficulties that would arise should manufacturing be performed based on the specification. The more open-minded product manager saw opportunities rather than potential problems in relation to the inquiry. His prime interest was profitable business, but, still, and this is important, after many years of involvement in stainless steel business he was reputed as a well-experienced product manager, firm as a rock, and he was known to be in possession of a substantial portion of common sense as well. It was just that his enacted view of reality differed (most likely) from the views held by the production and quality managers of UCR (Weick, [1969] 1979) – maybe his view was more holistic. Whether or not he was a bigger risk-taker than the other managers is difficult to say, as available information makes up the basis for risk calculation, and different individuals in an organization dispose of different information and operate towards different goals (Cyert & March, 1963; Lawrence & Lorsch, 1967). According to his judgment the business opportunities outbalanced the potential problems and later the business outcome showed he was right. For sure, the thinking of the product manager was more entrepreneurial than the thinking of the other managers as he was able to combine the commercial and the technical issues in a productive way. He saw opportunities and possibilities that other managers were not able (or willing) to see, he made a sound judgment as regards the balance between opportunity and risk, and he certainly had an ambition to land the order. Finally, he mobilized the necessary resources to expedite the order by convincingly stating “we can manage to manufacture this order”. The behavior of the product manager accords with Penrose’s (1959) description of an entrepreneurial-minded person. Penrose proposes entrepreneurial services to be expressed in terms of entrepreneurial versatility, entrepreneurial judgment, entrepreneurial ambition, and fund-raising ingenuity (p.35ff).

In the empirical case one entrepreneurial-minded individual (the product manager) acts on behalf of some other individuals (the functional managers), while guided by his entrepreneurial way of thinking, and by his basic philosophy of generating profitable business. This is a good illustration of practicing ‘strategic intention’ from a base of entrepreneurial thinking. The case also illustrates how a situation involving deviation

\textsuperscript{1} A routine performed in three stages where a set of variables are carefully considered at each stage, i.e. at, a) the inquiry stage, b) the order stage, and c) the stage of order execution.
from the normal opens for newness and development. By coincidence (or ‘chance’) the RPC inquiry reached the UCR mill during the holiday period and by coincidence (or ‘chance’) the entrepreneurial product manager was there to pick it up and get the business going. It is also clear that the expediting of the RPC order rendered the UCR organization a certain portion of learning and confidence as to the manufacturing of cathode starter plate (though the product specification was markedly tricky), and that the experience encouraged UCR to later accept producing cathode plate for MEL. The impact of the business episode on technological change is most obvious, as it prepares UCR for the future involvement in exchange with MEL, and by that it is an apposite example of relationship interconnectedness (Cook & Emerson, 1978). What goes on in one relationship may have a major influence on activities performed in another relationship, and resources available in one relationship may be closely interrelated to resources available in another relationship, and so on …

5.3.2 Setting the scene for relationship start-up – a resulting merger effect

UCR’s admission into business with MEL is the starting point for the development of a long-lasting business relationship between the two enterprises. It is also the starting point for a process of technological change involving many chops and changes through the years. The business setting involves three industrial groups, i.e. the Avesta Sheffield Group, the DML Group, and a North European conglomerate here called the “Multibranch” Group. The igniting spark initiating business exchange between UCR and MEL goes via the “Multibranch” Group. Figure 5:2 offers a simplified view (though static) of the actors and connections constituting the industrial system (the international production net) as it appears during stage 2, i.e. in the time period of 1992 – 1993.

By the merger in 1992 former British Steel Stainless (BSS(f)) and UCR legally link to each as both now become part of the Avesta Sheffield Group. The new formation implies there is an indirect connection between UCR and MEL involving the legal bonds interconnecting UCR and BSS(f), and the two exchange relationships between BSS(f) and Domestic Steel Ltd (DSL), and DSL and MEL respectively (see Figure 5:2). After the merger the Coil & Primary Division (C&PD), the basic feedstock supply system of the Avesta Sheffield Group, formally picks up BSS(f)’s supply responsibility concerning deliveries of hot coil to DSL, but in practice there is no change; it is business as usual. UCR’s involvement with RPC makes up another indirect connection between UCR and MEL, but in this case the connection is based on exchange between UCR and RPC (administered via the Avesta Sheffield sales organization in RPC’s home country) and the competitive relation between RPC and

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1The Coil & Primary Division comprises all steel smelting, continuous casting and hot rolling of coil of the Avesta Sheffield Group after the merger in 1992. Thus, the actor that is denoted BSS(f) in the text is included in the Coil & Primary Division.
MEL. Thus, before UCR and MEL involve in any kind of interaction, and maybe before they even know about each other, they are indirectly interrelated through the various connections previously established by way of ownership and previous business exchange. When discussing the issue of orientating in an industrial network Axelsson and Johanson (1992, p.232) propose opacity to be a relevant network feature, and it may be that second tier relationships in some cases are invisible to a focal actor, and, more often than not, third tier and higher tier relationships are probably unknown to most actors. The authors’ proposal seems to be much relevant in this particular case. UCR had probably just a vague idea (if any) about the existence of MEL and the DML group before MEL’s first inquiry appeared at UCR.

Prior to the merger neither British Steel Stainless nor the Avesta Group had run their own representation in X-land. The former had sold their products via an agent, whereas the latter had largely refrained from doing business in X-land. By the formation of the Avesta Sheffield Group a corporation of substantial size was

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1 The issue has not been checked with the employees of UCR, but if considering that UCR holds a customer portfolio of about 1000 customers the probability is small that much knowledge is accumulated about a company that is not even a suspect.
established, and, after a short period of struggle with an X-land agent, group management decided to establish a sales subsidiary in X-land. The development pattern accords with that of the stage model (Johanson & Vahlne, 1977). Company internationalization is proposed to follow certain development stages, i.e. no regular export, export via agent, own sales subsidiary, and finally establishment of own production in the host country. Progression through the various stages is supposed to balance risk over time by iteratively interrelating incremental learning and investment. Although the stage model is not the ideal tool for an analysis of Avesta Sheffield’s decision to invest in a sales subsidiary in X-land, it may bring some guidance. Three propositions will be discussed in relation to the investment, 1) by the merger the manufacturing operations of the combined company had grown much larger, which claimed for an increased market presence, and the X-land market was considered an interesting investment prospect, 2) the perceived risk of investing in a sales subsidiary in X-land was assessed to be reasonably low as the size of investment required was conceived of as rather small in relation to the size of the merged company, 3) the X-land sales agent contracted at the time of the merger had caused Avesta Sheffield serious problems ever since, but with the establishment of a sales subsidiary those problems would be eliminated once and for all.

The first proposition is about investing in the market in order to increase the company’s market presence, which may be synonymous with expanding and exploiting market opportunities. Johanson and Vahlne (1977) contend that companies increase their market commitment (invest in the market) in order to exploit opportunities or resolve problems. Prior to the merger BSS had involved in sales on the X-land market for many years and at the time of the merger they disposed of certain market knowledge. It seems reasonable to assume that they were knowledgeable about market opportunities likely to be better exploited within the firm than through an intermediary agent. This is the old inquiry of whether to organize activities within the firm (by way of hierarchical coordination) or to rely on deals established in the market, an issue that has been discussed at length through the years under headings such as ‘transaction cost economics’ and ‘internalization theory’ (Coase, 1937; Williamson, 1971; Buckley & Casson, 1976; Hennart, 1982). Economic theories of the kind strongly focus upon cost efficiency, whereas the stage model (Johanson & Vahlne, 1977) takes on a broader view in relation to the exploitation of opportunities where also effectiveness aspects are appreciated. It seems reasonable to assume that Avesta Sheffield’s decision to invest in a sales subsidiary on X-land ground at least to a certain extent was made in order to increase the company’s presence on the market, but certainly also the control aspect had a say in the play.

The second proposition concerns the risk aspect. It has been claimed that risk may be elaborated along two dimensions: a) the probability whether a particular outcome will occur, and b) “the significance of whatever it is that might be lost” (Penrose, 1959, pp.57-58). The term ‘significance’ might be illuminated by referring to the following
statement: ‘loosing a certain amount of money for a smaller firm is worse than loosing the same amount of money for a larger firm’, or if turning to the level of the individual human being: ‘a millionaire can more easily afford to loose a large amount of money than can an average-wealthy or poor person’. So, risk to a certain extent has to do with how much you put on stake in relation to what you can afford to loose without suffering to much pain. For Avesta Sheffield investing in an X-land sales subsidiary was probably a reasonably low risk project, as after the merger the company disposed of a large (financial) resource base making the investment proportionately moderate. As the company had at its disposal also certain knowledge about what it meant to do business in X-land it was possible to estimate the probable outcome of the investment. If referring to the stage model of company internationalization the investment implied a certain risk, but it seems that the risk anticipated by the company was well within the ‘tolerable risk frontier’, as discussed by Johanson and Vahlne (1977, p.30). The risk aspect certainly constitutes a core element of the stage model though the model doesn’t contribute much to the understanding of mergers or other situations involving discontinuity. Melin (1992, p.104) writes: “stage models describe developmental history as the result of predetermined factors and preprogrammed forces. But the consequences of unforeseen environmental interactions are hardly predetermined”. The third proposition concerns an interaction atmosphere characterized by misunderstanding and mistrust (Håkansson, 1982). It seems that the business relationship between Avesta Sheffield and the X-land agent involves more of conflict than cooperation (Ahrne, 1994), although there is only little data to find in the empirical case underpinning such a statement. However, based on available information a tentative conclusion is that the investment is done in order to get rid of a malfunctioning sales agent. According to the stage model (Johanson & Vahlne, 1977) both opportunities and problems recognized may trigger investments on foreign markets. As interaction with the X-land agent reached a critical point group management obviously decided to act. The decision and its implementation could be looked upon as certain moves along an incremental course of action, but as the strategic element is so conspicuous and the process format typically discontinuous it is probably more productive to approach it from the perspective of rationalistic thinking, planning and acting. To conceive of the internationalization process of the firm as strictly evolutionary, constituted by incremental change only caused by “no-ones”, is to give up on studying incidents, forces and mechanisms that are not fitting in with the pattern of continuous evolution. It is squeezing the empirical world into the frame of a certain theoretical model rather than aiming at understanding observed phenomena by utilizing theoretical tools for the purpose of interpretation. Moreover, it is viewing the message of Johanson and Vahlne too narrowly. The authors emphasize the view of company internationalization as an incremental and evolutionary process but at the same time they appreciate the influence of strategic thinking and strategic action. In an article published in the year 1990 they state:
Basically the process model is rather skeptical in regard to strategy. Nevertheless, we think that internationalisation processes are the result of a mixture of strategic thinking, strategic action, emergent developments, chance and necessity. We believe it is worthwhile to analyse the internationalization of firms with an open mind with regard to these factors. (Johanson & Vahlne, 1990, p.22.)

The action taken by the Avesta Sheffield group management to establish a sales subsidiary in X-land is not just the next natural step in an incremental process. It is rather a most rational strike triggered and constrained by new circumstances appearing in the wake of the merger where chance and necessity are playing important roles. In a fairly recent publication Johanson and Vahlne (2003, p.95) comment upon the phenomenon of acquisitions and how they may introduce discontinuous change in the business firm’s critical relationships.

When such acquisitions are made they will lead to discontinuous changes in the business firm’s set of critical relationships, which may result in expansions which are not related to the same patterns as those suggested by the internationalization process literature.

The merger in 1992 shaping the Avesta Sheffield Group is a most plausible illustration of discontinuous change involving new possibilities and new opportunities but also new constraints and new problems for the various actors concerned. Whether the Avesta Sheffield sales subsidiary in X-land (ASX) is established in order to make use of perceived opportunities or as a solution to experienced problems is difficult to judge. Probably both factors impact upon the decision to form the company. What is beyond debate, however, is that the existence of ASX is a most important element for the development of the UCR–MEL relationship, and implicitly for the evolution of technological change as it appears in the interaction process involving the two companies. From the perspective of the Avesta Sheffield Group the establishment of ASX is a most rational act based on ‘strategic intention’, but from the perspectives of UCR and MEL respectively the establishment represents an opportunity arriving by ‘chance’.

The establishment of ASX claims for the recruitment of appropriate personnel. A lot could be said about this matter, but the discussion will be kept short. Just two persons employed from start in ASX will be commented upon, because those individuals should come to strongly influence both the development of the UCR–MEL relationship and future technological change as to the new refinery process. From inception ASX is populated by X-land nationals with one exception only. The first managing director of ASX is a Swede hired for a couple of years to develop the business in X-land. In his previous position as UCR’s marketing manager he had gained detailed knowledge about the strengths and weaknesses of the UCR unit. The other most important person for the development of the UCR–MEL relationship is Hank Kennyson, an X-land native since years familiar with the DML Group. The

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1 The considerations and the proposed sources of change forwarded by the authors have been given a central position in the conceptual framework developed in paragraph 5.5.5 above.
empirical case tells about contacts between Kennyson and the DML Group as early as in 1978. Over the years the man had worked as a sales representative for various companies in the area of X-land where the DML Group had its headquarters, and he had learnt a lot about the Group. He had been into stainless all the time but he had never been in a position to offer DML/MEL mill direct supply of stainless steel cathode plate, because the companies for which he had worked had not been producers of stainless steel plate. In his position as a trader Kennyson had never tried to convey cathode starter plate to DML/MEL from “whatever source of supply”, because he was much too knowledgeable about all the difficulties that could easily arise in connection to the manufacturing of the product. Long-term competitiveness in this particular business must be based on mill direct deliveries, he contended, because mill to mill direct contact constitutes the only viable route to close communication and necessary adaptation.

The business story shows how two individuals, i.e. the first managing director of ASX and Hank Kennyson, bring with them previously developed experiential knowledge and personal relations as they start working for the new subsidiary, and the knowledge and the relations should later come to be of importance for the development of the UCR–MEL relationship and related business exchange. In a similar vein Johanson and Vahlne (2003, pp.88-89) report on individuals that make use of previously developed social relations when establishing business abroad. This is in line with claims raised in literature on ‘the born global’ and ‘international entrepreneurship’ (Oviatt & McDougall, 1994; McDougall & Oviatt, 2000) where social structure is claimed to be an important base for the rapid development of international business.

Since relationship building is time and resource demanding we have reason to expect that successful entrepreneurship is based on the entrepreneur’s existing network. Her/his experience and earlier commitments will influence where the market entry will occur. Whether this will be a foreign market entry or not depends on the relationships of the entrepreneur. Foreign market entry or internationalization is not an issue. The important issue will be the subsequent international expansion and network development. (Johanson & Vahlne, 2003, p.95.)

Except for the indirect relationships previously discussed where UCR and MEL are indirectly interrelated via BSS(f), DSL, and RPC (see Figure 5:2), it is obvious that already from inception the ASX unit interconnects viable indirect social relations and cross-fertilizes valuable knowledge for the possible future development of a mutually profitable business relationship between UCR and MEL.

5.3.3 Relationship start-up in network context: alertness and bonds close the circle

This thesis work departs from the assumption that technological change commonly interlinks with the business process and that the business process is a certain type of change process driven by business actors involving in interaction (see Figure 1:2
above). Such interaction comprises activities referred to as transformation and transaction. As actors interact they develop bonds that can both underpin and hamper future interaction. An important type of interaction concerns the exchange of information (Håkansson, 1982; Turnbull, 1979), which may be value-free or may aim at influencing the stance or behavior of others. It follows that information exchange may involve a certain element of negotiation (Cyert & March, 1963), which is particularly salient in situations where one actor is trying to persuade the counterpart about “the right way to go ahead”. The outcome of such negotiations to a large extent depends on the conceived power–dependence balance between the parties (Emerson, 1962; Thompson, 1967; Ahme, 1994) and the way information is distributed between the two (Cyert & March, 1963). The power–dependence balance has to do with who is in control of various resources and who needs them, and it is most obvious that both information and business relationships may function as powerful resource elements in such negotiations.

When UCR and MEL meet in the first business episode a complicated pattern of information exchange and negotiations evolves involving several other parties. A schematic outline of the various activities ending up in the first delivery of cathode plate from UCR to MEL is presented in Figure 5:3. The arrows 1 – 11 represent information exchange, negotiations, and formal exchange of documents between various parties. The arrows 12 and 13 represent physical delivery of material and equipment. The arrows a), b), and c) represent information exchange and negotiations between UCR and the distributor company (DIS) of the “Multibranch” Group concerning (among other things) which commission rate to apply for the lead submitted by DIS to ASX.

North European Mining Ltd (NEM) (part of the “Multibranch” Group) is the end customer along the activity sequence shown in Figure 5:3. The various steps are specified in Table 5:2 as to the type of exchange and exchange content, as well as the type of relation in regard of the various parties involved. However, the arrows a), b), and c) are not represented in the table. Much of the information forwarded in Figure 5:3 and Table 5:2 is of minor interest for the purpose of analysis, as it just recapitulates common activities referable to as business administration. Some items, though, are of particular interest and they will be discussed in detail below. An initial reflection in relation to the empirical case complies with a statement often forwarded in literature.
on business networks telling that business performed in networks is usually both complex and complicated (e.g. Ford, 1998). The activity sequence presented in Table 5:2 is underpinning the statement although it mediates a much simplified view of the activities that were likely to have been performed in connection with the establishment of NEM’s new refinery plant.

<table>
<thead>
<tr>
<th>Exchange activity (number)</th>
<th>Parties involved and exchange direction</th>
<th>Exchange Type of exchange</th>
<th>Exchange content</th>
<th>Type of Relation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DIS to/from NEM</td>
<td>Info exchange</td>
<td>Refinery plant project</td>
<td>Legal/Social (?)</td>
</tr>
<tr>
<td>2</td>
<td>NEM to MEL</td>
<td>Inquiry</td>
<td>Refinery plant</td>
<td>Business</td>
</tr>
<tr>
<td>3</td>
<td>MEL to/from DIS</td>
<td>Inquiry/Response</td>
<td>Cathode starter plate</td>
<td>Business</td>
</tr>
<tr>
<td>4</td>
<td>DIS to ASX</td>
<td>Inquiry (instructions)</td>
<td>Cathode starter plate</td>
<td>“Partner”</td>
</tr>
<tr>
<td>5</td>
<td>ASX to UCR</td>
<td>Inquiry (forwarded)</td>
<td>Cathode starter plate</td>
<td>Legal/Social</td>
</tr>
<tr>
<td>6</td>
<td>UCR to ASX</td>
<td>Offer</td>
<td>Cathode starter plate</td>
<td>Legal/Social</td>
</tr>
<tr>
<td>7</td>
<td>ASX to MEL</td>
<td>Offer (forwarded)</td>
<td>Cathode starter plate</td>
<td>Business/Social</td>
</tr>
<tr>
<td>8</td>
<td>MEL to NEM</td>
<td>Offer</td>
<td>Refinery plant</td>
<td>Business</td>
</tr>
<tr>
<td>9</td>
<td>NEM to MEL</td>
<td>Order</td>
<td>Refinery plant</td>
<td>Business</td>
</tr>
<tr>
<td>10</td>
<td>MEL to ASX</td>
<td>Order</td>
<td>Cathode plate</td>
<td>Business/Social</td>
</tr>
<tr>
<td>11</td>
<td>ASX to UCR</td>
<td>Order (forwarded)</td>
<td>Cathode plate</td>
<td>Legal/Social</td>
</tr>
<tr>
<td>12</td>
<td>UCR to MEL</td>
<td>Delivery</td>
<td>Cathode plate</td>
<td>Business</td>
</tr>
<tr>
<td>13</td>
<td>MEL to NEM</td>
<td>Delivery</td>
<td>Refinery plant</td>
<td>Business</td>
</tr>
</tbody>
</table>

Table 5:2 Activity sequence and specification in regard of the first business episode involving Unit Cold Rolled and Metal Extraction Ltd

When NEM decided to expand their refining capacity in the early 1990s ‘the MEL refinery process’ was the natural choice as the new process had become the state of the art in metal refining technology at the time. It was not a given, though, that UCR should become the supplier of cathode starter plate for the new plant. But why did that happen? Probably chance is a pawn in the game also here, but more importantly a particular kind of alertness played a key role in the course of action. The managing director of DIS, the distributor sister company of NEM in the “Multibranch” Group, saw and utilized an opportunity to make some easy money by exploiting his particular position at the crossing between two production nets. DIS operated as a distributor of a broad variety of industrial goods. Except for distributing the output products of NEM DIS also operated as an agent selling stainless steel products for Avesta Sheffield on a particular North European market. With one leg in each camp the managing director of DIS had got information about NEM’s expansion project already at the planning stage, and, as he also knew about the current status of the Avesta Sheffield organization, he brought the pieces together, developed a strategy and cashed in on “his asset” in the end of the day.

The strategy benefits from exploiting information that is not available to others and relations that others do not have. From an entrepreneurial point of view, on the one
hand, it could be interpreted as taking advantage of market imperfections by seeing and reacting upon signals and phenomena not recognized by others (Kirzner, 1973). From a structural (or network) point of view, on the other hand, it could be interpreted as profiting from the bridging over of a structural hole (Burt, 1992a) or closing a network void, which is equivalent with exploiting a certain network position. In this particular case the managing director of DIS is striking a bridge over two weakly interrelated production nets, the one residing in the mining industry, the other operating as part of the stainless steel industry. It is obvious that the managing director of DIS had no intention whatsoever to involve directly in cathode plate business, and even if he had nurtured such an intention his mandate to sell products produced by the Avesta Sheffield Group was constrained to the small North European market known to be DIS’ home market, and the man was fully aware of that all the time, no doubt. Whatever agreement he had made with the NEM people the empirical case is clear on one point. NEM instructed MEL to send their inquiry for stainless steel starter plate to DIS for an offer to be made. As MEL was interested in getting the business with NEM they acted in accordance with the instructions. Interestingly enough, the managing director of DIS immediately informed UCR and ASX about the inquiry, while stressing that should business materialize he anticipated to get a certain commission paid in exchange for the lead presented. His fax response to MEL read: “To be able to give you necessary local service we have instructed our partner in [X-land] to quote you.” That particular partnership didn’t really exist, but to MEL the fax description was probably conceived of as reasonable.

So far the strategy of the managing director of DIS had been successful. The further treatment of MEL’s inquiry would follow the normal professional route and should business materialize DIS could (for very good reasons) claim some commission from UCR in exchange for the lead. Whether the manipulative operations of the managing director of DIS, as illustrated by the continuous line arrows 1 to 4, and the dotted line arrows a), b), and c), in Figure 5:3, do meet a minimum level of business ethics can be questioned. Another question that may be raised concerns whether his involvement in the business process added some value or if it just increased the costs. If it is true that DIS and its managing director held a network position making it possible for them to influence the decision-making of NEM¹ regarding supply of stainless steel starter plate (which seems to have been the case), then UCR could thank their lucky stars that DIS pointed in the direction of Avesta Sheffield and not in any other direction², as several other potential steel suppliers were available in the market. One may consider in retrospect what the future had looked like had the managing director of DIS turned to Outokumpu (or any other supplier) and not to Avesta Sheffield.

However, when the managing director of DIS recommended Avesta Sheffield he didn’t do that by pure chance. He certainly had his reasons. For several years DIS had

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² To UCR the business with MEL should develop into a most profitable one for several years to come.
worked as the sales agent of the Avesta Sheffield Group on DIS’s home market, and they had developed thorough knowledge about the Group’s capabilities in the field of stainless steel manufacturing. The managing director of DIS was also knowledgeable about Avesta Sheffield’s recent expansion onto the X-land market by the establishment of ASX. At least three arguments pointed in the direction of Avesta Sheffield. The Group 1) disposed of highly developed capabilities in the field of stainless steel manufacturing making them well qualified for the task, 2) had an own sales representation in X-land facilitating local customer support, and 3) involved in a long-term distributor relationship with DIS, which guaranteed (more or less) that DIS could land a reasonable commission for the lead. Choosing Avesta Sheffield was not done at random. It was a most rational choice done by the managing director of DIS as he exploited existing relationships and network knowledge to make a profit. The case shows how a network position and access to information can become a profitable asset.¹

The operations performed by the managing director of DIS obviously brought UCR and MEL together. His manipulations became the “igniting spark” for the development of a business relationship between the two. If looked upon from the perspective of UCR and MEL it might seem that business grew out of chance, which is probably true to a certain extent, although before the “igniting spark” arrived from abroad a pointer going from Avesta Sheffield in the direction of MEL and cathode plate business had already been set out with the establishment of ASX. When the “igniting spark” arrived the industrial system of Avesta Sheffield was in a sense well prepared to take on the business. Several indicators point in that direction. Although the geographical distance between UCR and MEL was large indeed no exchange had yet occurred between the two units they were close to each other in several dimensions. UCR had already familiarized with cathode plate business by supplying material to RPC, which implied they were knowledgeable about the specificity of the technology, and it is clear that the knowledge involved a certain portion of application specific experience (Penrose, 1959). Furthermore, the managing director of ASX with a professional past in UCR had detailed knowledge about the capabilities and limitations of the UCR unit, and he had also developed many social relations with various people at UCR. When it comes to Hank Kennyson the man was already well familiar with the DML Group at the time he got employed by ASX. He knew several people in the various business units of the group and in his capacity as an X-land native he shared their culture. Thus, knowledge appropriate for involving in the cathode plate application was dispersed at several hands and units in the Avesta Sheffield system, and the critical connecting line from MEL to UCR via ASX was secured by a set of social relationships inherited from the

¹ Support for this particular logic can be brought in from several sources, as it is very much basic to both business network theory and social network theory. Burt’s (1992a) discussion about ‘structural holes’ departing from Granovetter’s (1973) discussion about ‘the strength of weak ties’ is probably the most adequate reference to point at. It is basically a matter of making use of existing relationships and the resources those relationships can bring.
past (Johanson & Vahlne, 2003). In the wake of the merger UCR and ASX had also become legally interconnected. Thus, history had shaped a setting characterized by proximity in several dimensions. We recognize the presence of technological, relational, cultural, and legal proximity in the case, but most importantly all these proximities appear at the same point in time, which is a manifestation of temporal proximity. The setting is missing out on spatial proximity as the geographical distance between UCR and MEL is large, but this disadvantage is well outbalanced by all the other proximities. To conclude, when the “igniting spark” started the business process between UCR and MEL the way was paved for a successful future1, as it seemed.

5.3.4 Stage 2: Summary discussion

A necessary condition for technological change to emerge as a result of interaction between UCR and MEL is that they come together, and according to the analysis performed above their encounter is largely the result of chance, at least if considered from the perspective of the two focal parties involved. A mixture of coincidence, strategic decisions at corporate level, and entrepreneurial thinking and acting at operational level suddenly place UCR and MEL face to face in a business situation.

The formation of ASX, a most important prerequisite for business to establish between UCR and MEL, follows in the wake of the merger between British Steel Stainless and the Avesta Group as the top management of the merged company determines on how to cope with opportunities and problems relating to the business operations in X-land. By the formation of ASX the problems encountered in relation to the X-land agent of the Group are resolved. Certainly also market opportunities, although not specified, are considered when establishing the subsidiary. If considered in the perspective of internationalization of the multinational corporation (the Avesta Sheffield Group) the expansion is driven by strategic intention rather than incremental developments, and the process is characterized by discontinuity rather than continuity (Johanson & Vahlne, 2003). If considered from the perspective of UCR the establishment of ASX invites to expanded business opportunities, but as UCR is not in a position to influence the establishment of ASX the opportunities arrive to UCR by chance (and that is so also from MEL’s perspective).

The manipulations of the managing director of DIS are also driven and controlled by strategic intention (they reflect a major portion of entrepreneurial thinking as well), and they are projected onto the surrounding network from a certain network position. The man is acting on a particular situation where he is benefiting from information not available to other network actors and from relations that other actors do not dispose of (Burt, 1992a). The resources he disposes of renders him the power to act and the legitimacy to be obeyed to, as he has something to offer that others are interested in and even depend on (Emerson, 1962). By cleverly navigating in the network he links

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1 One may talk about a business “whose time/space has come” (cf. Czarniawska, 1996, p.44 ff).
various actors to each other and he succeeds to initiate business exchange between the focal actors of the case, i.e. MEL and UCR (and ASX), and to get paid for it. For UCR business is sourced by chance. From the perspective of MEL external forces control behavior. If MEL is interested in getting the business with NEM, they have better to follow the instructions given to them, and those instructions include sending their inquiry for cathode plate to DIS. Thus, the activities of MEL are performed by necessity here controlled by “coercive forces” reaching them from the outside (Pfeffer & Salancik, 1978).

By coincidence the former marketing manager of UCR becomes ASX’s first managing director¹, an appointment that reduces the “distance” between X-land and Sweden considerably. It is less surprising that Hank Kennyson is hired by ASX in order to take care of “his particular area of X-land”, as he has already been operating there for more than two decades. But it is still a matter of coincidence that those two individuals, who carry with them so much of knowledge and relations with reference to UCR and MEL respectively, join under the same roof where their respective contribution fits in so nicely.

It is almost like an invisible hand prepares for the establishment of business exchange between UCR and MEL by 1) setting up ASX, a local hub crucial for the handling and conveyance of information and goods in relation to future business exchange between UCR and MEL, 2) populating ASX with two most appropriate profiles indirectly interlinking UCR and MEL already before the two companies even know about each other, 3) assigning the managing director of DIS the role of the “igniting spark” taking on the task to organize the first encounter between UCR and MEL, and 4) early – prior to UCR’s entrance into business with MEL – familiarizing UCR with electrolytic metal refining technology and the manufacturing of cathode starter plate by letting UCR serve RPC. The last item is of particular importance as UCR’s former experience in the field helps to reduce the unit’s hesitation to involve in a difficult product application when MEL’s inquiry arrives – at the time UCR nurtures a feeling of preparedness. The local hub, i.e. ASX, is in place ready to operate and already from start it is interrelating UCR and MEL by historical social links. The “igniting spark” is setting the system in motion. Proximity appears in the case along several dimensions; the technological, item 4) above; the spatial, item 1) above; the relational (to a certain extent both social and business relational), item 2) above; the cultural, ASX is populated with X-land natives; the legal, ASX belongs to the Avesta Sheffield Group; and as all these proximities appear in the same unit of time temporal proximity is attendant.

By the time of the merger in 1992 much of discontinuous change took place over a short period of time. The merger as such along with the strategic action performed at corporate level in the wake of the merger to a large extent organized the conditions for

¹ The truth is that the decision to appoint the Swede for the job was a resolution to a political conflict.
business exchange to materialize between UCR and MEL. From the perspective of UCR and MEL, i.e. the focal actors of the case, exchange between the two arrived rather by chance than as a result of strategic intention brought into action. A few entrepreneurial-minded individuals contributed to UCR’s entrance into cathode plate business, but without any reference whatsoever to long-term strategic planning. It seems rather that certain opportunities suddenly appeared for those individuals to act upon. And finally, out of the mist of strategic intention at corporate level, entrepreneurial thinking and alertness at operational level complemented by a major portion of coincidence and chance prepared for the evolution of a new business relationship as UCR met MEL.

5.4 Focal relationship development and technological change

As shown in the analysis above, the first encounter between Unit Cold Rolled (UCR) and Metal Extraction Limited (MEL) grew out of chance rather than action triggered by marketing or purchasing strategy, but as several proximities were in place already before the parties had met interaction between the two was facilitated in the early days of relationship development. However, cathode plate business between UCR and MEL did not emerge in a vacuum but in a network context. The analysis starts out by discussing this broader view of cathode plate business, as it appears during stage 3. Then the perspective is narrowed down into a study of technological change and focal relationship development as appearing in the business process with focus on the industrial operations of UCR and MEL.

5.4.1 Cathode plate business in a network perspective

The very first order of cathode plate placed by MEL at UCR concerned the expansion of refinery capacity at North European Mining Ltd (NEM), a mining company located in the northern part of Europe. The project started in early 1994 and one and a half year later it was successfully completed. On September 22, 1995, Hank Kennyson in a fax to his superior at ASX announced: “[NEM] project has been commissioned and no ‘prestripping’ has occurred and current density is high. This means that both flatness and finish are okay.” During the project time all three actors, i.e. UCR, MEL, and NEM, had involved frequently in interaction. In the beginning of the period NEM had been particularly concerned about the surface quality of stainless starter plate, as they knew about another refinery plant that had suffered from major ‘prestripping’ problems when starting to use ‘the MEL refinery process’.

While aiming at securing the achievement of the right quality NEM involved in direct discussions with UCR concerning the cathode plate product specification, and they also audited UCR’s manufacturing procedures on site at the time the first material was on its way through the production line.

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1 The Avesta Sheffield sales subsidiary in X-land.
Framed by the refinery expansion project the interrelationship between UCR, MEL, and NEM makes up a ‘closed triad’ (see Figure 5:4). Interaction between UCR and MEL, and MEL and NEM respectively, involves all those issues that large industrial projects commonly comprise when it comes to business exchange between suppliers and customers. The interesting connecting line in the triad is the one between UCR and NEM, i.e. between UCR and the customer’s customer of UCR. NEM’s strong involvement in the project including direct interaction and information exchange with UCR is most obvious, and their behavior may be explained in a few different ways. The most probable explanation is that NEM is uncertain about UCR’s ability to produce and deliver stainless sheet blanks appropriate for the downstream manufacturing of high quality cathode starter plate to be carried out by MEL. If so, NEM perceives transaction uncertainty (Ford et al, 1998), but as they know that the tricky manufacturing stage is at UCR and not at MEL, in order to secure the proper production of blanks, they choose to approach UCR directly. This argument is further supported by the fact that NEM is hiring an external consultant\(^1\) to evaluate the manufacturing abilities of UCR. Another explanation refers to the geographical location of the three units where UCR and NEM are both situated in northern Europe, whereas MEL is located on the other side of the globe. Maybe NEM finds it appropriate to take on part of the inspection job as they can more easily visit UCR’s production site. Maybe NEM also conceives of the psychic distance as smaller in relation to UCR than in relation to MEL (Johanson & Vahlne, 1977), and if so, they find it more convenient to talk directly to UCR than to go via MEL for the establishment of an indirect communication line to UCR, and, as the critical manufacturing stage takes place at UCR anyhow, the direct contact becomes particularly important to NEM. To conclude, NEM seems to conceive of a crucial need–ability gap in relation to UCR concerning technology, but at the same time they seem to experience closer spatial and cultural (most likely) proximity in relation to UCR than in relation to MEL. The former circumstance triggers, whereas the latter facilitates, direct contacts and information exchange between NEM and UCR.

The occurrence of a ‘closed triad’ in which MEL’s supplier and customer are interconnected is an exception in the business history of MEL. It occurred also during the early development of ‘the MEL refinery process’ as to DML and DSL\(^2\), but in all other cases MEL takes the full responsibility for the quality of the cathode plate vis-à-vis its customers. There are pros and cons connected to the ‘closed triad’ setting. The more flows of interaction there are in a system the easier it is, most likely, to more effectively and more reliably bring about technological change, and both ‘closed triad’ in an industrial business setting

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1 The consultant was hired from ‘Swedish Testing and Inspection Quality Consultant Co’.
2 Domestic Mining Ltd and Domestic Steel Ltd.
triads’ identified\(^1\) in the case are established around uncertainty about technology. However, from a commercial point of view the intermediate party (along the value chain) has less possibilities to exploit information in a ‘closed triad’ than in an ‘open triad’, as in the former setting information is shared by all three parties, whereas in the latter setting the intermediate party can share information upstream and downstream the value chain at its own discretion. From a business point of view the ‘open triad’ renders the intermediate party certain advantages that can be exploited (cf. Burt, 1992a; Coleman, 1988, pp.105-108), as the intermediator is the party that is “linking up different markets” (Kirzner, 1973, p.124).

It is clear that already UCR’s first involvement as supplier of cathode plate in a major refinery project run by MEL contributed to the successful establishment of new refining capacity, no doubt, but the road to success was by no means easy. It involved a lot of struggle and negotiations, inspection, testing, corrective action, and complementary deliveries to balance rejections. UCR’s experiences in the area of cathode plate manufacturing, gathered when expediting the RPC\(^2\) order a year earlier, had made them anticipate a fairly comfortable exercise as to the expediting of the first order placed by MEL. The anticipated “easy ride” soon turned into a much troublesome and drawn-out struggle that had to be handled by UCR in order to keep up with commitments made in regard of product quality and terms of delivery.\(^3\)

UCR’s entrance into cathode plate business meant active involvement in an already existing production net (see Figure 5:5), the actors of which probably conceived of UCR’s entrance into the net in different ways. DSL was still the major supplier of cathode plate to MEL, but MEL’s rapidly growing business put DSL under pressure to follow pace. As DSL closed down their own stainless steel metallurgy in 1988 they changed into becoming a stainless

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1 DML-MEL-DSL and UCR-MEL-NEM.
2 Refinery Plant Construction Ltd (RPC), a severe competitor of MEL.
3 The process of interaction evolving between UCR and MEL is analyzed in more detail in the subsequent sections of this chapter where technological change and focal relationship development are put in focus.
steel re-roller\(^1\) procuring hot band from British Steel Stainless\(^2\) in UK. MEL went on using DSL as their main supplier of cathode plate, although sporadically they also turned to some foreign re-rollers for supply, but more often with discouraging result.

With the formation of the Avesta Sheffield Group in 1992 several changes came about in a short period of time. Immediately BSS(f) and UCR became sister units in the merged company and soon ASX was established in X-land. By the time UCR and MEL started business exchange DSL found themselves in a position of being supplied by the Avesta Sheffield Group through BSS(f) at the same time as they involved in competition with the Group through the operations of UCR and ASX. Thus, simultaneously the Group adopted the supplier role and the competitor role vis-à-vis DSL. DSL had always been much important to MEL, not because they were a superior manufacturer of stainless steel products, because (as far as is known) they were not, but because of their local presence, which implied they were always close at hand in situations of urgency. With the formation of ASX, and the employment of Hank Kennyson, the Avesta Sheffield Group established a kind of quasi-local presence in X-land challenging the prime competitive advantage of DSL. Through ASX the Group (and implicitly UCR) could perform sales administration and customer service locally, and they could also to a certain extent solve problems relating to the physical product. But even more important, by the establishment of ASX the Group became an “insider” on the X-land market sharing the culture and behavior of the “native” actors. (Johanson & Mattsson, 1988)

As MEL’s business grew the ‘national production net’ that had been supportive through the years of development of ‘the MEL refinery process’ gradually showed signs of unbalance. MEL’s success on the global market had raised the demand for cathode plate to a level beyond DSL’s capacity to supply, a circumstance enforcing MEL to search complementary supply elsewhere. The observation serves as an illustration of the dynamic aspect of business relationships and networks (Hammarkvist et al, 1982; Axelsson & Easton, 1992). In the course of interaction and as the business process evolves the importance of one actor in relation to another may change. As a result the relationship between the two may become stronger or it may loose some of its strength (Johanson & Mattsson, 1988). Some relationships may even become dormant or may be terminated (Havila, 1996). As DSL is unable to increase their manufacturing capacity in pace with the expansion of MEL’s business it seems inevitable that the counterparts are drifting apart, i.e. that the relationship between the two has reached a phase of decline (Dwyer et al, 1987).

\(^1\) For an outline of the problem of relying on re-rollers on a volatile raw material market see section 2.6.1 above.

\(^2\) Here the British part of the Avesta Sheffield Group after the merger in 1992 is denoted BSS(f), i.e. ‘former British Steel Stainless’.
Another network aspect already touched upon above concerns the position of an actor along the value chain (Porter, 1986). Although DSL and UCR are holding the same position there is a most important difference between the two as DSL is forced to procure hot band on the market, whereas UCR disposes of hot band through an intra-organizational logistic arrangement (Ghoshal & Bartlett, 1990). As the stainless steel industry operates on a severely volatile market in regard of raw materials supply, and the volatility is transferred to the various markets for stainless products, customers using stainless in their operations suffer from strongly fluctuating prices and supply. And the rule goes: the more standardized the product, and the lower the value that is added to the product through the operations of the stainless steel producer (the steel mill), the less interesting is the business for the steel producer in times when raw materials supply is short (when the prices for raw materials are high)\(^1\). Hot band is a typically standardized product representing little value added, and when the demand for stainless steel products in general grows larger than the total production capacity of the stainless industry, hot band sales is given low priority. Then, implicitly re-rollers as a group will suffer from short supply. Thus, relying on re-rollers for supply of downstream flat products is a much uncertain strategy, and especially so when the market for stainless steel is booming. The mechanism described shows that the market is a less effective institution for coordinating stainless steel production activities in the upper end of the value chain, at least at times when the market is volatile.\(^2\) The more common argument raised in favor of vertical integration in an industry is the need for coordination of closely complementary activities (Richardson, 1972). The issue will be discussed at length in section 5.4.4 below.

MEL’s growing business enforces them to look for complementary supply, and as they do changed conditions also make up a starting point for future technological change in regard of ‘the MEL refinery process’. In a way MEL enters into the relationship with UCR by ‘necessity’, because in order to further develop their business they strongly need complementary supply. Of course, they could have chosen another supplier, but if considering all proximities “attached” to UCR it is likely that this was the best choice. Moreover, MEL didn’t approach UCR by free will. They were instructed to do so in order to get the business with NEM. Thus, two ‘necessities’ drove MEL in the

\(^1\) See the discussions in the sections 2.2.3 and 2.6.1, and in Appendix 2.
\(^2\) Vertical integration upstream in the stainless steel industry is an example of securing feedstock supply for downstream manufacturing. It could well be looked upon as a parallel to the strategy of ‘location-specific advantages’ (Dunning, 1988), the effect of which may be to secure the supply of raw materials by acquiring a particular source of supply, i.e. a mine or an oil deposit. However, most stainless steel producers refrain from integrating backwards into the various markets for raw materials. There is no univocal answer to why that is so, but one possible explanation might be that the stainless industry makes use of a lot of stainless scrap, which is brought in both from industrial markets and consumer markets, and it is likely that stainless steel producers are neither effective nor efficient if aiming at entering the market for stainless scrap (cf. Penrose’s (1959, p.109ff) discussion of ‘technological base’ or ‘production base’).
direction of UCR, 1) the ‘necessity’ to follow the instructions of NEM, and 2) the ‘necessity’ to develop a broader supply base.

At the time UCR’s first shipment of cathode plate arrived in X-land in the late 1994 Hank Kennyson went to MEL to inspect the goods and to promote future business with UCR. His travel report from a meeting with six of MEL’s leading managers during the visit reads:

> It is obvious in their situation they require continuity and quality of supply. I suggested the need to “get in bed” with a major producer such as ourselves and they agreed. … I believe that we have an excellent opportunity to cement an ongoing relationship with [MEL] and that the present Stainless Steel situation is working in our favor with this customer.

Without knowing exactly what had been discussed during the meeting it is likely that Kennyson had highlighted all the advantages that would follow should MEL associate with a large stainless steel producers that was operating an integrated production system where production capacity was not an issue and where hot band supply could be logistically secured. UCR in the role as the competent and reliable manufacturer, and ASX in the role as the local coordinator willing to operate as an interested trouble shooter when necessary, would be an unbeatable team. It is clear that the “present Stainless Steel situation” was used as an argument in the discussion and this argument was probably strong as MEL had already experienced problems resulting from short supply.

Thus, UCR entered into the cathode plate production net alongside with ASX, and it seems that DSL didn’t raise any major complaint about it. Maybe, they already realized that it was impossible for them to follow pace with MEL’s strong business expansion, and thus remain their single source supplier of cathode plate. UCR also checked for approval with DSL’s upstream supplier of hot band, i.e. BSS(f), but they saw no problem at all with UCR supplying MEL cathode plate. To conclude, the entrance of UCR/ASX into the cathode plate production net obviously didn’t cause any major excitement. The previously tight and well-balanced net had gradually gone out of balance due to MEL’s strong expansion, and by that an opening had been left for new actors to enter. As UCR and ASX took positions in the net the net balance was reestablished. (Johanson & Mattson, 1988; Forsgren & Olsson, 1992)

5.4.2 The focal relationship and the ‘gap reducing mechanism’

As UCR is accepted for cathode plate supply intensive interaction develops between UCR and MEL. Based on extensive information exchange and several negotiation rounds the first order\(^1\) is placed in late spring 1994, and, encouraged by the previous fairly successful manufacturing of cathode plate for RPC, people in the UCR camp are confident as to their ability to manufacture cathode plate to MEL’s satisfaction. Some

\(^1\) The order aimed for the expansion of NEM’s production site in northern Europe.
minor uncertainties remain in regard of surface finish and material flatness, but all in all UCR think they will be able to contain the agreed upon product specification without any major flaws. As regards surface finish the final agreement involves both an upper and a lower limit although UCR is not keen on having the lower limit specified, and MEL thinks that the lower limit as specified is much too low to be effective. Anyway, though not entirely happy with the product specification the parties are obviously quite confident that the manufacturing outcome will be satisfying. Moreover, at the time the first lot of plate is produced in August 1994 a design engineer from MEL, along with two representatives of NEM, visits UCR for an on site inspection round. Afterwards, the design engineer in a written report\(^1\) approves UCR’s appearance:

> Avesta Sheffield appear committed to supplying a product of high quality, and in accordance with our specifications and requirements. Judging by the inspected samples, their operations and their obvious experience, I do not see any reason for MEL to receive any inferior product.

All three parties involved are confident about UCR’s ability to produce high quality cathode plate in compliance with the agreed upon product specification. The level of uncertainty is low and everybody looks forward to an “easy ride”.

How wrong they were. As time goes by and interaction proceeds almost every gap imaginable emerges in the need–ability interface between UCR and MEL.\(^2\)

- **A first gap concerns the product specification.** Although, after much information exchange and negotiations a formal agreement is made concerning the product specification, there is still an underlying disagreement about which would be the acceptable lower limit for surface roughness (surface finish). Furthermore, doubts soon appear as to the methods used for testing and measurement.

- **A second gap concerns packing and transportation.** At arrival the very first shipment suffers from broken strapping and plate slipping in one of the freight containers. It becomes obvious that the material has not been properly packed for sea transportation, at least not for sea transportation performed under tough weather conditions. Fifty damaged plates are rejected raising demand for replacement material. At the second shipment the pallets have been loaded in such a way into the containers that unloading cannot be done without damaging some plates. Moreover, the inside of the containers is very damp.

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\(^1\) Report title: ‘Cathode plate steel production commencement for [North European Mining Ltd.] plates’.

\(^2\) The discussion performed below directs the relationship between UCR and MEL. Although ASX is a separate organizational unit the activities performed by Hank Kennyson are viewed rather as activities performed within the UCR-MEL relationship than activities performed outside the relationship by an external party. Kennyson is formally employed by ASX but spends full time work (more or less) on the MEL account.
- **A third gap concerns product quality.** Material that was initially approved by MEL is found to suffer from flaws when later brought into production. More than thirty tons are rejected for flatness out of specification and some additional material is rejected due to inappropriate surface finish. The gap concerning product quality is actually a gap in manufacturing and use technologies. There is an obvious friction somewhere along the ‘cathode plate route’ from raw material (the scrap yard at the steel mill) to operational service (metal refining).

- **A fourth gap concerns testing and measurement.** It is found that UCR and MEL are using non-matching instruments when measuring plate surface finish, a circumstance leaving data obtained useless for the purpose of comparison. There is also some doubt about the measuring of flatness as the common standard at UCR is measuring flatness with the plate relaxing on a horizontal substrate (a table), whereas the method specified in the product specification for cathode plate prescribes the plate to be tested while hanging in a vertical position.

- **A fifth gap concerns material logistics.** This gap emerges as MEL believes they can order large volumes of plate on short notice from UCR. They are not aware of the importance of planning in a vertically integrated production system as that of Avesta Sheffield. Another inconsistency appearing as a gap in material logistics is the resistance of the logistics manager of UCR to accept the low yield numbers achieved when manufacturing cathode plate, although the low yield numbers is the direct result of utilizing a specifically designed route developed for the manufacturing of cathode plate.

- **A sixth gap concerns delivery performance.** Due to problems relating to material logistics and product quality the delivery performance of UCR is suffering. Poor delivery performance means reoccurring material shortage at MEL with implications on MEL’s possibilities to deliver on time to their customers. As the contracts between MEL and their customers usually involve a penalty clause that is activated in case of late delivery, poor delivery performance on the hand of UCR is causing MEL severe problems.

- **A seventh gap concerns pricing.** Pricing is an issue that is causing much frustration through the years of business exchange. From 1994 up to 1998 just small price reductions are accepted by UCR. All quality problems and the low yield numbers make UCR hesitant about decreasing the price. When the economy is booming pricing is not a problem but as the price for standard material drops low, as in 1997/98 MEL is complaining about high prices leaving them at disadvantage in comparison with their competitors. Through the years there is a lot of talk about the necessity of UCR to “walk down the experience curve” in order to reduce manufacturing costs but little happens.
The seven gaps identified indicate there is uncertainty residing in the interface between UCR and MEL. Interaction carried out by the parties involving information exchange, negotiations, learning and adaptation reduces or closes some of the gaps quite soon, whereas other gaps seem to resist almost any attempt to make anything about them. Thus, the gaps concerning ‘product specification’, ‘packaging and transportation’, and ‘testing and measurement’ are reduced to a healthy level already as UCR are struggling through the first order for MEL. The issue of ‘packaging and transportation’ comes to the surface already by the first shipment of plate to X-land, as Hank Kennyson, who is inspecting the material after arrival, reports back to UCR in Sweden. His reporting includes a comprehensive description of the status of the material after arrival, as well as detailed recommendations about how to go about with the packaging problem in order to solve it. As UCR learn and adapt the gap is closed. The inconsistency concerning testing and measurement of surface finish is closed by way of extensive information exchange and the testing of a common set of samples in both “cotts”. The testing of the same material both at UCR and MEL makes possible the comparison of data and the establishment of a common norm. Both parties are learning from the exercise and they reciprocally adapt to each other. By that uncertainty about the significance of test data regarding surface finish is erased. The uncertainty about how to measure material flatness is erased by information exchange and by UCR taking on the method of measurement prescribed by MEL. As the problems regarding packaging and material testing and measurement are resolved also the gap concerning product specification is to a certain extent reduced.

The gaps in product quality, material logistics, delivery performance, and pricing are most resistant against change. UCR and MEL are struggling with these gaps to a greater or lesser degree through the entire 1990s. Some of the gaps are gradually reduced over time but there are several backlashes on the route to closure. An important step is taken concerning the gap in material logistics as MEL adapts to UCR’s coil reservation system. By presenting a purchasing budget and by adhering to the rules for booking and specification of orders MEL is accepted for the system, which means they are guaranteed access to material in accordance with a specified time table, but they are at the same time obliged to place orders at a rate complying with the time table. The other major problem as to material logistics is resolved first after four years of interaction (both inter- and intra-organizational interaction) and business exchange. Through the years the logistics manager and the quality manager of UCR refuse to accept the extremely low yield outcome of the cathode plate business. They compare it with the average yield for all production performed by UCR specifying the same steel grade, thickness and width, and while referring to the comparison they conclude that the business with MEL is inferior business. Though many arguments are raised by others as to the special requirements of the cathode plate product and the high price paid by the customer, the logistics manager insists that the yield in production has to be significantly improved if the business is to be profitable long term. To increase the amount of input material in order to fill out the orders, just
because the yield is much too low, would be to permanent poor business, he claims. The issue triggers a conflict between the marketing manager of UCR and the two managers for logistics and quality. In the early autumn of 1997 the marketing manager, squeezed to the utmost between the need of the customer and intra-organizational stubbornness (as he saw it), in an internally distributed mail loudly announces:

Since last summer I have promised that in case our process route is not reliable we have to work with a larger stock. However, this has been blocked primarily by [the quality manager] and [the logistics manager] who both claim that we don’t have a substantiated process route and therefore can’t lay down a stock. I can’t wait any more. The matter is about to explode and we have to be able to tell what we are doing. I will ask [the production manager] to raise the matter in the management team while asking for either the right to raise a stock or an instruction as to what answer we shall give. One thing is clear WE CAN’T WAIT A DAY LONGER UNTIL WE TAKE ACTION.1

In the same time period the marketing manager initiates the formation of a cross-functional discussion forum, the aim of which is to settle all unresolved issues relating to the MEL business. The measures taken during the autumn eventually result in the establishment of a buffer stock as well as changed routines as to the amount of input material to be started for the MEL orders. The gap concerning material logistics has finally been reduced to a minimum.

The gap concerning pricing is also a tough nut to crack for UCR and MEL. The original price level was set once by DSL, who run a fairly inefficient production route for cathode plate manufacturing involving small-scale production (and later external supply) of hot band and piece-mal roller leveling of plate. When UCR enters into the production net they adopt the price level already established by DSL in order not to embarrass them, and that price level is left unchanged, by and large, as UCR and DSL for several years operate as complementary suppliers of cathode plate to MEL. This is an illustration of relationship interconnectedness. What goes on in one relationship influences the activities performed in another relationship (Cook & Emerson, 1978). Notwithstanding, as business evolves between UCR and MEL soon the issue about UCR’s “learning curve completion” is raised. How much material has to be processed by UCR for them to be able to reduce their manufacturing costs and by that create room for price reductions? This is the long-term issue as to the gap in pricing.

The short-term issue concerns how to cope with volatility on the markets for raw materials and stainless steel. As cathode plate makes up a large portion of the value of refinery plants, and MEL sell their plants and equipment at firm price, they need firm price when ordering stainless sheet blanks. The sales manager (SJ) of UCR, an “old-timer” much experienced in project sales, participated in the early business with MEL. During times characterized by strongly fluctuating raw materials prices the man

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1 Translation from Swedish. The capital letters comply with the original mail.
bought forward on raw materials (while following the normal practice for project sales), and by so doing he was able to offer MEL firm price. At the time a new marketing manager was enrolled in UCR the short-term gap in pricing suddenly grew wide, as the man started to use a “rise & fall clause” linked to price when offering material to MEL. The step triggered a strong customer reaction that was channeled back to UCR via Hank Kennyson. Soon the “rise & fall clause” was withdrawn, and the previous routine was restored. Though UCR had rapidly reintroduced the practice of buying forward on raw materials still a robust formula for the calculation of price was lacking, a pricing formula taking account of fluctuating raw materials prices and currency rates. It took more than a year, and the opportunity to land a large project, for such a formula to be developed. By the work of product manager (OJ) at UCR the formula was in place in the late 1996, and the short-term gap concerning price had been considerably reduced.

The gaps concerning product quality and delivery performance remain wide through the most part of the 1990s. For some periods the gaps are decreasing just in order to grow wide again at a later point in time. It is most obvious that the gap concerning delivery performance is the result of existing gaps in product quality and materials logistics. The latter two gaps also interrelate. As the gap in materials logistics is reduced to a workable level step by step, the gap in product quality remains the major obstacle for business exchange to occur between UCR and MEL. The gap in product quality is basically a reflection of mismatch or friction in the collected ‘production and use system’ known as ‘the cathode plate route from raw materials to operational service’. This issue will be thoroughly discussed in the sections below.

The discussion of the seven gaps identified in the empirical case revolves around the ‘gap reducing mechanism’\(^1\). As UCR and MEL interact they learn about each other and about the various needs and abilities of the counterpart. They make commitments in relation to each other and they adapt to each other in various ways. As they do they invest in the relationship, they become increasingly mutually dependent, and they develop trust. Publications on cooperative interorganizational relationships maintain that relationship development involves decreasing uncertainty as a result of learning through interaction (Ford, 1980; Dwyer et al, 1987). The statement seems plausible if assuming an overall perspective on relationship development. However, if studied somewhat more in detail a slightly modified view of relationship development emerges as is indicated in the above discussion.

At a first glance the initial phase of the development of the UCR-MEL relationship seems to involve just a minor portion of uncertainty. A lot of information is exchanged between the parties, and before the first order is placed the product specification and other things are negotiated to satisfaction (as it seems). It is likely that the parties enact different views of the current situation (Weick, [1969] 1979), but, whichever the

\(^1\) See section 4.7.2 above.
differences may be, it is clear that the views reported have one thing in common – the
different parties are confident about UCR’s ability to manufacture high quality cathode plate in
response to MEL’s order, and not only UCR and MEL, but also NEM, are confident
about that. The parties go on interacting as the order is manufactured and expedited,
and, as they do, item by item uncertainties show up in the case. Thus, a gap concerning
packaging and transportation appears. Soon a gap in product quality is causing a lot of
pain in the young relationship. There is also an obvious mismatch in the methods for
testing and measurement. As the business proceeds with new orders placed by MEL
uncertainty about materials logistics shows up, delivery performance is causing
problems, and pricing which has initially been a no problem item suddenly exposes an
obvious misfit as the new marketing manager is enrolled in the UCR organization
(Smith Ring & Van de Ven, 1994, pp.103-104).

One may wonder whether it is a myth that learning implies reduced uncertainty, as the
empirical case seems to point in another direction. Here the point is made that early in
the process of interaction (addressing a particular issue) the uncertainty perceived may
increase, but as the process proceeds and the various bits and pieces successively come
together uncertainty goes down. Or otherwise expressed, in the early phase of the
process the collected information is still incomplete and fragmentary. The situation
may invoke confusion, which may increase uncertainty perceived by the actors. As
learning produces increased understanding and meaning uncertainty in a later phase of
the process goes down.

Business counterparts involving in interaction frequently make decisions as they go
along. All decision-making is based on available information, and, thus, suffers from
bounded rationality (Simon, [1945] 1997). Expectations and available information
make up the basis for organizational choice (Cyert & March, [1963] 1994). Strongly
believing without actually knowing may bring about an illusion of certainty, and if an
outcome differs from what was anticipated ex ante, certainty suddenly changes into
uncertainty. Knowing just a little may be devastating as it may put an actor in a
troublesome position, because what is known might not be sufficient to guide sensible
behavior. Searching for information, as business parties involve in exchange along the
process of interaction, is a most delicate task. By involving in business relationships
actors strive to make the future more predictable (Ford et al, 1998), but even within the
frame of a long-term relationship not anticipated uncertainty may suddenly show up.
That is so because there is always more to learn about the other party, but also because
conditions may change by coincidence or out of chance.

As business relationships are commonly interconnected, action performed for a
particular purpose in one relationship may cause unintended consequences for
exchange performed in another relationship. The empirical case involves a much
typical episode where UCR invests in a new cold rolling mill designed for the high
speed manufacturing of thin, 1500 mm wide material. The investment is directed
towards a group of customers much different from the type of customer that MEL is representing. The bad thing is that for more than six months the new mill doesn’t perform well. As a consequence the perceived uncertainty regarding the manufacturing of high quality cathode plate soars, and the entire business with MEL is jeopardized.

Another argument in the context of learning and uncertainty refers to the difference between ‘objective knowledge’ and ‘experiential knowledge’ (Penrose, 1959; Johanson & Vahlne, 1977). Until UCR has actually produced material for MEL, and until MEL has used UCR’s material in their operations, interaction between the parties involves ‘objective knowledge’ only, i.e. the kind of knowledge that can be codified and articulated. As the business proceeds and the parties perform manufacturing and assembly activities both accumulate ‘experiential knowledge’ adding to the understanding of the other party as well as to the business as such.

As business parties interact they become familiar with each other, and as a result the perceived uncertainty goes down, which is illustrated by the dotted line in Diagram 5:1. At an aggregate level this is likely to be a most adequate description of the relationship between learning and uncertainty (Ford, 1980; Dwyer et al, 1987). Observations done in regard to the empirical case complement the picture by rendering support to the contention that interaction and learning might bring about increased (as perceived) uncertainty. The idea is that all learning starts out from an introductory stage of information gathering, which might bring about confusion rather than clarification. As learning to a large extent emanates from doing (‘experiential knowledge’), and as there is an obvious lag between talking and acting, sometimes learning appears to be a slow process. Based on these arguments it seems reasonable to claim that large industrial projects in particular may suffer from slow learning. An additional argument rendering such a standpoint support is that projects of the kind often involve several different technologies and many organizational actors, elements that make learning a most complex and complicated process.
The empirical case is an illustration of slow learning in an industrial context where uncertainties show up at various points in time as the business process proceeds. The context is characterized by complexity and many technologies of the case are utterly complicated. There is a gap concerning product quality that seems to resist almost any attempt to make anything about it. The gap is an indication of an underlying uncertainty about the technologies involved, about mismatch and friction difficult to come to grips with. The continuous line in Diagram 5:1 illustrates how ‘perceived uncertainty’ seems to change over time as UCR and MEL interact and learn about each other in various dimensions. As the learning process proceeds uncertainty is reduced but there are many backlashes along the road.

As time goes by the gap between UCR and MEL concerning product quality as to cathode plate seems to remain wide open. Special attention, education of line personal, allocation of the product manager (OJ) to the MEL account, the establishment of a project group, and the formation and running of a discussion forum are steps taken in the UCR organization to come to grips with the problem. In the meantime MEL swaps and rewrites manufacturing and assembly schedules in order to navigate through late deliveries and defect material. “The cathode plate route” stretching from raw materials handling on the scrap-yard of Avesta Sheffield via manufacturing and assembly activities of MEL to operational services in various refinery plants around the world manages to get along but not without friction. Through the years up to 1998 (stage 3) several situations characterized by severe difficulty occur. There are “major problems”, “drama”, and even a situation that is about to “explode”. The large geographical distance between UCR and MEL constitutes a major obstacle when defect material finally arrives in X-land a couple of days or weeks behind schedule.

“The cathode plate route” suffers from malfunction during these years, but business is still upheld though the one or the other party at several occasions is about to quit. An interesting temporal solution to the product quality problem is arranged as UCR’s competitor in X-land, i.e. DSL, is mobilized for corrective roller leveling of material suffering from insufficient flatness. It is likely that the operations of DSL is saving the relationship between UCR and MEL, because through the years 1994-1997 so much material is posterior roller leveled by DSL that hadn’t this facility been available the business had probably collapsed.

Why DSL accepted to support UCR is not entirely clear. There are a few possible explanations. BSS(f) supplying hot band to DSL is sister unit to UCR and DSL told Hank Kennyson “that in the interest of our good relationship [DSL] will not ‘rip us off’ with a high rate” for the roller leveling. Thus, DSL’s relationship with BSS(f) might well have influenced their decision to support UCR. Another explanation might be that DSL had already concluded that they were unable to follow pace with MEL’s expansion and therefore welcomed UCR as a complementary supplier. If so, they didn’t consider UCR to be a difficult competitor. The fact that UCR adopted the price level once established by DSL might have further played down the atmosphere of
competition. Another factor of importance might have been that ASX already from inception played with open cards against DSL. Maybe DSL considered ASX rather to be a complementary supplier than a difficult competitor in X-land. The long and the short of it is that the necessary resources securing business continuation between UCR and MEL were mobilized in the existing production net, and they were brought in from a competitor of UCR. The case is a nice illustration of networking (Ford et al, 1998), and the situation was such that DSL had now picked up the sub-contractor role in relation to the Avesta Sheffield Group in addition to the other two roles as customer and competitor. It happens at times that the world of business becomes much peculiar.

5.4.3 The cathode plate route – resources in sequence

As the business between UCR and MEL evolves UCR gradually improve their capability to manufacture cathode plate. In parallel the cathode plate product specification is subject to slight modification, and the establishment of certain administrative arrangements between the parties facilitates business exchange. Friction originally appearing along “the cathode plate route” is reduced to a manageable level, and, although not yet fully stabilized, after several years of interaction between UCR and ME “the route” is fairly well established. The analysis performed below addresses the resource constellation and the activity structure, as they appear in the end of stage 3.

The reusable stainless steel cathode plate, a substitute for the disposable starter sheet used in the traditional electrolytic refinery process, makes up the core element of ‘the MEL refinery process’ and is also the focal product of the empirical case. It is designed to operate in harmony with other resource elements making up the electrolytic section, i.e. the concrete basin, the hangers keeping the cathodes and the anodes in place, the computerized control system, the transportation system (pumps, conveyers, etc.), and other equipment. But the electrolytic section has to be adjusted also to other major components of the refinery plant, i.e. the anode machine, the cathode preparation line, and the scrap machine. The cathode preparation line of ‘the MEL refinery process’ differs from that of the traditional refining process in that the former in contrast to the latter incorporates a cathode stripping machine separating the metal deposit from the cathode plate.

The MEL refinery system is a meeting place for various resource components operating as production facilities. An encounter between two resources constitutes a resource interface. Such an encounter may be smooth, or it may be harsh or problematic causing friction. Two production facilities that are well adapted to each other produce a smooth encounter. The facilities are compatible and the interface friction is low or non-existent. A system involving several related production facilities includes several resource interfaces. If all interfaces are characterized by smooth encounters the system is a low friction system. One single harsh encounter may suffice
to turn the system into becoming a high friction system. An example from the empirical case serves to illustrate the phenomenon. Cathodes suffering from inappropriate flatness are not compatible with the dimensions of the basin, the number of cathodes and anodes stipulated for the refinery process, the optimal thickness of the deposit, etc. and in case a short-circuit occurs inappropriate flatness is certainly incompatible with the electric system as the short-circuit may stop the entire refinery process. Inappropriate flatness turns the system into a high-friction system, which in turn leads to undesired economic consequences. High friction may impact detrimentally on both the cost side and the revenue side. Product quality uncertainty (uncertainty about which is the “right” quality\(^1\)) as well as product quality instability (quality differs from one lot to another\(^2\)) makes friction soar.

The empirical case shows that several sets of production facilities are involved in the establishment of a refinery plant, which, if viewed from the perspective of those that are operating metal refineries, in itself may be considered an integrated production facility. From MEL’s perspective production facilities are those resources that, when activated, bring about the physical establishment of a refinery plant. Thus, resources activated for the manufacturing of cathode plate are production facilities from the perspective of MEL, but also other resources have to be considered. The basin in which the electrolytic section is operating is a concrete construction. A comprehensive construction work is needed to put such a thing in place, and in order to carry out the work suitable facilities are to be activated. The computerized control system needs the activation of particular facilities to become a reliable device adapted to run the refinery process, and the electronic components making up the system carry with them a lot of knowledge suitable for the purpose. The manufacturing of various mechanical equipment and transportation systems requires both engineering expertise and workshop facilities.

Cathode plate manufacturing involves several sets of activated production facilities starting out with steel production in a melting shop, progressing via hot rolling in a hot rolling mill, and ending up in a cold rolling system, where the plate is rendered final dimensions and properties. Altogether these facilities make up a vertically integrated production system (Johanson & Mattsson, 1992) that is operated by the Avesta Sheffield Group in the empirical case. The cold rolling activities are performed by UCR. The output product of the UCR unit is the stainless sheet blank. The blank is redefined into an input product, which is further machined by MEL into stainless steel cathode starter plate suitable for use in ‘the MEL refinery process’. As the cathode plate product moves to the last stage of “the cathode plate route” it is redefined into a production facility meant for use in refinery plants.

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1 Product quality uncertainty is equivalent with ‘transaction uncertainty’ (Håkansson et al, 1976).
2 Product quality instability indicates there is friction from time to time between some resource categories making up the production (and use) system.
Figure 5:6 Chain of production facilities and resource set interfaces

Figure 5:6 is a schematic outline of the cathode plate route in a resource perspective. Along the route friction may occur at each resource interface where the output product in progress is redefined into an input product. Thus material arriving at the hot rolling mill may not be suitable for hot rolling, hot band entering the cold rolling system may not be appropriate for the further manufacturing by UCR, sheet blanks arriving at MEL may not be suitable for the manufacturing of cathode plate, and cathode plate when redefined into a production facility may not work satisfactorily in the metal refining process. Any such malfunction is a manifestation of resource interface friction. Friction may be the consequence of inappropriate rule inscriptions residing in the various technological artifacts constituting the production facilities of the production system, or it may be a reflection of inappropriate activation of the production facilities (by the application of inappropriate techno-human routines or by activation “at random”). Thus, each one of the interfaces between the various facilities and facility sets have to be managed in a proper way to achieve a workable end product, a cathode plate that can be utilized, if not entirely without friction, so at least with a reasonably low level of friction in the refinery plant.

For reason of simplicity Figure 5:6 is constrained to show production facilities and resource interface friction at an aggregate level. A more detailed representation of subsets of production facilities is given in Table 5:3 below. However, it is a given that the various production facilities of each production unit, whether be it the steel mill, the hot rolling mill, the cold rolling unit, etc. may suffer from resource interface friction. The reason resource interface friction is a problem in systems employing long-linked or process technologies is that such systems, when operating, involve interdependent activities (Thompson, 1967). In such systems downstream activities depend on upstream activities, but it is also often the case that downstream activities, for their proper performance in relation to a particular output purpose, to a larger or lesser extent determine the execution of upstream activities.
As a product in progress travels along a chain of production facilities value is gradually added to it. At the point of redefinition from ‘product’ to ‘production facility’ its value is peaking. Then, as the product, now considered a production facility, is brought into service, over time it is gradually consumed, and successively it loses its value. The sequence might be called ‘the product-production facility life cycle’. With few exceptions the model is valid for all industrial products (as well as consumer goods). A particular aspect of value creation concerns the relationship between input and output as to manufacturing operations, i.e. the level of productivity achieved. The more output that is achieved from the processing of a certain amount of input, or the less input that is consumed for the manufacturing of a certain amount of output, the higher is the productivity. With reference to the empirical case various output fractions result from UCR’s manufacturing activities as to “the cathode plate route”, i.e. the manufacturing of starter sheet blanks (Figure 5:7). Out of the hot band tonnage (input) that is entered into the cold rolling operations half of it, or somewhat more, comes out as ‘prime material’ (output), i.e. material meeting the product specification of MEL.\(^1\) This material has got the appropriate rules inscribed into it, rules that, when activated, properly guide the operations for which the material is meant. ‘Arisings’ are non-defective material, which, for various reasons, doesn’t meet the product specification for which it is produced. That implies it doesn’t contain the appropriate rules making it suitable for cathode plate service. On the market ‘arisings’ are valued lower than prime material. Usually the rules inscribed into ‘arisings’ also deviate from the requirements specified for standard products. From a use and value point of view ‘seconds’, ‘scrap’, and ‘waste’ are inferior output categories. UCR’s low yield numbers (the ratio between prime material and input feed) as to cathode plate manufacturing is an indication of resource interface friction in the production system.

\[\text{Figure 5:7 Output fractions emanating from UCR’s manufacturing of starter sheet blanks}\]

\(^{1}\) The various terms, i.e. prime material, arisings, seconds, scrap, and waste, are clarified in section 2.6.3 above.
It might be that the production facilities of UCR are not appropriate for the manufacturing of cathode plate, i.e. the rules inscribed are not properly guiding the manufacturing operations needed, or it might be that the facilities are not appropriately activated. Maybe both explanations apply.

5.4.4 The cathode plate route – activities in sequence

The various production facilities of the case contain a lot of knowledge-based rules that are guiding manufacturing operations. As the facilities are activated manufacturing takes place. Table 5:3 is a compilation of the production and use sequence of the empirical case here labeled “the cathode plate route”. It employs a large number of technologies involving a comprehensive amount of production facilities that are activated for the production and use of cathode plate. The order of the major production sections 1 – 11 corresponds to “the cathode plate route”, i.e. the production and use sequence valid for the customized product delivered to MEL. The activities performed within the Avesta Sheffield system of technologies (sections 1 – 7) are complementary, which means “they represent different phases of a process of production and require in some way or another to be co-ordinated” (Richardson 1972, p.899). Note that section 3 and 5 represent the same manufacturing equipment, the annealing and pickling line (APL). That means that the material goes through this line twice; preparatory annealing (including most of the activities from 3a) to 3h) is carried out prior to the cold rolling operation and final annealing (including all the activities from 5a) to 5h) is performed after the rolling. Preparatory annealing and final annealing are an example of similar activities i.e. “activities which require the same capability for their undertaking” (ibid. p.888).

The identification of similar activities has a bearing on economies of scale as well as economies of scope because activities that are similar can make use of the same equipment and skills\(^1\). Activities may be similar and complementary at the same time as shown in the example. But activities may also be dissimilar, requiring different capabilities for their execution. Hot rolling and cold rolling are dissimilar activities requiring different capabilities. Dissimilar activities cannot benefit from economies of scale because different sets of production facilities must be activated for their execution. In case the aggregate output of a certain type of activity (along a chain of activities) comprises standardized products matching the requirements of the general-purpose input of another subsequently located type of activity, both as regards quantity and quality, coordination is easily performed by ordinary exchange in a market. No special arrangement is needed to coordinate the activities. If, for a certain activity to

\(^1\) In this example only the production route for cathode plate is considered. The volume produced for this purpose is less than half a percent of the annual production of steel in the Avesta Sheffield steel mill and hot rolling mill. In the cold rolling mill of UCR the share is somewhat bigger. As a rule stainless steel production is benefiting from economies of scale. It goes without saying that a very great number of similar activities are performed within each one of the various production sections of the Avesta Sheffield production system.
### The Cathode Plate Route from raw materials to operational service – activity sequence

<table>
<thead>
<tr>
<th>Unit of analysis</th>
<th>Primary Products (PP)</th>
<th>Unit Cold Rolled (UCR)</th>
<th>Metal Extraction Ltd (MEL)</th>
<th>MEL’s Customer (MELC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major production/use section</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Steel mill (SM)</td>
<td>2</td>
<td>Hot rolling mill “Steckel”</td>
<td>3</td>
</tr>
<tr>
<td>Activity (the activity relatedness is subject to special analysis for activities marked with extra bold type)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1a) raw material handling</td>
<td>2a) hot band rolling</td>
<td>3a) preparatory annealing</td>
<td>4a) cold rolling</td>
<td>5a) final annealing</td>
</tr>
<tr>
<td>1b) steel melting</td>
<td></td>
<td>3b) quenching</td>
<td>4b) quenching</td>
<td>5b) quenching</td>
</tr>
<tr>
<td>1c) continuous casting</td>
<td></td>
<td>3c) blasting</td>
<td>4c) blasting</td>
<td>5c) blasting</td>
</tr>
<tr>
<td>1d) levelling</td>
<td></td>
<td>3d) pickling</td>
<td>4d) pickling</td>
<td>5d) pickling</td>
</tr>
<tr>
<td>2b) steel melting</td>
<td></td>
<td>3e) rinsing</td>
<td>4e) tension levelling</td>
<td>5e) rinsing</td>
</tr>
<tr>
<td>2c) continuous casting</td>
<td></td>
<td>3f) drying</td>
<td>4f) tension levelling</td>
<td>5f) drying</td>
</tr>
<tr>
<td>2d) levelling</td>
<td></td>
<td>3g) tension levelling</td>
<td>4g) tension levelling</td>
<td>5g) tension levelling</td>
</tr>
<tr>
<td>2e) levelling</td>
<td></td>
<td>3h) inspecting</td>
<td>4h) inspecting</td>
<td>5h) inspecting</td>
</tr>
<tr>
<td>Critical product property</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- final thickness</td>
<td>- final thickness</td>
<td>- metallurgical structure; grain size and shape</td>
<td>- surface finish</td>
<td>- flatness</td>
</tr>
<tr>
<td>- geometrical shape</td>
<td>- geometrical shape</td>
<td>- surface morphology</td>
<td>- residual stress</td>
<td></td>
</tr>
</tbody>
</table>

### Production and use sequence

*Table 5:3 The cathode plate route – activity sequence*
perform well, the input required raises demand for a preceding activity to be adapted in a special way (the product required has to be tailor-made to satisfy a particular need) the two activities are reciprocally dependent (interdependent). Reciprocally dependent activities have been called closely complementary (ibid. 891). Coordination of such activities requires ex ante matching of plans. The market is not a suitable mechanism for the coordination of closely complementary activities. Such activities are better coordinated within a hierarchical structure as an organization, or in close cooperation between business counterparts. Cooperation within business relationships often addresses activities that are both closely complementary and dissimilar.

The concepts introduced apply to the empirical case. The technology structure of “the cathode plate route” is outlined in Table 5:3. Each major production (or use) section comprises a set of production facilities organized in a particular way. The equipment is activated to perform certain activities, which are listed according to sequence. Refining (i.e. electrolysis), activity 10a), represents the end use activity of “the cathode plate route”. Refining is the activity that consumes the stainless steel product/equipment for the creation of value involving another “base” or “value carrier”, i.e. the ‘metal’ that is refined in the process. Whatever the particular metal concerned (zinc, copper, nickel, etc.), it constitutes the carrier of value from the mine down the line to an end use, no matter what that end use may be. Refining, activity 10a), is closely complementary with each one of the activities marked with bold letters in Table 5:3. The close complementarity is either direct or indirect. The proper operation of the refining plant depends on the quality of the cathode plate regarding flatness, which in turn depends on the way the following activities are performed: continuous casting (section 1), hot band rolling (section 2), cold rolling (section 4), quenching, blasting, pickling, tension leveling (section 5), roller leveling, stretching (section 7), edge trimming, welding (section 8), assembly (section 9), and stripping (section 11).

The activities 7b) and 7c) are both direct closely complementary to activity 10a)\(^1\). Upstream activities in various ways influence the results achieved in activity 7b) and 7c) and by that they may also influence activity 10a). Each one of these upstream activities are indirect closely complementary to activity 10a) if they are especially adapted to match activity 10a). In an activity structure like the one forwarded in Table 5:3 there are several examples of complementary activities, but also examples of activities that are direct closely complementary, and activities that are indirect closely complementary.

It should be noticed that the use sections 10 and 11 form a circle. The cathode plates are used again and again. After refining the cathodes are transferred to the stripping

\(^1\) If assuming that the impact of ‘edge trimming’ 8a), ‘welding’ 8b), and ‘assembly’ 9) on ‘refining’ 10a) is negligible. Normally these activities should not detrimentally impact upon the result of refining unless a major mistake is done during their execution.
machine where the deposit (the refined metal) is stripped off the stainless surface. Stripping is carried out by mechanical means (hammering) and the stripping process uses controlled force. If the plate surface is too coarse the prescribed force level doesn’t suffice to remove the deposit. Then increased force is needed, but that implies an increased risk that the plate goes out of flatness (cold deformation introduces tension into the material with bearing on flatness). If surface roughness hits the level specified the risk to damage the plate during stripping is small (negligible tension is entered into the material during stripping). The conclusion is that every upstream activity impacting upon the surface quality (surface morphology) of the end product (the cathode plate) indirectly also impacts upon the outcome of the stripping activity performed in use section 11, which in turn may influence the flatness of the cathode plate and thus the performance of the refining activity carried out in use section 10. The degree of thickness reduction during cold rolling is crucial for the final surface quality of the plate, as the grain size of the metallurgical structure is largely determined by the rate of reduction. This circumstance puts certain requirements on the upstream activities of continuous casting and hot rolling. Both operations have to be carried out in a proper way so that suitable material thicknesses are achieved (slab thickness and hot band thickness respectively). Also such activities as blasting and pickling (section 5), and roller leveling (section 7) affect the surface quality of the cathode plate product. The other extreme as to surface morphology is too smooth a surface, the effect of which manifests as refining process failure caused by premature deposit slip-off.

To summarize, activities can be similar, dissimilar, complementary, and closely complementary. Close complementarity may either be direct or indirect, but so far only vertically organized complementarity has been notified. However, the empirical case comprises a phenomenon that may be identified as horizontal close complementarity. In Table 5:4 closely complementary activities of the case are listed along two activity sub-chains, i.e. sub-chain A and sub-chain B. Sub-chain A contains closely complementary activities related to the surface quality of the end product, and sub-chain B contains closely complementary activities related to the flatness property of the end product. The activity ‘refining’ (electrolysis) is closely complementary to each activity along both sub-chains direct or indirect but on different grounds (in relation to either surface quality or material flatness). The critical aspect defining the respective activity sub-chain determines the activities that are identified as closely complementary. Some activities appear in both sub-chains, whereas some other activities appear in just one of them and not in the other. Activities that belong to both sub-chains, i.e. common activities, are of particular interest, because when these activities are accomplished two critical aspects have to be considered simultaneously with reference to two tailor-made solutions.

1 Activities that are not closely complementary are excluded from the two sub-chains as such activities do not claim ex ante planning of the actors involved.
The cold rolling activity is a good example. Cold rolling has to be carried out in such a way that a certain thickness reduction is achieved with impact on the surface quality of

<table>
<thead>
<tr>
<th>Activity sub-chain A:</th>
<th>Activity sub-chain B:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Critical aspect:</strong> surface quality</td>
<td><strong>Critical aspect:</strong> flatness</td>
</tr>
<tr>
<td>Activities closely complementary to stripping and refining:</td>
<td>Activities closely complementary to refining (electrolysis):</td>
</tr>
<tr>
<td>continuous casting</td>
<td>continuous casting</td>
</tr>
<tr>
<td>hot rolling</td>
<td>hot rolling</td>
</tr>
<tr>
<td>cold rolling</td>
<td>cold rolling</td>
</tr>
<tr>
<td>-</td>
<td>Quenching</td>
</tr>
<tr>
<td>Blasting</td>
<td>Blasting</td>
</tr>
<tr>
<td>Pickling</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>tension leveling</td>
</tr>
<tr>
<td>roller leveling</td>
<td>roller leveling</td>
</tr>
<tr>
<td>-</td>
<td>Stretching</td>
</tr>
<tr>
<td>-</td>
<td>Stripping</td>
</tr>
</tbody>
</table>

Activities closely complementary to stripping:
- impact upon strength of adhesiveness; too coarse a surface raises demand for super-normal force when stripping, which implies increased risk for plate damage;

...and to refining:
- if plate flatness deteriorates the efficiency of the refining process is negatively influenced, which implies activities that are closely complementary to stripping are indirectly closely complementary to refining;
- the activities that impact upon surface quality are also directly closely complementary to refining because too smooth a surface causes process failure (deposit slip-off) during refining;

<table>
<thead>
<tr>
<th>Activities closely complementary to stripping:</th>
<th>Activities closely complementary to refining:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- impact upon strength of adhesiveness; too coarse a surface raises demand for super-normal force when stripping, which implies increased risk for plate damage;</td>
<td>- impact upon refining productivity; the flatter the material the higher the productivity;</td>
</tr>
</tbody>
</table>

**Table 5:4** Closely complementary activities

the final product, but simultaneously the rolling operation must control also the intersection geometry of the coil in order to prepare for downstream manufacturing of a product flat enough for the cathode plate application. Thus, on the one hand cold rolling and stripping are closely complementary activities, and on the other hand cold rolling and refining are closely complementary activities, implying that close complementarity appears along two activity sub-chains. This phenomenon may be denoted ‘bifurcate collateral close complementarity’. It is different from ‘parallel close
complementarity’ by its enclosure of a bifurcation point that is bridging the sub-chains upstream. Parallel close complementarity would be understood as two chains, both characterized by close complementarity, coming together in one common activity (the chains are merging) that is part of the close complementarities of both chains. As the two sub-chains A and B come together downstream in the refining activity there is also parallel close complementarity present in the case. ‘Bifurcate collateral close complementarity’ and ‘parallel close complementarity’ are different manifestations of ‘horizontal close complementarity’. It seems reasonable to contend that the appearance of ‘parallel close complementarity’ is most common in industrial operations, whereas the appearance of ‘bifurcate collateral close complementarity’ is rare.

Now, cold rolling for the cathode plate application has to be performed in a much special way in order to simultaneously satisfy the product specification as to surface quality and flatness of the final product. Furthermore, cold rolling cannot be taught. It has to be learned by doing. An experienced cold rolling operator is a person that is “knowing how” rather than “knowing what” when it comes to rolling (Ryle, 1949). Some people learn to do it, others don’t. Hank Kennyson tells about a floor manager in the UCR production department, who “could make the cold rolling mill sing, if he wanted”¹. It goes without saying that it takes both explicit and tacit knowledge (Polanyi, 1966] 1983) to successfully manage a cold rolling mill, but it is a mistake to underestimate the importance of the latter category. To successfully perform cold rolling in relation to the cathode plate application involves two obvious subtasks, 1) to figure out how to successfully do the rolling, and 2) to reliably carry out the rolling at each occasion. Case information reveals that it takes several years to figure out how to properly roll the material for the application. In the early days of relationship development between UCR and MEL nobody really recognizes the crucial importance of the cold rolling operation for the achievement of the right quality of the final product. After a few years of interaction Kennyson points at the need to consider activities upstream the production line. At the time he had learnt quite much about the operations of UCR, and his close contacts with Carl Juhlin, the UCR manager responsible for the running of the cut-to-length line (CTL), had further added to his understanding of cathode plate manufacturing. In mid March 1996 a fax from Kennyson to UCR reads:

>Whilst we all believe that we have made progress on the CTL line, we still have some areas to improve. … I believe that we need to pay more attention to quality aspects during processing prior to CTL department …..

> I believe that we should ‘extend back’ into the processing line …..

>Operators need to understand that they control the material condition and have a major influence on the end result.

And later in a fax of mid 1997 he adds to the same theme:

¹ Interview with Hank Kennyson on November 22, 2001.
Now is the time when we need to produce a document along similar lines to that which was compiled for the KLCC project by I believe [TD]. … My idea is that the document should contain details of the production route with a step by step description of how each operation is to take place and the relevant test/check procedures at each stage. Every action needs to be included and given parameters – machine settings, line speeds, temp., shot blast pressures, roller leveler setting, stretcher tensions, loop heights and configurations, shear settings etc. Theoretically the document should be able to be the “recipe to bake a cake” – a very flat one at that.

At any stage of production I expect to be able to read the document and see that the steps are being adhered to, within reason, it goes without saying that not all of the feed behaves the same and that there is a need for variations. However these variations need to be justified and documented to enable a better understanding as to why they occur and what additional controls need to be in place to prevent them occurring. This may sound very basic, however I believe that if we don’t establish a base, we can very easily run-off track again if operators begin to individually interpret how it should be produced.

Kennyson’s messages maintain that written documents containing all “codable” information are needed for reliable production to materialize, but also that written documents are not enough for successful manufacturing to occur. Line operators are also to use their personal knowledge and skills in a sensible way. What is actually needed is explicit and tacit knowledge both at the level of the individual and at the level of the collectivity. This particular knowledge asset has been denoted ‘intellectual capital’ (Nahapiet & Ghoshal, 1998, p.245). An organization’s intellectual capital may be appropriate for a certain purpose or it may not. If appropriate for a particular purpose and if embedded in the standard operating procedures of the organization, then the organization disposes of appropriate techno-human routines making reliable manufacturing for the current purpose possible. But still the possibility to successfully fulfill the task may be circumscribed by the production facilities (technological artifacts) available to and controlled by the organization (Pfeffer & Salancik, 1978). Resource interface friction may emerge as a result of non-matching rules inscribed into material artifacts and/or embedded in techno-human routines. It is obvious that the actors of the empirical case put their main attention on how to use existing production facilities in order to reliably produce a high quality product, i.e. they focus on which techno-human routines to establish and operate for the successful production of cathode plate. The empirical case doesn’t display any particular investment claims in relation to the cathode plate application, neither as regards new production facilities nor as regards modification of existing facilities. Probably that is an effect of the distribution of power in the network system constituted by MEL, ASX, UCR, and the top management/board of directors of the Avesta Sheffield Group. Everybody knows that any major investment in UCR has to be approved by the board or by Group management, and minor investments have to be approved by the management of UCR. As neither of the two coalitions show much interest in cathode plate business until late in the process, and, as the mobilization of ‘allocative resources’ referring to “forms of transformative capacity generating command over objects, goods or material phenomena” is dominated by those two coalitions, probably nobody at lower
organizational levels found it worthwhile asking for something they didn’t anticipate they would get (Giddens, 1984, p.33). At the time interest arrived at the upper level of the Avesta Sheffield Group appropriate techno-human routines had already been established for the low-friction operations of “the cathode plate route”.

5.4.5 Stage 3: Summary discussion

The stage 3 analysis indicates that difficult technological issues tend to trigger extensive interaction. During the early stage of relationship development at the time UCR is about to qualify as MEL’s cathode plate supplier the customer of MEL, i.e. NEM, directly involves in interaction with UCR concerning cathode plate manufacturing and also performs on site inspection at UCR. In the early days of development of ‘the MEL refinery process’ a similar pattern appears as DML, DSL and MEL interact in a close domestic circle while solving various problems relating to the development of the new technology. When there is need to handle complicated and complex technological issues or in other situations where uncertainty is high, business parties tend to get closer to each other (Ford, 1980). The closed triad appears as a structural manifestation signaling increased interaction and extended information exchange.

It has been contended that networks are both stable and changing (Hammarkvist et al, 1982; Axelsson & Easton, 1992). The empirical case shows how the gradual expansion of MEL’s business challenges the stability of the domestic production net due to DSL’s inability to match MEL’s increasing need for cathode plate. When DSL is closing down their metallurgical operations as to stainless steel production they signal decreasing commitment in relation to MEL. DSL, now a re-roller in stainless, is obliged to procure hot band from external sources\(^1\), which means increased uncertainty as to feedstock supply and particularly so at times when raw materials markets are volatile. There is an increasing gap emerging between the need of MEL and the ability of DSL. As DSL refrains from doing anything to reduce the gap MEL starts to look for complementary supply of cathode plate. The growing unbalance of the domestic production net opens for UCR’s entrance into the net. By establishing business with UCR MEL secures supply from a major stainless steel producer moving large volumes of stainless steel to the market, and, even more important, MEL associates with an actor that is part of a vertically integrated production system less sensitive to changes on the markets for raw materials. Interestingly enough at a later point in time DSL is saving UCR’s business with MEL by subcontracting roller leveling for UCR. As they do they now shoulder three different roles in relation to the Avesta Sheffield Group, viz. the competitor role, the customer role, and the subcontractor role. The various relationships making up the network system identified as the cathode plate production

\(^1\) DSL begin to procure hot band from British Steel Stainless in UK. By the merger in 1992 British Steel Stainless become part of the Avesta Sheffield Group.
net are closely interconnected and the collective actors operating the system are most interdependent as well.\textsuperscript{1}

As the UCR-MEL relationship evolves gaps in several dimensions successively become visible. What was early supposed to be an “easy ride” gradually turns into a “nightmare”. Mismatch concerning product specification, packaging and transportation, product quality, testing and measurement, material logistics, delivery performance, and pricing shows up as the interaction process unfolds. The simple linear relationship between learning and uncertainty as proposed in the literature (Ford, 1980, Dwyer et al, 1987) doesn’t seem to be entirely credible. At an aggregate level linearity might be a reasonable representation of the relationship between the two, but at a lower level of aggregation is seems that learning up to a certain point implies increased rather than decreased uncertainty. A possible explanation to the observed phenomenon might be that actors early in the process of involvement base their judgments on a limited set of “converging” data leading up to a perception of certainty, but that certainty perceived is markedly apparent. With the arrival of complementary “diverging” data actors might later conceive of increasing uncertainty. However, it is certainly true that the gap reducing mechanism when properly operating produces trust between actors, and that trust thus accumulated functions as an asset that can be utilized in case of uncertainty increase. A higher level of trust facilitates the management of uncertainty and problems appearing in a relationship. To sum up; several gaps are emerging as interaction proceeds between UCR and MEL; some of the gaps are closed quite soon whereas other gaps resist almost any attempt to reduce them; the most resistant gaps are those concerning product quality, pricing, and delivery performance. In the latter end of stage 3 it seems that also these three gaps are about to decrease to a manageable level.

“The cathode plate route” is the entire route from the Avesta Sheffield scrap yard (where stainless scrap meant for steel smelting is stored) up to an operating refinery. The route incorporates a large number of production facilities that are activated for the purpose of producing and using cathode plate. To be more precise it involves a number of sequentially organized technological artifacts and techno-human routines that are guiding the manufacturing and use activities. The rules that are inscribed into the artifacts and are found embedded in the routines determine the level of effectiveness and efficiency of “the cathode plate route”. They also determine whether the route appears as a high-friction or a low-friction system. Discussed along this vein of logic

\textsuperscript{1} With reference to Johanson and Mattsson (1988) it is interesting to note that the micro-position of DSL in relation to the Avesta Sheffield Group involves several different roles. The fact that the various business units of Avesta Sheffield are interconnected by a mixture of legal ties and business-related interdependencies complicates the picture. If considering the multi-role operations of DSL with reference to Ghoshal and Bartlett’s (1990) conceptualization of the multinational corporation as an inter-organizational network a most intricate picture emerges. The case offers strong empirical support to propositions made concerning business relationship interdependences (Cook & Emerson, 1978), and such interdependences may well involve multi-role actors as the case is indicating.
technological change, then, is about changing the rules those two manifestations of technology carry with them, no more and no less. The empirical case doesn’t report on any major investment done in new or modified production facilities for the improvement of the cathode plate route. On the contrary, an investment done in a new cold rolling mill is almost about to cut off “the cathode plate route”. The rules inscribed into the new mill were designed for the manufacturing of thin material, and even worse, the mill involved “intra-unit friction”. From start-up it suffered from several teething problems, and it didn’t come up to expectations until it had been operating for six months. To conclude, there are no major changes made as to the technological artifacts operating along “the cathode plate route”, but there are several changes as to the various activities performed.

The activities performed along the cathode plate route involve many interdependences and the above analysis shows that the structure of the manufacturing activities of the case is most complex. In the early days of business exchange between UCR and MEL it is supposed that all product quality problems can be resolved in the cut-to-length line (CTL). As the business proceeds it is recognized step by step that some problems created upstream cannot be corrected in the CTL. At this point in time attention is gradually redirected upstream the Avesta Sheffield production system. The presence of a large number of closely complementary activities along the route necessitates a holistic perspective, and the case reports about a large number of activities that are tuned over time in order to make the route effective and reliable for the manufacturing of cathode plate. In the end of stage 3 the work has come quite far, but a lot of activities are still performed without people actually knowing what would be the “right” way to act. So far no detailed routines have been established. Sufficient knowledge and skills as to the manufacturing of cathode plate seem to be available in the UCR organization, but as it is dispersed over different shifts and different individuals coordination problems now and then appear.

‘Emergent developments’ is the prime source of change during stage 3. As the parties interact they gradually learn about each other and about the technologies involved, and as they do they successively adapt to each other. The parties develop trust between themselves, which serves as an asset when they run into various sorts of exchange problems. One such problem follows on the strategic decision of UCR to invest in a new cold rolling mill. The investment most detrimentally impacts upon the everyday business of UCR and MEL. It goes without saying that the decision never meant to negatively affect the cathode plate business, but by coincidence it did. All in all, stage 3 of the empirical case is characterized by continuous change unfolding within the frame of the business relationship between UCR and MEL.
5.5 Some influential episodes in the maturing of cathode plate business

At the time the cathode plate business of Unit Cold Rolled (UCR) and Metal Extraction Ltd (MEL) enters into stage 4 it has reached a certain level of maturity. The various technologies involved are reasonably well tuned for operation along “the cathode plate route”, the parties are familiar with each other and they trust each other, and business exchange is smoothly performed while leaving little room for unpleasant surprises. However, during the few coming years some influential episodes should come to strongly impact upon “the cathode plate route” and business exchange between UCR and MEL.

5.5.1 The lost order episode: gap reduction as to pricing

During stage 3 UCR supplies MEL large volumes of cathode plate without losing a major order to a competitor, if disregarding for a moment the fact that Domestic Steel Ltd (DSL) and UCR for some time perform parallel supply of cathode plate to MEL. However, the empirical case reports about one occasion where UCR indirectly loses an order to another steel supplier as a secondary effect of MEL losing a large project on price to Refinery Plant Construction Ltd (RPC). According to MEL the lost project was a result of UCR’s high price on cathode plate, which had been transferred to the potential customer as part of MEL’s offer. And it is certainly true that pricing was still an obstacle at the time the UCR-MEL business approached stage 4. The problem of how to manage fluctuating raw materials prices had been covered in previous agreements, but the problem of how to cope with fluctuating stainless steel base prices over an economic cycle had not yet been resolved. In short the problem related to the fact that the base price for cathode plate was kept stable over time (because cathode plate was considered a customized product), whereas the base price for standard material soared during periods characterized by strong demand in the market (boom), and hit rock-bottom during periods of weak demand (recession). As a result during boom periods there were no complaints raised about high cathode plate prices, but with decreasing prices for standard products during periods of recession the problem of high price surfaced.

In the late 1998 North European Mining Ltd (NEM), the company that had once introduced UCR to MEL, were about to further expand their metal refining capacity and approached MEL a second time. NEM received MEL’s offer, but, based on investigations they had done about prices on the stainless steel market, they found MEL’s price for refinery equipment higher than anticipated. Several negotiation rounds between NEM and MEL, where MEL negotiated backwards with ASX/UCR, revealed a large price difference between the offers given by UCR and Outokumpu

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1 See the discussions in the sections 2.2.3 and 2.6.1 and in Appendix 2 for more information.
2 The costs for cathode plate make up a large share of the price for refinery equipment.
(OTK) for stainless sheet blanks\(^1\). Arguments forwarded by MEL, with reference to the superior product quality of UCR’s customized material compared to the ordinary quality of the standard product offered by OTK, didn’t impress on NEM, who, driven by the large price difference, finally enforced MEL to go for standard material produced by OTK. The lost order made the pricing issue hit the top of UCR’s agenda for cathode plate business. The issue of pricing had already been raised by MEL several times through the years, but at each occasion UCR had claimed that low yield numbers and quality problems related to manufacturing prohibited them from reducing the price. The lost order arrived as a heavy argument for renewed discussions about price and pricing between the two.

In long-term business relationships, where the interacting parties strive to optimize effectiveness and efficiency, issues concerning product customization and other forms of adaptation usually take precedence over pure price issues (Håkansson, 1982; Ford et al, 1998). The UCR-MEL relationship serves as a typical illustration. Business exchange between MEL and their various customers also concerns a much “customized product”, i.e. the refinery plant and refinery equipment. However, in the case of NEM’s second expansion project various views are afloat concerning the level of customization needed when it comes to the stainless sheet blank. It is certainly true that UCR had struggled for a long time with quality problems relating to flatness and surface morphology in regard of cathode plate manufacturing, but at the time of NEM’s second expansion uncertainty prevails as to which is the quality level of the standard products produced by OTK concerning these two aspects. OTK had “said that this was normal cold rolled off their production line??”\(^2\) when discussing the product specification with MEL, but until manufacturing had been carried out nobody actually knew whether that was the case. It is obvious that OTK themselves strongly believed in their manufacturing capabilities as did NEM. ASX and UCR were more uncertain about them, but should OTK be able to satisfy MEL’s specification with a standard product that would certainly be a heavy blow to UCR’s business with MEL. Based on different experiences, different ambitions, and different expectations the various actors involved nurtured different views (Cyert & March, 1963; Weick, [1969] 1979), and before OTK had expedited the order for the NEM refinery plant nobody really knew what would be the outcome.

Hank Kennyson used the opportunity to convince UCR about the necessity to establish a long-term supplier agreement with MEL including a formula of transparent pricing. He argued: “Out of this we have an opportunity now that they [MEL] are talking long term supplier agreement, to put to [MEL] a proposal and sign an agreement before Outokumpu can prove if they can or can’t produce to [MEL] spec.”\(^3\) Thus, it takes

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\(^1\) The input product that is further transformed into cathode plate by MEL.

\(^2\) The quotation including the question marks is brought in from Kennyson’s fax to UCR of March 3, 1999.

\(^3\) Interview with Hank Kennyson on November 22, 2001.
several years of business exchange and a lost order of magnitude until the pricing issue reaches the top of UCR’s agenda. Although MEL had approached the issue at several occasions prior to the lost order episode, every time UCR had been fairly unresponsive about it. The episode served as an igniting spark for the first real formulation of a sensible pricing formula between UCR and MEL to be further developed in future business.1

Some reflections can be made in relation to “the lost order episode”. First, different actors nurture different views of reality which implies they conceive of uncertainty in different ways in relation to one common situation (Weick, [1969] 1979). OTK obviously believes they will satisfy the needs of MEL by supplying a standard product and NEM agrees, whereas ASX/UCR are more doubtful about it. The issue is of major importance to the actors as it has a major impact on price. The crucial question looking for an answer is: Should the stainless sheet blank intended for the manufacturing of cathode plate be considered a customized product? Later the outcome of OTK’s manufacturing showed that they succeeded fairly well as they delivered 85% of the material within specification. The outcome was thus commented upon by MEL: “it was a pretty good shot for the first time they produced this material, to get so close”.2 Whether the good result arrived by chance or by way of close manufacturing control is unknown as OTK never “fired off another shot” for MEL. Second, the episode exemplifies that business relationships are interconnected (Cook & Emerson, 1978). In this particular case it is most obvious that interaction occurring within the relationships of OTK-NEM, OTK-MEL, and NEM-MEL respectively, strongly impact upon the focal relationship of UCR and MEL, because what goes on in these relationships triggers UCR and MEL to reduce the destructive gap concerning pricing that has been an obstacle in their relationship for a long time. The lost order episode becomes the starting point for the establishment of a long-term supplier agreement between UCR and MEL including a sensible pricing formula.

“The lost order episode” illustrates how business interaction leads up to a point where UCR by necessity has to adapt to relational and contextual requirements in order to stay in business. The gap concerning pricing is an obstacle that UCR cannot afford to ignore anymore. ‘Necessity’ is certainly the main source of change as to the reduction of the pricing gap, but necessity seems to appear as a result of ‘emergent developments’.

5.5.2 The new strategy episode: cathode plate business put at a disadvantage

A few years before the turn of the millennium UCR got a new plant manager, and with him followed a new strategic direction. From now on highest priority should be given

1 Ibid.
2 Ibid.
to the manufacturing of thin material with strong emphasis on productivity. The new rolling mill (V3) was designed for thin rolling and in the year 2000 the new plant manager announced that a new slitting line and new stretcher leveller designed for the processing of thin material were under way. As a consequence cathode plate manufactured for MEL was put at disadvantage as it hit the thicker end of UCR’s product program. The new strategy provoked a lot of reorganization in the production department. Carl Juhlin, the production manager responsible for the cut-to-length line (CTL), who had been much supportive to the cathode plate business for several years, was now transferred to the new slitting line under construction. The inspection people, who had previously carefully monitored the product in progress along the product line, were withdrawn in order to reduce costs. The new plant manager claimed that cathode plate was nothing but a standard product and should be treated accordingly, nothing special, no extra resources needed. The previous high status and special treatment of cathode plate business was deported to history from now on. Product quality dropped low as nobody cared for the cathode plate product anymore, and the knowledge and skills that had previously been in place to manage the manufacturing task were now spread into various places as a result of reorganization. The combined effect of withdrawing and reshuffling people in the production department was a disaster. And even worse detailed documents informing about how to properly run cathode plate manufacturing were missing.

A few much interesting reflections relate to “the new strategy episode”.
First, the new plant manager shoulders a most comprehensive responsibility when changing the direction of the business unit. Reorganization and withdrawal of resources put the cathode plate business on risk. It is likely that also other accounts suffer from the changes, but as information is lacking that cannot be shown. Second, the measures taken in connection with reorganization, reallocation of resources and investment in new resources in combination with strong intra-organizational promotion of the new strategy seem to gradually infuse new values into the organization with an obvious effect on priorities (Selznick, 1957). Informal rules and intra-organizational connections inherited from the past are sacrificed. Operator skills required for the reliable manufacturing of high quality cathode plate are dispersed or lost in the process. Implicitly UCR loses out on intellectual capital (Nahapiet & Ghosahl, 1998). Third, the new plant manager performs all the organizational changes without securing that written documents are in place to guide “the cathode plate route”, and as the UCR tradition concerning formalization and documentation is weak there is only a small number of documents available informing about the specificities of the manufacturing of cathode plate. And even worse their content is both brief and shallow. Hank Kennyson verifies the conditions described above when interviewed on November 22, 2001. In response to a question addressing whether knowledge about the cathode plate route had been documented by UCR he answers:

No, they hate that. I mean, there were some loose control documents, but, I mean, I have given talks to everyone on that plant when I was over here for about four or five
weeks, trying to get people to better understand what the process involved and the reason for why they [MEL] wanted things. And of course, with the change of management it just became a thing of production. …"Can’t you make this thing go faster?”

The quotation is self-explanatory. There were only some tiny documents available. Most information was stored in the minds of those who had performed the operations in the past, and the skills and routines that had evolved through several years of teamwork were now split up and spoiled as the new strategy was introduced at UCR and with it a reshuffled organization. The following excerpt from the above quotation renders the new strategy a particular flavor: “Can’t you make this thing go faster?”

5.5.3 The cathode plate route formalization episode: gap reduction as to quality

After a few years of struggle with the new management of UCR Hank Kennyson was much frustrated. The specific cathode plate route that had been established by way of negotiations and adaptations through several years of hard work was now erased, by and large, and in its place standard operating procedures were installed for the manufacturing of cathode plate. From a quality point of view the change was a disaster as to the manufacturing of cathode plate. The old problems relating to flatness and surface quality reoccurred, and the relationship between UCR and MEL suffered a lot of pain. During a visit to UCR in the summer of year 2000 Kennyson, now hovering between hope and resignation, in a meeting asks whether anybody would be willing voluntarily to take on responsibility for the manufacturing of cathode plate as Carl Juhlin is no more available for the task. Kennyson actually asked for somebody willing to be his “eyes and ears” in the UCR mill. A quality assurance (QA) guy raised his hand while telling that he was willing to take on the task, and he was assigned the job. This was a most important turning point for the reestablishment of a high product quality as to cathode plate, although it should take almost a year until the task was fulfilled.

The QA guy started out by inventorying the current situation as to the manufacturing of cathode plate, and as he did he brought together all the knowledge and information fragments he could obtain from different places in the organization. From the base of data collected he began to restore the cathode plate route, and as new orders were executed he picked up complementary data and further refined the process route. A year later Kennyson describes the detective work performed by the man:

He’s put in place a whole series of … documenting the procedures back to basics. So that we set the machine … Well, first of all we are not going to set the machine. We clean the machine down. We have the maintenance people coming in. Check everything out and then we lump together all these small orders, which we have had, into a campaign, which will last two or three days so that we then go back and zero all the equipment. And he has also written a control document, which tabulates all the setting on the equipment, that your inlet gap is 0,84 and the outlet 3,5 and that’s this
and its so, so anyone can come along and press the buttons to make these numbers come up, whereas previously it was a mystery.

... And it has taken a bit of mystery ... off the operator. ... Within reason you still have to have a lot of feeling with the equipment, but, within reason, if you put the right numbers in ... within reason, the right stuff should come out in the end.1

After seven years of struggle the special operating procedures constituting the UCR part of the cathode plate route were finally formalized and written down in documents.

There are some reflections as to “the cathode plate route formalization episode”. First, interestingly enough, the need to formalize the manufacturing procedures of the cathode plate route becomes urgent only after UCR has lost the capability to reliably produce high quality material. Two comments can be made in relation to the late formalization, 1) prior to the UCR reorganization formalization is not needed because appropriate manufacturing can be smoothly performed based on available knowledge and skills at the level of the individual as well as on informal routines at the level of the collectivity, routines worked up through years of process development related to the manufacturing of cathode plate, and 2) when knowledge, skills and informal routines are no more in place a situation of emergency appears triggering the need for change if cathode plate business is to be maintained. Second, it is clear that much knowledge and information relating to the manufacturing of cathode plate can be codified and put down in written procedures, but, if accepting Kennyson’s statement: “[w]ithin reason you still have to have a lot of feeling with the equipment”, a certain portion of the skills needed cannot be captured in writing. The example is a pertinent illustration of the way explicit and tacit knowledge combine into workable techno-human routines (Nelson & Winter, 1982; Nahapiet & Ghoshal, 1998). It also shows that tacit knowledge captured in skills and informal routines may constitute an important part of techno-human routines also in industrial operations characterized by a high level of automation.

Third, the influence of tacit knowledge may differ from one techno-human routine to another. In one routine the tacit knowledge may be extremely influential, whereas in another routine its influence may be marginal. If the influence of tacit knowledge is critical for the execution of a techno-human routine then it renders the possessor/possessors a certain amount of power in the organization (Pfeffer & Salancik, 1978). The amount of power thus coupled with the individual/individuals is “[proportional] to the organization’s need for resources or performances which that element can provide and [inversely proportional] to the ability of other elements to provide the same resource or performance” (Thompson 1967, p.30). As tacit knowledge is unique and particularly so at the level of the collectivity it is not easy to replace should a drop out occur (Nahapiet & Ghoshal, 1998). It takes time to develop

1 Interview with Hank Kennyson on November 22, 2001.
tacit knowledge as it links to experiences gained from the partaking in various sorts of operation (Penrose, 1959). Thus, if tacit knowledge is an important element of a particular techno-human routine the possessor/possessors of the knowledge have a strong power position. In the empirical case it seems that the lion’s share of the knowledge needed for the successful manufacturing of cathode plate refers to explicit knowledge as it can be codified. Fourth, by formalizing the cathode plate route UCR step by step picks up on product quality as to the manufacturing of cathode plate, i.e. the gap concerning product quality is gradually reduced.

5.5.4 The merger episode: legitimizing cathode plate business from the outside

Eight years between the mergers, that seems to be the normal merger rate over the last few decades in the Swedish stainless steel industry. In 1984 Avesta AB is formed, in 1992 the Avesta Sheffield Group becomes established, and in the end of year 2000 AvestaPolarit appears. Concerning the merger between Avesta Sheffield and the stainless operations of Outokumpu soon the merger transforms into a pure acquisition as Outokumpu Oyj gradually increases their shares and finally becomes the single owner of the new group.

But how to combine and utilize various production facilities after a merger or a major acquisition has been accomplished? That is actually one of the more important issues to consider. Prior to the merger UCR and the cold rolling unit of OTK had met in competition as to the MEL business, but now after the merger the two had suddenly come together as sister units in a new larger constellation, and implicitly market competition in regard of the MEL account was no more an issue. From now on hierarchical authority determined which would be the manufacturing responsibility of the various units of the group. During spring 2001 it was decided that UCR should shoulder business responsibility for the MEL account, but information is lacking about the precise course of action leading up to this decision and how the decision was announced to the parties concerned. A most obvious effect of the decision, though, was the radical shift (in a positive direction) in attitude of the UCR management concerning the MEL business, a shift that Hank Kennyson recognized with satisfaction but also with a certain portion of surprise. In the meantime, as a result of the work performed by the QA guy – the person that had been appointed the task to restore the cathode plate route less than a year earlier – the manufacturing yield numbers had gradually come up as the cathode plate route was step by step restored. Hank Kennyson’s comment to a shipment performed in the early autumn of year 2001 acknowledges the improvements achieved: “This shipment here has been done using that process, and, we’re quite honest, it is the easiest I’ve ever seen in advance”1.

1 Interview with Hank Kennyson on November 22, 2001.
Here follows some reflections in relation to “the merger episode”. First, the shift in attitude of the UCR management as to the MEL business is a most obvious merger effect. Suddenly people are once again interested in the manufacturing of cathode plate, from the top to the bottom of the organization. It is likely that the management of UCR seriously evaluated the “playroom” that was given to them in the new industrial constellation, while concluding that the customer accounts they were allotted after the merger they had to treat well in order to have a chance to survive as a unit in the new formation.

It seems also that the thin product strategy that was strongly promoted by the UCR management prior to the merger is now replaced by a broader strategy where special grades, added value products, and various sorts of customized solutions are given prominence. And in this broader strategy the MEL account fits in as a much appreciated element. Thus, the ‘strategic intention’ of corporate management of the merged company paves the way for future cathode plate business at UCR; or if looked upon from the perspective of the UCR management: by ‘necessity’ (enforced by corporate management) the UCR unit has to do its best to treat the MEL account well and to fulfil the unit’s obligations as to cathode plate business; or if looked upon from the perspective of the business as such (or those individuals at operational level that are strongly fighting for the business): by ‘chance’ cathode plate business is legitimized from the outside. Thus, depending on which is the perspective chosen the source of change differs. At corporate level it is a matter of ‘strategic intention’, at unit level it is a matter of ‘necessity’ (enforcement), whereas at operational level it is a matter of ‘chance’.

Second, the restoration and refinement of the cathode plate route that was lately realized in the UCR production system made the yield numbers from cathode plate manufacturing increase half way up to the yield numbers valid for standard grades. This was a major breakthrough that finally helped to reduce the two remaining gaps that had resisted any past closure efforts – the gaps in product quality and delivery performance had now become, if not closed, so at least substantially reduced.

5.5.5 Stage 4: Summary discussion

As a result of business interaction during stage 3 UCR and MEL learn about each other, they adapt to each other, and several of the gaps that caused a lot of trouble in the early days of exchange are closed or at least reduced to a manageable level. Although the relationship develops and the parties come closer to each other some gap dimensions seem to resist any closure effort. Thus, as the relationship enters stage 4 there is still an obvious gap in pricing, and although the gaps concerning product quality and delivery performance have decreased a great deal the matching in these dimensions is still somewhat shaky. The four episodes highlighted in the above analysis point at some interesting courses of events in regard to business relationship
development and technological change. In “the lost order episode” the pricing issue is brought into focus and moves towards its final resolution. In “the new strategy episode” and “the cathode plate route formalization episode” product quality goes roller coaster. First the new management of UCR is downgrading cathode plate into a standard product and product quality goes down. Then Kennyson succeeds in activating the “QA guy” to take responsibility for the reestablishment and formalization of the cathode plate route and product quality successively goes up and stays high. And as the issue of product quality gradually approaches a final solution the gap regarding delivery performance goes down. By that all seven gaps representing various sorts of mismatch in the infant UCR-MEL relationship are closed or reduced to a manageable level. However, as the UCR management decides about the new strategic direction they create an additional relationship gap, i.e. a gap concerning goals. In “the merger episode” a strong external force disciplines the UCR management to reorient their strategic direction so that MEL and cathode plate once again become part of the core business of UCR. The business is legitimized from the outside.

To conclude, it takes almost eight years of interaction until the UCR-MEL relationship reaches a condition where business exchange flows smoothly and efficiently, and the “journey” up to this particular condition is all but straight. On the contrary, influence comes from many sources along the route. During stage 4 ‘strategic intention’ is identified in” the new strategy episode” as well as in “the merger episode”, in the former episode at a disadvantage for cathode plate business, in the latter episode at an advantage. When corporate management interferes in cathode plate business in “the merger episode” it is something that happens by ‘chance’ if considered “from within” the cathode plate business. Nobody in the UCR unit can do much about it, and MEL is certainly unable to influence the decision. “The lost order episode” as well as “the cathode plate route formalization episode” involves a certain portion of ‘necessity’, the former as regards pricing, the latter as regards product quality. The episodes show critical moments in the late development of the UCR-MEL relationship. UCR’s power of choice is low. If the unit decides to go for the business with MEL, the issues of pricing and product quality have to be resolved by ‘necessity’. It seems that the course of events appearing during stage 4 is influenced by various sources of change. ‘Strategic intention’, ‘chance’, and ‘necessity’ show up as influential sources, but most episodes also involve a certain amount of ‘emergent developments’ as the various actors involve in interaction.

It is interesting to note that uncertainty about product customization – the issue that was in focus in the early days of the UCR-MEL relationship – reappears in “the lost order episode”, but in this episode it is OTK’s manufacturing ability that is put in focus. OTK and NEM are both certain about the capability of OTK to produce high quality cathode plate by employing OTK’s standard operating procedures. MEL, ASX, and UCR are more uncertain about the appropriateness of OTK’s standard procedures
for the manufacturing of high quality cathode plate. The outcome shows up to be reasonably good, or as MEL concluded: “it was a pretty good shot for the first time they produced this material”\(^1\).

Finally a few words about the formalization of the cathode plate route. In order to establish the route in writing first the “QA guy” has to collect all existing data about the route, data that, after the latest reorganization, are “hiding in various corners” of the UCR organization. Then, the data collected have to be validated by way of manufacturing practice. In order to further refine the route thus established complementary data have to be collected and additional tests and validation by way of manufacturing have to be carried out. It takes the man a year to pin down all information and restore the cathode plate route. In this instance it is interesting to note that this is the first serious attempt ever done to collect and codify the accumulated knowledge residing in the UCR organization as regards cathode plate manufacturing. And then one should take into account that UCR and MEL have already involved in business exchange with each other for seven years when the task is fulfilled. It is true that some fragmentary documents addressing quality control had been compiled at an earlier point in time, and it is also true that the production manager in the beginning of 1997 had announced that a reasonably safe process route had now been established for cathode plate manufacturing, but comprehensive documentation was still lacking. When the “QA guy” establishes the entire cathode plate route in writing (as far as concerns the manufacturing at UCR) the process of technological change, as part of business exchange between UCR and MEL, approaches its further end. However, the set of procedures developed in writing concerning the manufacturing and monitoring of cathode plate do not give the full picture. For the procedures to function smoothly and efficiently in practice, the explicit knowledge captured in the documents have to be filled out by tacit knowledge, and that kind of knowledge resides in the minds of those activating the technological artefacts and the techno-human routines constituting the tangible part of the cathode plate route.

### 5.6 Conclusive summary

The analyses of business evolution and technological change as performed above address collective actors in an international, industrial system. Four sources of change have been identified, viz. ‘strategic intention’, ‘emerging developments’, ‘chance’, and ‘necessity’. It is claimed that ‘necessity’ and ‘chance’ both represent conditions where the actor power of choice is non-existent or even negative (the ‘necessity’ case). It is also contended that ‘emergent developments’ derive from everyday business operations where the actors involve in exchange with each other. As exchange parties go on interacting the “gap reducing mechanism” operates at the core of relationship development and as a result sometimes long-term cooperative relationships establish.

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\(^1\) Interview with Hank Kennyson on November 22, 2001.
Interaction framed by such relationships is often markedly institutionalized implying that the parties take for granted what to do and how to react. In this type of business context more often change appears to be incremental although at times radical change may occur. The empirical case involves mergers and major industrial investments creating radical change and discontinuity. However, phenomena of the kind do not easily lend themselves to analysis by the employment of the “gap reducing mechanism” model. As ‘proximity’ is introduced an analytical tool is developed underpinning the analysis of prevailing conditions appearing in the wake of radical change. Considering various proximities may inform managerial interests and academic scholars alike.

As focus of the above analyses have been on collective actors and their interaction, so far the social dimension has been put at a disadvantage. The research question of the thesis goes: “How does technological change come about in an international, industrial system?” By more closely emphasizing the social dimension in the coming analyses a richer and more comprehensive answer can be given in response to the research question, it is argued. And that is the kind of analyses to be carried out below.
6 ORGANIZATIONS AND SOCIAL STRUCTURE (THEORY)

Collectivities of people performing joint activities have been given different names in the academic literature. In economics they are commonly referred to as ‘firms’, whereas in the field of social sciences they are denoted ‘organizations’. Several central themes concerning the formation and behavior of collectivities, most of them found in the tradition of organization theory, are discussed. The development of a conceptual framework for use at micro level completes the chapter.

6.1 The managerial view of the firm

With the advent of managerial economics\(^1\) as a field of science in the mid 20\(^{\text{th}}\) century the neoclassical view of the ‘firm’ is extended to capture also managerial aspects (Dean, 1951). This extended view of the firm comprises the assumption that firms are instrumental vehicles that can be fully controlled by management. By its close connection to business practice the managerial view of the firm soon becomes broadly adopted and nowadays it is likely to serve as the most common description of the firm. At least there are strong indications pointing in that direction, as in contemporary society a widely held conception seems to be that organizational life, technological development and business performance can be fully controlled from within organizations, and that decisions made by management, if properly activated by subordinates, carry enough quality to regularly bring about desired ends. Why otherwise should salaries and bonuses of top executives and upper-level managers skyrocket? Since long managerial potency has been strongly emphasized in the popular management literature where even complex enterprise operations and business exchange activities can be perfectly planned in advance, be controlled in detail throughout the phase of execution, and, thus, can be realized into given ends according to plan (cf. Furusten, 1995).

6.1.1 A contemporary view of the firm in managerial economics

The view of the firm as depicted above recurs in a recent article written by Clifford W. Smith Jr.\(^2\), a scholar in the tradition of managerial economics. Smith gives an account of “the business environment as exogenous, or beyond the managers’ control. By contrast, business strategy and organizational architecture are endogenous variables –

\(^{1}\) The area of ‘managerial economics’ was developed in the late 1940s and the early 1950s by several scholars, who translated abstract theories of economics into ready-to-use principles of business practice. Joel Dean articulates his views on the concept in his classic textbook *Managerial Economics* published in 1951 (Sheth, et.al., 1988, p.96).

\(^{2}\) The article is based on remarks given by Clifford W. Smith Jr. at the 2000 meeting of the Southern Finance Association (SFA), USA, where Smith was awarded Distinguished Scholar for 2000. The article “Organizational architecture and corporate finance” was published in *The Journal of Financial Research*; Tempe; Spring 2001.
that is, they are policy choices made by the management in response to the business environment.” (Smith, 2001, footnote 4). The statement echoes Chandler’s (1962) well-known proposition that environment sets the tone for strategy, which in turn determines organizational design. While outlining the concept of organizational architecture Smith refers to a book1 of his own and colleagues.

In Brickley, Smith, and Zimmerman (2001), we apply the term organizational architecture to refer to three key aspects of the firm: (a) the assignment of decision rights within the organization, (b) the structure of systems to evaluate the performance of both individuals and business units, and (c) the methods of rewarding individuals. (Smith, p.1)

The author claims these three features to be regularly identified in economics and management literature on organizational design. It is consistent with agency theory focusing upon the principal-agent contractual relationship (Berle & Means, 1932; Alchian & Demsetz, 1972; Jensen & Meckling, 1976). Concerning the issue of how to control human behavior Smith proceeds:

[I] believe that in the context of managerial making, economics is particularly useful. Managers frequently are interested in fostering changes in behavior. ... In contrast to other models of behavior based on psychology or sociology, economics not only provides a theory of how individuals make choices, it also offers concrete guidance on how to alter behavior. Economics emphasizes that individuals respond to incentives. Thus, desired behavior can be encouraged by lowering relevant costs or increasing the perceived benefits facing the decision maker for undertaking desired actions. (Ibid. p.2)

The picture sketched assumes man to be at the same time utility seeking and rational, both prerequisites making organization design and development an engineering task. The view coincides with Philip Selznick’s (1957) description of the ‘administrative organization’:

The organization thus designed is a technical instrument for mobilizing human energies and directing them toward set aims. ... All this is conceived as an exercise in engineering; it is governed by the related ideals of rationality and discipline. ... It refers to an expendable tool, a rational instrument engineered to do a job. (p.5)

6.1.2 The rationality of ‘economic man’

The conception of the firm as an “instrumental tool” ready at any time to make service at rational perfection is “economic man” clustered into organizational format, a hierarchical construct saturated with formal rules and procedures. There is a long tradition fostering people along this typically rationalistic line of thought. Already with Adam Smith (1776) and his “division of labor” in the 18th century problems relating to work task organization and activity coordination became relevant themes of

investigation. According to classical economics ‘economic man’ was supposed to behave rationally, regularly and predictably.

Neo-classical microeconomics evolving during the late 19th and early 20th century sustained the conception of man’s behavior as entirely rational and predictable. Conceptually the firm was considered a rationally managed production function. Frederick W. Taylor (1911) developed the concept of “scientific management” while offering firms rational methods for work task organization and control, methods compatible with the prevalent view of the firm. Most attempts to explain the existence of firms have ascribed the owner and/or the professional manager the governing role of the firm (e.g. Knight, 1921; Berle and Means, 1933; Coase, 1937; Penrose, [1959] 1995; Alchian & Demsetz, 1972; Williamson, 1975; Hennart, 1982, Porter, [1980] 1998, 1985). Along this line of thought the argument is strong for a positive correlation between hierarchical structure and power distribution within the firm. Sympathetic with this idea is the conception that outcomes can be predicted in advance, i.e. by carefully planning and controlling the activities of the firm goals will be safely and regularly achieved.

6.1.3 Criticism of the view of the firm in economics

The dynamic element of business is largely omitted in the tradition of economics.¹ Neither is the human nor the social part of economic activity considered. The science of economics is markedly under-socialized (Granovetter, 1985). Originally the firm in economic theory was considered nothing but a production function. To the “production function” was later added the “managerial function” assigned responsibility to administer and control the production function. But “[t]he innovating, multi-product, ‘flesh-and-blood’ organizations that businessmen call firms” (Penrose, [1959] 1995, p.13) are recognized neither by orthodox nor by managerial economics. The managerial view of the firm describes the firm as an instrumental or administrative organization, a hierarchical coordination system obedient to commanding rules. Both the orthodox and the managerial view of the firm suffer from unrealistic simplifications. “The ‘Firm’ is not a Firm” (ibid.) – Penrose’s criticism is still most valid. And the criticism indicates that there is still much more to say about the “islands of conscious power” once observed by D.H. Robertson².

6.2 Organizations and institutions

An organization is ”a group of people that has a more or less constant membership” (Webster’s Dictionary, [1961] 1993). With reference to the above discussion it seems

¹ There are exceptions, though. Evolutionary theorists Nelson and Winter (1982), for example, build a set of theories addressing the phenomenon of economic change while borrowing elements from behavioral science.

² See section 4.1 above.
that the firm and the organization are two entirely different phenomena. While the firm is basically considered a production function the organization is looked upon as a particular group of people, namely those in possession of membership (Ahrne, 1994), or, differently expressed, those contributing to the survival of the organization (Barnard, [1938] 1968; March & Simon, 1958; Cyert & March, [1963] 1994; Pfeffer & Salancik, 1978).

Commonly organizational survival does not depend on chance but on purposeful action, which, in case operations involve several individuals, raises demand for some kind of coordination. And coordination usually has to be orchestrated. Only in exceptional cases self-regulation at the level of the individual is a viable means of coordination, but that solution to the problem of coordination is applicable, most likely, only if the number of participants is small. That the purposeful coordination of collective action requires some kind of authoritative force was early observed by Max Weber ([1922] 1978), who ascribes meaning to the concept of organization by referring to the interrelationships between domination, legitimacy and obedience.

A circle of people who are accustomed to obedience to the orders of the leaders and who also have a personal interest in the continuance of the domination by virtue of their own participation and the resulting benefits, have divided among themselves the exercise of those functions which will serve the continuation of the domination and are holding themselves continuously ready for their exercise. (This is what is meant by “organization”.) (p.952)

Conceptually both the firm – at least the view of the firm as it appears in managerial economics – and the organization involve as a central component some kind of authoritative force directing joint action of the collectivity. A major difference between the two concepts, though, is that the former is looked upon as an economic entity whereas the latter is considered a social entity.

A study of organizations by necessity involves considerations about institutions and processes of institutionalization. According to Meyer et al. (1987 p.36) ”an institution is first of all a set of cultural rules that may regulate social activities in a patterned way”. Czarniawska and Sevón (1996, pp.3-4) write: “Institutions can be thus defined as collections of stable rules and roles, and corresponding sets of meaning and interpretations.” Institutions develop through social interaction. Organizations are the more “tangible” representation of institutions (Ahrne, 1994, pp.4-5).

6.2.1 Early contributions to institutional theory

The earliest institutional arguments within the field of economics refer back to the famous ”Methodenstreit” in Germany in the late 19th century. A group of economists challenged the common view of man of that time, the “economic man”, a rational, utility-seeking creature. The challengers, led by Gustav Schmoller, ”insisted that economic processes operated within a social framework that was in turn shaped by a
set of cultural and historical forces” (Scott, 1995, p.2). The principal defender of the classical school, Carl Menger, “insisted on the utility of simplifying assumptions and the value of developing economic principles that were both abstract and timeless” (ibid.). The basic reason for the institutional approach to evolve was a discontent with the classical school of economics, which exhibited, it was argued, an obvious mismatch between theory and real world phenomena.

Emile Durkheim and Max Weber were early contributors to institutional theory in sociology. Initially Durkheim upheld an instrumental approach while contending that social order could be successfully negotiated by individuals, i.e. he saw social order as “the unintended aggregate of individual self-interest” (Scott, 1995, p.9 with reference to Alexander, 1983b, pp. 131, 134). Later he revised his view to focus on a collective normative framework that supplies “the noncontractual elements” of contract (Durkheim, [1893] 1949, book 1, chap. 7). His mature view was that symbolic systems such as systems of knowledge, belief, and ”moral authority” are social institutions (Scott, 1995, p.10).

Institutions, Durkheim writes, are a product of joint activity and association, the effect of which is to “fix”, to “institute” outside us certain initially subjective and individual ways of acting and judging. Institutions, then, are the “crystallations” of Durkheim’s earlier writing. (Alexander, 1983a, p.259)

Weber’s contribution to early institutional theory is extensive and his impact on the work of more recent institutionalists such as Talcott Parsons and Robert Merton and their successors is substantial. But at the time period of Weber’s active writing the word ‘institution’ had not yet been institutionalized. It had not yet become a broadly accepted concept in the scientific community dealing with social theory.

Although Weber did not explicitly employ the concept “institution”, his work is permeated with a concern for understanding the ways in which cultural rules, ranging in nature from customary mores to legally defined constitutions or rule systems, define social structures and govern social behavior, including economic structures and behavior. (Scott, 1995, pp.10-11)

Weber saw action as socially based ”when and in so far as the acting individual attaches a subjective meaning to his behavior” (Weber, [1922] 1978, p.4). In his Wirtschaftssoziologie he attempted to bridge the chasm that had arisen in the Methodenstreit (and which had never been reconciled) by attending to both historical circumstance and developing analytic theory (Scott, 1995, with reference to Swedberg, 1991). Another early figure deserving attention is Charles Horton Cooley who emphasized the interdependency between self and social structure. ”The individual is always cause as well as effect of the institution” (Cooley, [1902] 1956, p.314).2

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1 The theme is discussed also by Granovetter (1985).
2 It is close at hand to think about Anthony Giddens “Theory of Structuration” (Giddens, 1984) when reflecting upon Cooley’s thesis.
In sociology institutional theory has been under continuous development without interruption since the early work of Durkheim and Weber, while in economics and political science other theoretical bodies gained prominence during the latter part of the first half of the 20th century.

6.2.2 “The three pillars of institutions”

In different time settings and in different scientific contexts the concept of institution has been assigned somewhat different meanings. Scott (1995) offers a comprehensive model that categorizes institutions into “three pillars”, i.e. the regulative, the normative and the cognitive pillar.

The regulative pillar (p.35):

Institutions constrain and regularize behavior. Scholars supporting this pillar are distinguished by the prominence they give to explicit regulative processes – rule-setting, monitoring, and sanctioning activities. In this conception, regulative processes involve the capacity to establish rules, inspect or review others’ conformity to them, and as necessary, manipulate sanctions – rewards or punishments – in an attempt to influence future behavior. These processes may operate through diffuse, informal mechanisms, involving folkways such as shaming or shunning activities, or they may be highly formalized and assigned to specific actors, such as the police or the courts.

Economists, including economic historians, are particularly likely to view institutions as resting primarily on the regulative pillar.

The normative pillar (pp.37-38):

Emphasis here is placed on normative rules that introduce a prescriptive, evaluative, and obligatory dimension into social life. Normative systems include both values and norms. Values are conceptions of the preferred or the desirable together with the construction of standards to which existing structures or behavior can be compared and assessed. Norms specify how things should be done; they define legitimate means to pursue valued ends. Normative systems define goals or objectives … but also designate the appropriate ways to pursue them …

Some values and norms are applicable to all members of the collectivity; others apply only to selected types of actors or positions. Such specialized values and norms are termed roles: conceptions of appropriate action for particular individuals or specified positions.

The normative conception of institutions is held by a large number of sociologists and by many political scientists as well.

The cognitive pillar (p.40):

[p]rincipally anthropologists … and sociologists … stress the centrality of cognitive elements of institutions: the rules that constitute the nature of reality and the frames through which meaning is made.

Symbols – words, signs and gestures – have their effect by shaping the meanings we attribute to objects and activities. Meanings arise in interaction and are maintained –
and transformed – as they are employed to make sense of the ongoing stream of happenings. Emphasizing the importance of symbols and meanings returns us to Weber’s central premise. … Weber regarded social action as action to which subjective meaning is attached. To understand or explain any action, the analyst must take into account not only the objective conditions but also the actor’s subjective interpretation of them.

Based on the three pillars Scott (1995) formulates what he denotes an “omnibus definition of institution”:

Institutions consist of cognitive, normative, and regulative structures and activities that provide stability and meaning to social behavior. Institutions are transported by various carriers – cultures, structures, and routines – and they operate at multiple levels of jurisdiction. (p.33)

Appreciating the social dimension of organizations and the existence of institutions is recognizing that humans for various reasons not always conform to formal rules and hierarchical order but now and then adhere to other prescriptive directives including their own ideas and various interpretations of the external world. It means that values, norms and conceived meaning make up a viable ground for action. By developing, sharing and defending common values and norms organized individuals are the carriers of an organization’s particular social substance, the culture component of the organization. It is certainly true that organization members and firm employees to a certain degree obey to the commanding rules set forth by their leaders but it is also true, no doubt, that they obey to rules of other origin as well. Thus, it seems that institutionalized organizations to a certain extent live their lives beyond formal managerial control.

6.2.3 The organization: instrumental or institutional?

In his article “The unanticipated consequences of purposive social action”, published in 1936, sociologist Robert Merton challenged the rational principal of managerial activity and in an essay from 1940 he discusses the phenomenon of officials that obey to rules ”to the point where primary concern with conformity to the rules interferes with the achievement of the purposes of the organization” (Merton, [1940] 1957 p.199). Both contributions raise inquiries about the rational functioning of organizations. After Max Weber’s most important writings had been translated into English during the late 1940s Merton revived his interest in studying bureaucracies and bureaucratization.\(^1\) At Columbia University he gathered around him a group of

\(^1\) Here it would have been appropriate to elaborate Max Weber’s indispensable contribution to the understanding of the rational-legal type of organization denoted bureaucracy (Weber, [1922] 1978, chapter XI), but I refrain from doing so in detail. However, this rationalistic type of organization, largely omitting the social aspect of human action, closely relates to the view of the firm later appearing in managerial economics (see section 6.1.1). Weber writes: “Bureaucracy is the means of transforming social action into rationally organized action. Therefore, as an instrument of rationally organizing authority relations, bureaucracy was and is a power instrument of the first order for one who controls the bureaucratic apparatus.” (ibid., p.987). Weber’s ideal model of bureaucracy comprehends five main components; 1) division of labor, 2) centralization of influence, 3) rules and
students who performed a series of empirical studies on organizations (Scott, 1995, p.17). One of his students, Philip Selznick, gives a detailed description of the process of institutionalization:

Institutionalization is a process. It is something that happens to an organization over time, reflecting the organization’s distinctive history, the people who have been in it, the groups it embodies and the vested interests they have created, and the way it has adapted to its environment. ... In what is perhaps its most significant meaning, “to institutionalize” is to infuse with value beyond the technical requirements of the task at hand. (Selznick, 1957 pp.16-17)

Selznick distinguishes between the administrative organization and the institution (the institutionalized organization):

"The most striking and obvious thing about an administrative organization is its formal system of rules and objectives. Here tasks, powers, and procedures are set out according to some officially approved pattern. ... The organization thus designed is a technical instrument for mobilizing human energies and directing them toward set aims. ... The term “organization” thus suggests a certain bareness, a lean, no-nonsense system of consciously coordinated activities. It refers to an expendable tool, a rational instrument engineered to do a job. (Ibid. p.5)

An “institution”, on the other hand, is more nearly a natural product of social needs and pressures - a responsive, adaptive organism. ... Institutions, whether conceived as groups or practices, may be partly engineered, but they have also a “natural” dimension. They are products of interaction and adaptation; they become the receptacles of group idealism; they are less readily expendable. (Ibid. p.5 and pp.21-22)

Selznick’s approach refers to historical events for explaining the emergence of institutions. In contrast with Merton, who studied general characteristics of the group of organizations labeled bureaucracies (rational-legal organizations), Selznick’s interest was in the institutionalization patterns of specific organizations. His description of the “administrative organization” reflects the formal part of the organization while his “institution” conforms to those values that are infused into the organization as it persists and evolves over time. Such values are infused as members of the organization interact with each other and with counterparts in the external environment while aiming at solving problems and seeking satisfaction.

According to Selznick the informal characteristics of an organization is the result of social interaction but they may as well be consciously engineered. He claims that “the more precise an organization’s goals, and the more specialized and technical its operations, the less opportunity will there be for social forces to affect its development” (ibid. p.16), i.e. the less room there will be for the organized individuals’ own ideas and interpretations. Selznick’s view fits in nicely with that of

directions, 4) impersonality, and 5) written documentation (Sjöstrand, 1978, p.101-102; translation from Swedish by the thesis author).

1 This particular tradition in organization theory that was developed by Merton and those working with and around him has been denoted “the Columbia School”.
Merton, who saw “unanticipated consequences of purposive social action”. The message is that a variety of forces impact upon the development of an organization. Some forces are internal as those emanating from the leaders and other members of the organization, whereas other forces are external as those coming from counterparts with which the organization and its various members are dealing. Moreover, some forces are openly recognizable whereas others are hidden. The underlying “logic” for action may vary as well from rational to institutional and some forces do operate along formal lines of organization whereas others operate along informal lines.

6.3 An open-system view of organization

The early institutionalists were mainly interested in explaining the interrelationship between individuals and society whereas little attention was given to the institutional aspect of organizations. According to James March in “Handbook of Organizations” (March ed., 1965, p.xiii) a small number of works published over a few years around 1940 makes up the platform for organization theory as a distinct field of study, i.e. Barnard (1938), Roetlishberger and Dickson (1939), and Simon (1945). Traditions preceding these works saw Max Weber (sociology) and John Commons (economics) as important contributors.

6.3.1 Uncertainty, bounded rationality and institutionalized behavior

With Herbert Simon and those adopting his ideas about “bounded rationality” (the Carnegie School) a new perspective on micro features and functions of institutional forms was established. His nowadays broadly accepted description of “administrative man” builds on the assumption of bounded rationality, i.e. because of the delimited capacity of man to gather and process information his decisions and actions always involve a residual element of uncertainty. As man acts from an incomplete base of information his actions can be nothing but boundedly rational. Rationality is circumscribed due to lack of information. Simon ([1945] 1997) emphasizes that value assumptions, cognitive frames, rules and routines support rational behavior in organizations, albeit rationality is bounded. He claims: “The rational individual is, and must be, an organized and institutionalized individual” (p.111). March and Simon (1958) put forward that “search and choice processes are very much abridged ... Most behavior, and particularly most behavior in organizations, is governed by performance programs” (pp.141-142). The essence of the message is that existing rules and procedures to a large extent govern organizational behavior.

Subsequent work by Cyert & March ([1963] 1994) amplifies the impact of standard operating procedures (SOP) on behavior while maintaining that SOPs are the result of conflict resolution involving various groups of an organization. The authors make the general assumption that organizations are marred by conflicts about goals and expectations and that organizational learning closely relates to the process of search
and choice. Programs, routines, and procedures result from negotiations in which individuals play different roles. It means that such procedures are the outcome of social processes, i.e. “those in which the action is a part of the system of actions of two or more men. Its most common form is verbal communication”. (Barnard, [1938] 1968, p.20). It follows that programs, routines, and procedures consist of stable, agreed upon rules organized into patterns. Such rule patterns make up the basis for institutionalized behavior. Evolutionary theorists Richard Nelson and Sidney Winter (1982) draw heavily upon the idea of routinized behavior while referring to Cyert and March ([1963] 1994). Winter (1990) is particularly innovative using the metaphor ‘routines as “genes” of organization’.

6.3.2 The organization and the environment

Talcott Parsons refers the institutional characteristics of an organization to its connections with the external world. He claims that the organization’s value system is legitimatized by “the main institutional patterns” in “different functional contexts” (Parsons, [1956] 1960, p.20) and that institutionalization is a process through which shared norms are internalized. Internalization occurs both at the level of the organization and that of the individual. Parsons contends that organizations are vertically differentiated into three fairly distinct layers, the technical, the managerial and the institutional. The technical layer concerns production activities, the managerial is about control and monitoring of coordination activities including the handling of input and output, and the institutional layer concerns the organization’s connections to the external environment, i.e. the society as such, its conventions and culture. (Scott, 1995, pp.20-21)

Thompson (1967) adopts Parson’s categorization when formulating his set of propositions about the behavior of organizations operating, as he expresses it, “under norms of rationality”. Thompson’s view on rationality conforms to that of the Carnegie school - Simon-March-Cyert1 - assuming that rationality is circumscribed by uncertainty. In this view the organization appears as a “problem-facing and problem-solving phenomenon” (Thompson, 1967, p.9). Rationality is bounded. Decisions are taken from an incomplete base of information. Information gathering involves processes of searching and learning.

In this view, the organization has limited capacity to gather and process information or to predict consequences of alternatives. To deal with situations of such great complexity, the organization must develop processes for searching and learning, as well as for deciding. (Ibid, p.9)

The assumptions about uncertainty, bounded rationality and processes of searching, learning and deciding are important points of departure for Thompson’s work and in this setting profit maximization cannot on rational grounds be defended as an

1 Simon (1945), March and Simon (1958), and Cyert and March (1963).
organizational goal, as the full range of alternative choices are never fully known. That implies Thompson retreats from the one-to-one application of the rational model of organization\(^1\).

By bringing together the Parsonsian pattern of organizational differentiation - the differentiation of the organization into three layers, i.e. the technical, the managerial and the institutional layer - and the view of the organization as a more or less open (or a more or less closed) system\(^2\), Thompson develops a model for rational decision-making in organizations operating in environments characterized by uncertainty and contingency. He basically appreciates the open-system view of organization but emphasizes the necessity of protecting the technical core from undesired influence from external forces.

As we suggested the logical model for achieving complete technical rationality uses a closed system of logic – closed by the elimination of uncertainty. In practice, it would seem, the more variables involved, the greater the likelihood of uncertainty, and it would therefore be advantageous for an organization subject to the criteria of rationality to remove as much uncertainty as possible from its technical core by reducing the number of variables on it. Hence if both resource-acquisition and output-disposal problems – which are in part controlled by environmental elements and hence to a degree uncertain and problematic – can be removed from the technical core, the logic can be brought closer to closure, and the rationality, increased. (Ibid. p.12)

It is obvious that Thompson finds it unproductive to conceive of an organization as a fully closed system. With reference to Emerson (1962) he states that “an organization is dependent on some element of its task environment (1) in proportion to the organization’s need for resources or performances which that element can provide and (2) in inverse proportion to the ability of other elements to provide the same resource or performance” (p.30\(^3\)). Thus, Thompson looks upon the organization as a semi-closed (or semi-open) system, a system that accepts and even appreciates a certain impact from external forces but where the forces are treated in such a way by the system that they do not negatively impact upon its technical core. By and large it is a management perspective on organizing and organization although uncertainty and unpredictability are appreciated. It involves some kind of “discriminating door-keeper”

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\(^1\) Thompson (1967) refers the rational model to three major lines of thought presented in the literature about organizations. He writes: “Whether we consider scientific management (Taylor, 1911), administrative management (Gullick and Urwick, 1937), or bureaucracy (Weber, [1924] 1947), the ingredients of the organization are deliberately chosen for their necessary contribution to a goal, and the structures established are those deliberately intended to attain highest efficiency” (pp.4-5).

\(^2\) The open-system view appreciates that “external” forces influence the organization whether such forces emanate from informal organization structures from within (“sentiments, cliques, social controls via informal norms, status and status striving, and so on”) or from “true” environmental forces from without the organization. This view acknowledges the existence of uncertainty and unpredictability. The closed-system view on the other hand is equivalent with a determinate system where uncertainty is reduced to zero and influence from “external” forces, if existing, are altogether predictable. (Thompson, 1967, p.4 ff.)

\(^3\) “[t]hose parts of the environment which are ‘relevant or potentially relevant to goal setting and goal attainment’” William Dill (1958) denoted task environment (Thompson, 1967, p.27).
assigned the role of rejecting (if possible) undesired influence from without. The essence is that environmental influence on the organization can be accepted up to a point where the rational operation of the technical core remains in place.

6.3.3 Organizational design and the handling of information

Thompson (1967) identifies two task environment dimensions that he finds crucial to organizational design, i.e. the homogeneous-heterogeneous continuum and the stable-shifting continuum, and he recommends the establishment of boundary-spanning units to handle environmental heterogeneity and dynamism.

The more heterogeneous the task environment, the greater the constraints presented to the organization. The more dynamic the task environment, the greater the contingencies presented to the organization. Under either condition, the organization seeking to be rational must put boundaries around the amount and scope of adaptation necessary, and it does this by establishing structural units specialized to face a limited range of contingencies within a limited set of constraints. The more constraints and contingencies the organization faces, the more its boundary-spanning component will be segmented. (p.73)

Thompson refers to March and Simon (1958), who “predict that process specialization will be carried furthest in stable environments, and that under rapidly changing circumstances specialization will be sacrificed to secure greater self-containment of separate programs.” Population ecologists Hannan and Freeman (1977) support the idea. With reference to Penrose (1959) and Cyert and March (1963) they identify the existence of organizational “slack” as a manifestation of a generalist approach and as they do they maintain that increasing “slack” inevitably leads to decreasing efficiency (ibid., p.949). It seems clear that complexity is basically perceived as an information-handling problem related to size of operations, market heterogeneity, and market dynamism. Expanding operations may not add complexity per se but may imply that operations become more multiple by the addition of new products, new markets, or new technologies. It follows that an enterprise performing extensive multinational business while facing a highly heterogeneous and dynamic environment is living a very complex business life.

It is reasonable to assume that the larger the company the more extensive the amount of information that has to be gathered, processed and understood. And it is equally reasonable to assume that the growing company encounters growing costs for information handling but also that the quality of information may deteriorate with growing size. Several solutions to this dilemma have been proposed. Penrose ([1959]

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1 Thompson (1967, p.73) quoted from March and Simon (1958, p.159).
2 Bartlett (1932) made the observation that “serial reproduction [of information] brings about startling and radical alterations in the material dealt with. Epithets are changed into their opposites; incidents and events are transposed; names and numbers rarely survive intact for more than a few reproductions; opinions and conclusions are reversed – nearly every possible variation seems as if it can take place, even in a relatively short series. At the same time, the subjects may be very well satisfied with their
1995, p.55) contends that decentralization, specialization and knowledge development are means to come to grips with managerial diseconomies. The multidivisional form of business organization (the M-form) has been proposed as a solution to the information-handling problem (Chandler, 1962; Williamson, 1971).

The M-form originated in the United States in the 1920s but did not proliferate until after 1950. Large-scale organizations formed divisions in order to economize on the high costs of information needed to manage the complexity of diverse product lines, extensive markets, and diverse technologies. (Johnson, 1992, p.22)

Burns and Stalker (1961) “identified two types of organization - organic and mechanistic. ... The mechanistic form was effective in stable markets, while the organic was effective in rapidly changing markets and technologies” (Galbraith, 1973, p.2). The former links to a closed-system strategy whereas the latter fits in with an open-system strategy. In 1967 Lawrence and Lorsch launched their “contingency theory of organization”, which comprises the idea that contingencies in an organization’s environment impact upon organizational design. The authors’ build their theory from two important aspects of the functioning of systems:

First, as systems become large, they differentiate into parts, and the functioning of these separate parts has to be integrated if the entire system is to be viable.
Second, an important function of any system is adaptation to what goes on in the world outside. (Lawrence & Lorsch, 1967, p.7)

Different parts of an organization encounter different parts of the environment. They also take on the responsibility of performing different subtasks. It is quite obvious that such a fragmented system easily runs into conflicts about goals, priorities, means, etc. and it is reasonable to maintain that any differentiated system is in need of coordination. Lawrence and Lorsch (1967) criticize early organization theorists for believing “that integration is accomplished through an entirely rational and mechanical process” (p.12). Their opinion is that integration can be achieved in various ways and they point out four integrating devices: (1) managerial hierarchy, (2) integrating committees and teams, (3) routine control and scheduling procedures, and (4) integrating activity carried out by individual managers outside official channels. They also mention “interpersonal skills required to achieve integration” and “trust among the parties, which results in more effective problem solving”. Their focal question is:

**efforts, believing themselves to have passed on all important features with little or no change, and merely, perhaps, to have omitted unessential matters” (p.175). Basically Williamson (1970) refers to the same mechanism when contending that the demand for organizational efficiency puts a further limit to company size. The passing on of information successively from one hierarchical level to another makes information become more and more distorted and the more distorted the information the higher the costs for coordinating activities within the boundary of the firm. The argument is central both in transaction cost economics and in internalization theory (e.g. Hennart, 1982). The issue can also be related to Weick’s ([1969] 1979) discussion about the process of enactment, which encompasses the idea that a person’s conception of the outside world is a merger product deriving from two simultaneously ongoing processes, the process of perceiving and that of creating. Current perceptions are processed along with stored conceptions from the past (memories) following some kind of rational (logic). Missing pieces in the current inflow of data are compensated for by logic reasoning and by the recycling of old material judged as suitable for the purpose.**
“how can integration be facilitated without sacrificing the needed differentiation?” (ibid., p.13). Lawrence and Lorsch’s view of the organization-environment relationship is similar to that of Thompson (1967). Both point at contingencies in the environment influencing organization design and behavior and both propose solutions aiming at strengthening the viability of the organization although the strategies proposed are somewhat different.

Jay Galbraith (1973) effectively clarifies his theoretical base by announcing:

The author finds himself in a school labeled as contingency theory. This theory is based on two conclusions drawn primarily from large-scale empirical studies.

1. There is no best way to organize
2. Any way of organizing is not equally effective (p.2)

Deeply rooted in contingency theory and the issues of differentiation and integration Galbraith develops a model for organizational design in which the problem of handling information is central. He maintains that “the greater the task uncertainty, the greater the amount of information that must be processed among decision makers during task execution in order to achieve a given level of performance” (p.4). Galbraith proposes four organizational solutions in relation to the information-handling problem: (1) the creation of slack resources - what you can’t afford to do today you postpone until tomorrow, (2) the creation of self-contained tasks – divisionalization/creation of the M-form of organization, (3) the investment in vertical information systems - increasing information gathering and computation efficiency by investing in information systems, and (4) the creation of lateral relations – establishing direct contact, liaison roles, task forces or teams in an existing organization or creating a full-blown matrix organization. The first two solutions reduce the need for information processing whereas the third and the fourth both increase the organization’s capacity to process information. If no particular solution is deliberately selected the growing organization will finally end up in a position of using slack resources, i.e. if appropriate actions are not taken additional time will be used and task completion will be postponed.

Scholars such as Talcott Parsons, James Thompson, Tom Burns, George Stalker, Paul Lawrence, Jay Lorsch, Jay Galbraith and others challenge the all-rational model of organizing building on the closed-system strategy. They all appreciate the inevitable impact of environmental forces on the structure and behavior of organizations. To exemplify, when elaborating the managerial layer and the institutional layer of organization Thompson (1967) writes (with reference to Parsons ([1956] 1960)):

The second level, the managerial, services the technical suborganization by (1) mediating between the technical suborganization and those who use its products – the

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1 It is interesting to note, however, that there is no reference whatsoever to any of James D. Thompson’s former works in Lawrence and Lorsch (1967). Neither is there any reference to any of the works of Paul R. Lawrence or Jay W. Lorsch in Thompson (1967). This is somewhat surprising, as all three scholars were published several times prior to 1967.
customers, pupils, and so on – and (2) procuring the resources necessary for carrying out the technical functions. (pp.10-11)

Finally … the organization which consists of both technical and managerial suborganizations is also part of a wider social system which is the source of the “meaning”, legitimation, or higher-level support which makes the implementation of the organization’s goals possible. (p.11)

Organization literature appreciating uncertainty and unpredictability as a point of departure commonly nurtures the idea that organizational structure and behavior is shaped, to a larger or lesser degree, by environmental forces and factors. To survive any organization needs the support of at least some receiving and supplying counterparts. If support is withdrawn both the motive and the possibility to go on will disappear.

6.4 Resource dependence, organizational boundaries and external control

6.4.1 A resource dependence perspective

Although Thompson (1967) and others foreshadow a resource dependence perspective the concept is established and clarified by Pfeffer and Salancik (1978). It focuses the importance of getting access to input resources as well as finding an outlet for the products or services created by the organization. An organization incapable of mobilizing enough support from the environment is lacking survival potential. But in a resource dependence perspective the organization is still considered the unit of analysis although its contextual frame has become more visible. Pfeffer and Salancik (1978) raise heavy criticism against practitioners and researchers, who exclusively refer to internal factors when explaining the actions and outcomes of organizations, i.e. those who assume that an organization is an entirely rational and instrumental entity.

Because organizations import resources from their environments, they depend on their environments. Survival comes when the organization adjusts to, and copes with, its environment, not only when it makes efficient internal adjustments. The context of an organization is critical for understanding its activities. Despite considerable pro forma acknowledgement of the environment, managers and researchers continue to attribute organizational actions and outcomes to internal factors. Such attributional processes flow from cognitive and perceptual biases that accompany the observation of organizations, as well as from the desire to view social behavior with a feeling of control. These attributions have led to the neglect and serious underestimation of the importance of social context for understanding organizational behavior. (Ibid, p.19)

Thus, no organization whatsoever is self-sufficient it is claimed. Instead every organization to a larger or lesser degree depends upon its environment for input supply and disposal of output. With reference to Katz and Kahn (1966) the authors support an
open system view of organization. Survival is directly linked to the organization’s ability to acquire and maintain resources.

In accord with Cyert and March (1963) Pfeffer and Salancik (1978) consider the organization to be a coalition of various groups made up of individuals willing to render the organization support. And support is secured, they assume, only if the individuals concerned find that inducements received equal or exceed sacrifices made. “An organization … is viable as long as its available inducements are sufficient to elicit the necessary contributions – in other words, to maintain a viable coalition of support” (ibid. p.25). It is “the balancing of burdens by satisfaction which results in continuance” as Barnard ([1938] 1968, p.57) once wrote, or otherwise expressed, it is the balancing of burdens by satisfaction which results in organizational survival.

6.4.2 The organization as a coalition of individuals

A related issue - of particular importance for this thesis work – is how to draw the boundaries of an organization. Where does one organization end and where does another start? Cyert and March ([1963] 1994) state:

Let us view the organization as a coalition. It is a coalition of individuals, some of them organized into subcoalitions. In a business organization the coalition members include managers, workers, stockholders, suppliers, customers, lawyers, tax collectors, regulatory agencies and so on. … Drawing the boundaries of an organizational coalition once and for all is impossible. Instead, we simplify the conception by focusing on the participants in a particular “region” – either temporal or functional. That is, over a specified (relatively brief) period of time we can identify the major coalition members; or, for a particular decision we can identify the major coalition members. (p.31)

The description is not particularly informative in relation to the concept of organizational boundaries. Some clarification is brought forth as the authors elaborate upon the goal formation process of the organization, a process they conceive of as one of negotiation and bargaining.

[...]there are important reasons for viewing some coalition members as quite different from others. For example, it is clear that employees and management make somewhat different demands on the organization. In their bargaining, side payments appear traditionally to have performed the classical function of specifying a joint preference ordering. In addition, some coalition members (e.g., many stockholders) devote substantially less time to the particular coalition under consideration than do others. It is this characteristic that has been used to draw organizational boundaries between “external” and “internal” members of the coalition. Thus, there are important classes of coalition members who are passive most of the time. (ibid. p.34)

The authors claim that “in a business organization the coalition members include managers, workers, stockholders, suppliers, customers, lawyers, tax collectors, regulatory agencies and so on”. Then they differentiate between “external” and “internal” members of the coalition and recognize only “internal”/active members as
“true” organization members while leaving “external”/passive members outside the “core”. The choice is not bad because critical readers would probably not accept “external” coalition members such as “suppliers, customers, lawyers, tax collectors, [and] regulatory agencies” being “true” members of the organization. The idea of “the more narrow organization” – the one made up of “internal” coalition members only – needing the support of a broader coalition of members seems still highly valid as it is difficult to think of any business organization capable of surviving in a market economy without relating to other parties. Thompson (1967) “adopts the concept of task environment used by Dill (1958) to denote those parts of the environment which are ‘relevant or potentially relevant to goal setting and goal attainment’: … (1) customers (both distributors and users); (2) suppliers of materials, labor, capital, equipment, and work space; (3) competitors for both markets and resources; and (4) regulatory groups, including governmental agencies, unions, and interfirm associations” (pp. 27-28).

6.4.3 Enactment and task environment differentiation

Notifying that an organization “is a coalition of individuals” draws attention to the human dimension of organizing emphasizing such aspects as human conceptions of reality and human preferences. How to conceive of empirical phenomena and what to prefer in a choice situation are basically matters reflecting an individual’s background, taste and way of thinking, or, with reference to institutional theory it would be appropriate to maintain that the individual’s conceptions and preferences derive from his aspirations, values and norms. The idea of differentiation once elaborated by Lawrence and Lorsch (1967) appreciates that “individual managers bring to an organization several motives that they seek to fulfill. Among the most important are a need for achievement, a need for affiliation, and a need for power” (p.17). The need for achievement closely relates to whether the manager possesses the appropriate capability and competence for achieving his work task. The need for affiliation concerns whether he is happy with the social environment at the workplace. The need for power, finally, has to do with whether his need to control others is fulfilled. As environmental demands require that organization members perform their jobs well it is of importance that the organization is structured in such a way that the individual manager\(^1\) experiences that his needs are satisfied. “Thus, if we concern ourselves with understanding what type of organization meets different environmental demands, we will also be confronting the question of developing organizations that offer a high probability of satisfying needs of individuals for achievement and competence” (ibid. p.18).

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\(^1\) Lawrence and Lorsch (1967) focus upon managers in their discussion. Although this employee category is certainly particularly important to any business organization in this thesis work the scope is extended to incorporate also other employee categories.
Pfeffer and Salancik (1978) further develop the idea of differentiation by linking it to the way individuals conceive of their external environment. With reference to phenomenologist Alfred Schutz (1967) and social psychologist Karl Weick ([1969] 1979) the authors contend that through the process of enactment individuals conceive of reality in different ways, i.e. different individuals ascribe one same world situation different content and different meaning. And as an individual’s interpretation of reality affects his or her behavior, different individuals will behave differently in one same situation.

The enactment process comprises two sub-processes, that of perceiving and that of creating. Empirical phenomena as-perceived by the individual (current data) are processed through a filter made up of recreated historic information once evaluated and stored as a memory. Voids and missing pieces are compensated for by innovative creation.1 If considering the “internal” members of an organizational coalition, i.e. the organization as conceived of in a “narrow sense”, it is reasonable to assume that each member, over a particular period of time, collects just a minor share of the entire amount of data that is potentially accessible to the organization as a whole, and, as different members collect different information, it is clear that different members will conceive of the “external” environment in different ways, i.e. each one of them will enact its own view. While quoting Dill (1962, p.97) Pfeffer and Salancik (1978, p.74) writes: “Because of the sheer quantity and diversity of the inputs that are accessible and relevant, no organization is likely to notice or attend to more than a small portion of them.”

The observation directs attention to one of the most important and most difficult managerial problems of any business organization, i.e. the problem of compiling a relevant and coherent picture of the organization’s task environment. There is a lot of literature available approaching this problem, particularly in the field of marketing and management, and when all is said and done it is clear that it is all a matter of securing that the organization’s internal operations are properly adjusted to the prevailing conditions of the environment (or that actions are taken to manipulate those conditions) by searching, storing and analyzing the “right” information. However, if considering that different members of the organization enact the environment (as well as the internal of the organization) in different ways any attempt to establish a relevant and coherent picture of the environment seems to be a kind of “mission impossible”. Rather there will emerge a vast number of environmental pictures inside the organization and some of these pictures will “live” in harmony with one another whereas others involve in conflict.

It is also necessary to recognize that individuals and subgroups within organizations do not access the same environments and that the information they have varies. Individuals and subgroups have their own goals and activities that may bring them into contact with different aspects of the organization’s environment. Thus, it may be more...

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1 Also compare this discussion with the discussion performed in one of the footnotes in section 6.3.3.
reasonable to speak of different environments, attended to or enacted by different individuals and groups within the organization. (Pfeffer & Salancik, 1978, p.74)

6.4.4 The organization as a set of interstructured activities

Cyert and March’s ([1963] 1994) definition proposal to organizational boundaries is actor based focusing upon the demarcation line that distinguishes “external” from “internal” coalition members. Pfeffer and Salancik (1978) offer a different process oriented proposal. Activity performance is crucial to any organization. The creation of wealth grows out of what is being done. Both resource development and resource consumption are the result of activity performance, a fact ascribing the issue of activity control particular importance. As regards organizational boundaries the authors claim that, “the organization ends where its discretion ends and another’s begins” and “the boundary is where the discretion of the organization to control an activity is less than the discretion of another organization or individual to control that activity”. The more precise definition goes: “The organization is the total set of interstructured activities in which it is engaged at any time and over which it has discretion to initiate, maintain, or end behaviors” (ibid. p.32)

To view the organization as a set of interstructured activities that is ending where the discretion to control the activities is ending brings with it some advantages because it focuses on the behavior of individuals and not on the individuals themselves. But as most individuals are usually engaged in more than one collectivity it is possible to talk about degree of membership.

A person’s inclusion in a collective structure can be defined as the proportion of his or her behavior included in that structure, or the amount of the person’s behavior included in that particular behavior structure divided by the total amount of the person’s behavior in all structures. … The organization survives to the extent that the activities included are sufficient for the organization to maintain itself. (Ibid.)

It follows that the behavior of individuals, groups and organizations, as far as it contributes to the survival of a focal organization, and is controlled by the focal organization, is part of the interstructured activities constituting the focal organization. If actor behavior is not controlled by the focal organization it is not part of the interstructured activities constituting the focal organization. A person or a group of persons, legally belonging to a focal organization, may, from an activity control point of view, be included, to a larger extent, in another organization’s set of interstructured activities than in that of the focal organization.

When the social-system boundary problem is approached from the perspective of interlocked or coordinated behaviors, rather than from the perspective of individual participants, much of the ambiguity about where the organization begins and the environment ends disappears. The boundary is where the discretion of the organization to control an activity is less than the discretion of another organization or individual to control that activity. (Ibid.)
It is interesting to note that an activity-based definition of organizational boundary imposes difficulties when it comes to distributing individuals and groups of individuals to various organizations as the borderline between “external” and “internal” coalition members (Cyert & March, [1963] 1994) becomes blurred. An organization’s pay-list is obviously a dubious measure if aiming at establishing who is contributing to the survival of the organization and who is not. Being an employee of an organization is not necessarily equivalent with contributing to the organization or being controlled by the organization. An employee may act on behalf of the organization employing him but he may as well act on behalf of his own or on behalf of another organization. Sociologist Göran Ahne (1994) sketches the profile of the organizational centaur:

All affiliates of an organization act both on behalf of the organization and on their own. Everything that is done in organizations is enacted through the bodies of its individual affiliates. The organizational centaur is the embodiment of both actions on behalf of organizations and actions on behalf of the natural person; it is part organization, part human. When individuals act on behalf of organizations they act as part of the organization, but since they are humans they invariably supersede the organizational context. (pp.28-29)

The interstructured activities that individuals control on behalf of an organization, whether the individuals controlling the activities are formal affiliates of the organization or not, constitute the boundaries of the organization, i.e. the demarcation line between the organization and its environment. Activities make change come about. In its verbal form the meaning of change is “to make different (alter, modify, transform, convert)” or “to give a different position, status, course or direction”. Activities, then, may be divided into two main subcategories, viz. transformation and transaction, where transformation refers to “the action of making something different in form, quality or state (alteration, modification, transformation, conversion)” and transaction is about realizing exchange between parties, which in a wide sense is about giving “a different position, status, course or direction”, an activity commonly involving various strains of negotiation, compromise and physical transfer. Activity control implicitly means controlling resources as activities referred to as transformation or transaction, basically, one way or the other, concern the manipulation of resources.\(^1\)

6.5 Power, dependence and interdependence

In any discussion of power and domination it is difficult to ignore the influence of Max Weber. Richard Emerson is another important contributor to our understanding of power aspects of social relations. His article “Power-dependence relations”, published in 1962, is since frequently referred to particularly in the field of organization theory.

\(^1\) Definitions referred to in this paragraph come from Webster’s Third New International Dictionary, ([1961] 1993).
Therefore it seems reasonable to inventory some of the ideas presented by these two authors and to investigate the various ways subsequent scholars have used and developed their findings.

6.5.1 Power aspects of social relations reflecting Emerson, 1962

Based on the power-dependence dichotomy Richard Emerson in the early 1960s established a simple theory of power relations (Emerson, 1962). His piece of work is since frequently referred to in subsequent literature on organization theory.

Dependence can be seen as the obverse of power. (Thompson, 1967, p.30)

It should be clear that not all coalition participants provide contributions that are equally valued; some are valued more, others less. Those coalition participants who provide behaviors, resources and capabilities that are most needed or desired by other organizational participants come to have more influence and control over the organization, for one of the inducements received for contributing the most critical resources is the ability to control and direct organizational action. … The power of the participant is a function of the dependence of others in the organization on his contributions, activities, capabilities. (Pfeffer & Salancik, 1978, p.27)

Power is relational. If the relation between two or more organizations is based on direct dependence we can talk about power. … When an organization uses the dependence on its resources of another organization to make that organization do things it would not otherwise do, power is clearly involved. (Ahrne, 1994, p.117)

All three quotations refer back to Emerson’s paper, which attempts to “construct a simple theory of the power aspects of social relations” (Emerson, 1962, p.32). The theory emphasizes the relational aspect of power while contending that the amount of power an actor can exert against a particular counterpart is directly proportional to the counterpart’s degree of dependence on the actor. The argument seems to imply that vis-à-vis a certain counterpart an actor is either dependent or powerful, but it does not immediately point out that an actor may hold both positions simultaneously, or, even more interestingly, a situation where both actors of a dyadic relationship find themselves simultaneously to be both dependent and powerful. Interdependence, then, is the kind of two-dimensional reciprocity where power and dependence go in both directions at the same time.

Social relations commonly entail ties of mutual dependence between parties. A depends upon B if he aspires to goals or gratifications whose achievement is facilitated by appropriate actions on B’s part. By virtue of mutual dependency, it is more or less imperative to each party that he be able to control or influence the other’s conduct. At the same time, these ties of mutual dependence imply that each party is in a position, to some degree, to grant or deny, facilitate or hinder, the other’s gratification. … In short, power resides implicitly in the other’s dependency. (Ibid.)

Emerson uses the word party in the above quotation. In his paper he also frequently uses the word actor, which he gives a specific and precise meaning: “[w]e shall speak

1 The italics belong to the original text.
of relations among actors, where an actor can be either a person or a group. Unless otherwise indicated, any relation discussed might be a person-person, group-person or group-group relation” (ibid.). Intuitively the social relation building on the person-person format can fairly easily be comprehended but how to understand a social relation involving one or two collective actors. It is clear that different individuals have different personal goals and different ambitions, that they represent different ideas and preferences, and that they come up with different solutions to common problems. If considering these facts Emerson’s stance seems quite problematic. How, for example, can a person uphold a social relation with a counterpart consisting of a gathering of disparate individuals going in various directions? And even worse, how can two collectivities of the kind run a social relation? It seems reasonable to ask: Who is the counterpart? Emerson’s theory closes the apparent gap between the level of the individual and that of the group.

A group is a coalition of persons and group formation involves the development of ‘group norms’ and ‘role-prescriptions’, two concepts that Emerson (1962, p.38) defines in the following way.

**Role-Prescriptions.** Specifications of behavior which all group members expect (demand) of one or more but not all members.

**Group Norms.** Specifications of behavior which all group members expect of all group members.

A particular group member, whom other members of a group depend upon, is assigned specific importance, or otherwise expressed, certain authority. The more the other members depend upon the person the greater is that person’s authority. ”[A]uthority appears quite naturally to be legitimized power, vested in roles, and ‘legitimation’ is seen as a special case of the coalition process through which norms and role-prescriptions are formed” (ibid., p.31). As the coalition process proceeds norms evolve and different roles emerge and with each role follow a certain amount of legitimized power. Some roles get a lot of power attached to them whereas other roles are given almost no power at all. Authority ascribed to a role renders the person occupying the role legitimacy to act on behalf of the group, but the legitimacy is constrained by the role-prescription. With the establishment of group norms and the distribution of authority among the various members of the group a “loose” gathering of disparate individuals develops into a distinct collectivity – an actor – with the potency of gathering resources and performing activities. Such a group is basically a social construct, an institution in its own right, made up of the agreed upon norms and role-prescriptions of the group and those norms and role-prescriptions at the same time enable and constrain the behavior of the various members of the group as well as the behavior of the group as a unit.

Emerson’s intention to “construct a simple theory of the power aspects of social relations” valid for a broad variety of actors, i.e. both for individuals and groups, obviously reached far. The theory has been frequently referred to and it has been used
to elaborate power-dependence relations both in an intra- and an inter-organizational perspective. His theory offers a reasonable explanation of the way power is distributed among individuals and collectivities, but most interestingly it also offers an explanation proposal to the (organic) emergence of groups and group action through representation. Along the same line of thought where the control of organizational resources is held in focus Thompson (1967) elaborates the concept of ‘dominant coalition’ in relation to organizational goals.

> [Organizational goals are established by individuals – but interdependent individuals who collectively have sufficient control of organizational resources to commit them in certain directions and to withhold them from others. (Thompson, 1967, p.128)]

These interdependent individuals having sufficient control collectively to establish the goals of the organization are the ‘dominant coalition’, according to Thompson, but it seems clear that in such a coalition some figures capture more dominant positions than do others. Nevertheless, the setting attributes power to the organization making it a full-fledged actor equipped with a potency to make decisions and to act, as “power implies a capacity to act” (Ahne, 1994, p.117). The phenomenon specified by Thompson as the ‘dominant coalition’ has been given various names in the literature, e.g. ‘managerial group’, ‘administrative group’, or ‘management team’ (Penrose, [1959] 1995, p.45 ff). In everyday language, however, the phenomenon is commonly communicated as an organization’s ‘management’. Specifying a ‘dominant coalition’ notifies there are other coalitions as well. This is the view of the organization elaborated by Cyert and March ([1963] 1994, pp.44-45).

We assume a set of coalition members, actual and potential. Whether these members are individuals or groups of individuals is unimportant. Some of the possible subsets drawn from this set are viable coalitions. That is, we will identify a class of combinations of members such that any of these combinations meet the minimal standards imposed by the external environment of the organization. Patently, therefore, the composition of the viable set of coalitions will depend on environmental conditions.

To a certain extent the viability of a particular coalition depends on whether and to which extent the coalition is rendered support from the outside, no doubt, but it is obvious that also other variables, e.g. political and institutional, may influence coalition viability. What is important to note in this connection is that the organization usually comprehends several, sometimes many, different intermeshing coalitions competing with one another to get hold of physical and human resources deriving from one common intra-organizational base of resources. This condition brings into focus the issue of power-dependence relations, as resource control basically refers to the distribution of power and dependence in an organization and the balance between the two.

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1 It is interesting to note that Emerson’s work on power-dependence relations published in February 1962 is not considered in Cyert and March’s publication from 1963. Maybe the authors didn’t know about Emerson’s work at the time the book was sent to the printers or perhaps they didn’t consider it important.
6.5.2 Domination, interest and legitimacy – Max Weber revisited

Weber ([1922] 1978, p.943) emphasizes “two diametrically contrasting types of domination, viz. domination by virtue of a constellation of interest (in particular: by virtue of a position of monopoly), and domination by virtue of authority, i.e., power to command and duty to obey”. It is clear that Emerson (1962) and those adopting his “theory of the power aspects of social relations” relate to the former type of domination, i.e. domination by virtue of a constellation of interest or a position of monopoly. It is very much obvious in the following quotation collected from Thompson (1967, p.30) “an organization is dependent on some element of its task environment (1) in proportion to the organization’s need for resources or performances which that element can provide and (2) in inverse proportion to the ability of other elements to provide the same resource or performance”. It is evident that if the resources or services in question are not important to the organization dependency is not an issue, but if the resources or services are essential to the organization and if supply cannot be provided from any other source (i.e. the market is characterized by monopoly on the supply side) the organization is in fact dependent on the “element” to the extent that the resources or services are considered important or until another source of supply is established (an alternative source supplying the same resources or services or a source supplying feasible substitutes).

Explaining domination by virtue of a constellation of interest, and its special case, a position of monopoly, is certainly very much valid in many situations of social life. When it comes to understanding and predicting the behavior of actors operating on a “free” market “the monopoly approach” has certainly been fruitful. Whether a monopoly (or monopoly-like) position is secured through differentiation and the establishment of patent rights (Chamberlin, 1933), technological development of the “creative destruction”-type (Schumpeter, [1912] 1934), entrepreneurial operations on an imperfect market (Kirzner, 1973), or in any other way, the actor operating from a monopoly position, whether spatially and temporally “wide-reaching” or valid on a local market just for a short time period, can benefit from it as long as it can be upheld. By the same token it is clear that business counterparts that involve in exchange with each other are mutually dependent and mutually powerful at the same time if the “market” on which they meet comprises just the two of them, i.e. no other potential suppliers or buyers exist. If both parties judge exchange with its counterpart to be of particular importance strong interdependency establishes between the two, as the parties involve in a relationship characterized by a certain type of reciprocity, viz. one of “monopoly” on the supply side and “monopsony” on the demand side¹.

The second type of domination highlighted by Weber ([1922] 1978, p.943) is “[d]omination by virtue of authority, i.e., power to command and duty to obey”. To

¹ The statement is not entirely correct as a market structure characterized as monopoly involves one supplier and many buyers whereas a market structure characterized as monopsony involves one buyer and many suppliers.
Weber authority is equal to legitimate domination and he defines domination “as the probability that certain specific commands (or all commands) will be obeyed by a given group of persons” (ibid., p.212). Authority, as ‘legitimate domination’ or, if using Emerson’s terminology, ‘legitimized power’, “implies a minimum of voluntary compliance, that is, an interest (based on ulterior motives or genuine acceptance) in obedience” (Weber ([1922] 1978, p.212). Looked upon in this way, ultimately the authority of a dominant party is traceable to “the belief in legitimacy” (ibid. p.213) on the hand of those dominated, as the position taken by those persons involves a certain amount of free will. As Weber screens out from his theory of domination and legitimacy pure coercive treatment (exploitation of slaves and the like) he signifies that domination is founded in some kind of interest on the hand of the dominated party, an interest that is manifesting through the granting of legitimacy. It follows that authorities operating from a foundation of weak legitimacy run frail regimes, as superiors not awarded sufficient legitimacy from subordinates do not have at their disposal the sufficient amount of power needed to properly administer their regimes.

Governments running their regimes while putting into practice values and norms insufficiently supported by a majority of their people sometimes resort to the use of coercive power in defense of their positions. In search of legitimacy they turn to groups such as the police, the military force or other powerful instances. Also when coercive power is not an issue coalescing with others often help to strengthen a power position that, for one reason or another, is considered as almost too weak. It is obvious that coalescing is a method frequently applied on the political arena to mobilize power. Stinchcombe (1968, p.162) comments upon the mechanism:

A power is legitimate to the degree that, by virtue of the doctrines and norms by which it is justified, the power-holder can call upon sufficient other centers of power, as reserves in case of need, to make his power effective.

According to Weber the claims to legitimacy gain validity on three different grounds, each one forming the basis for a particular type of authority (Weber ([1922] 1978, pp.215-216).

1. Rational grounds – resting on a belief in the legality of enacted rules and the right of those elevated to authority under such rules to issue commands (legal authority).

2. Traditional grounds – resting on an established belief in the sanctity of immemorial traditions and the legitimacy of those exercising authority under them (traditional authority); or finally,

3. Charismatic grounds – resting on devotion to the exceptional sanctity, heroism or exemplary character of an individual person, and of the normative patterns or order revealed or ordained by him (charismatic authority).

1 Emerson, (1962) claims: “Our integrated knowledge of power does not significantly surpass the conceptions left by Max Weber” (p.31), and he continues: “Max Weber, in The Theory of Social and Economic Organization, New York: Oxford University press, 1947, presents what is still a classic formulation of power, authority and legitimacy” (p.31, footnote 4).
In the case of legal authority, obedience is owed to the legally established impersonal order. It extends to the persons exercising the authority of office under it by virtue of the formal legality of their commands and only within the scope of authority of the office. In the case of traditional authority, obedience is owed to the person of the chief who occupies the traditionally sanctioned position of authority and who is (within its sphere) bound by tradition. But here the obligation of obedience is a matter of personal loyalty within the area of accustomed obligations. In the case of charismatic authority, it is the charismatically qualified leader as such who is obeyed by virtue of personal trust in his revelation, his heroism or his exemplary qualities so far as they fall within the scope of the individual’s belief in his charisma.

According to Weber none of these three types of authority can be observed in pure form in everyday life. They are just constructs developed for analytical purposes. Authority manifesting in everyday life appears as a blend of the three forms. However, it is interesting to consider Weber’s pure types of authority for a while. Legal authority is the type of authority commonly referred to when dealing with the phenomenon of formal organization, and, if asking ordinary people to say something about Max Weber, they would probably mention his writings on bureaucracies. The hierarchically structured organization – the bureaucracy – employs legal authority as the means of coordination and Weber praised this particular solution for being highly efficient. His view of the system is that of a ‘bureaucratic machinery’ in which all participants know exactly what to do at every occasion, as everybody is subject to an impersonal order constituted by technical rules or norms. Weber’s view of the bureaucracy phenomenon coincides, by and large, with that adopted by scholars active in the field of managerial economics, although those scholars seem to have forgotten that legitimacy makes up an important factor in the formation of power. Conceptually, the exertion of legal authority relates to the regulative pillar of institutions, i.e. “rule-setting, monitoring and sanctioning activities”, as proposed by Scott (1995, p.35).

Weber’s concept of ‘traditional authority’ relates closer to the normative pillar of institutions as proposed by Scott (ibid., pp.37-38). It is authority based on values and norms more or less taken-for-granted but without anybody knowing why. Legitimate behavior then is such behavior that conforms to the norms and values as prescribed by tradition. Weber links authority to “the person of the chief who occupies the traditionally sanctioned position of authority” (Weber [1922] 1978, p.216). If relaxing the strong coupling between authority and a particular person for a moment it is reasonable to conceive of values and norms as a kind of impersonal reservoirs of “accumulated authority” created in the past having an impact upon decision-making and behavior currently and in the future. The posture is broadly agreed upon in the field of institutional theory.

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1 See paragraph 6.1.1 above for a discussion about the managerial view of the firm.
2 Confer the discussion in section 6.2 above. Reference can also be made to Giddens’ (1984) view of social structure as the reification of social action. “In speaking of the structural properties of social systems I mean their institutionalized features, giving ‘solidity’ across time and space” (p.24); “System integration refers to connections with those who are physically absent in time and space”
Charismatic authority, finally, goes back to the ability of the individual person to fill others with enthusiasm and to get them going in a particular direction. This ability is certainly a valuable asset in the hands of company officials as well as others in the position of directing people. Some individuals seem to have this ability as a natural characteristic whereas others have not. Particularly to the entrepreneur a charismatic appearance should be important as he is often in need of support for the new ideas he is striving to introduce and develop. With some difficulty this type of authority may be related to the cognitive pillar of institution (Scott, 1995, p.40), because it seems reasonable to assume that a leader exerting charismatic authority possesses the capability of establishing affectional ties with subordinates, and, no matter which is the venture, the ties established are likely to be saturated with meaning.

In the end of the day “power is the means to get things done” (Giddens 1984, p.175) and a leader missing out on power cannot manage to properly do his job. But power comes to a person in different ways (1) by the assignment of a particular organizational position (legal authority), (2) by inheritance as part of a certain tradition (traditional authority), and (3) by others ascribing the person charisma (charismatic authority). No matter the source of authority, possessing the necessary amount of authority equips a person with “the means to get things done” (ibid.). According to Selznick (1957, pp.152-153) “[t]he art of the creative leader is the art of institution-building, the reworking of human and technological materials to fashion an organism that embodies new and enduring values”. It seems reasonable to assume that the art of institution-building to a large extent links to issues referring to domination, interest, and legitimacy. Giddens (1984) contends that “resources are media through which power is exercised” (p.16), i.e. from a position of domination power is exercised through some kind of facility or resource (p.29). He maintains that the mobilization of ‘allocative resources’ and ‘authoritative resources’ is what domination depends upon.

Domination depends upon the mobilization of two distinguishable types of resource. Allocative resources refer to capabilities – or, more accurately, to forms of transformative capacity – generating command over objects, goods or material phenomena. Authoritative resources refer to types of transformative capacity generating command over persons or actors. (Ibid. p.33)

By allocative resources is understood transformative capacity generating command over material phenomena whereas by authoritative resources is meant transformative capacity generating command over persons or actors. From a control point of view the distinction is important as the former comprises the exertion of power over material phenomena whereas the latter concerns the direct exertion of power over persons or actors, i.e. individuals or collectivities (groups or organizations), but also the indirect exertion of power over the transformative capacity to command physical phenomena and other human beings in so far as such capacity extends into more distant tiers of
authority. Situations where the direct exertion of power over material phenomena translates into the indirect exertion of power over other human beings (and over other material phenomena) should not be disregarded. It is difficult to conceive of any manufacturing process of some complexity, for example, where such an order of command is not present.

6.5.3 Interdependence and interconnectedness

Appreciating that interdependencies develop between organizational actors is presupposing that organizations are open or natural systems needing support from the outside. If uncertainty is considered and appreciated the entire business landscape develops into an ant-heap where intention and counter-intention, action and reaction, matching and non-matching, etc. become equally significant elements and signals. Causal relations get blurred. What is reasonable or unreasonable, sane or insane behavior becomes arbitrary in a context saturated by uncertainty in which interpretation, decision, and action appear in bounded rationality. The meaning perceived becomes a function of who is the observer, what is the perspective chosen, and which is the information at hand. Actors strive to reduce environmental uncertainty by coordinating activities with one another. As they do they become increasingly interdependent. Interdependence reduces the discretion to act as the power to control is partly given away to others.

Interdependence is the reason nothing comes out quite the way one wants it to. Any event that depends on more than a single causal agent is an outcome based on interdependent agents. … In social systems and social interactions, interdependence exists whenever one actor does not entirely control all of the conditions necessary for the achievement of an action or for obtaining the outcome desired from the action. (Pfeffer & Salancik, 1978, p.40)

Interdependence, then, may concern actor outcome or actor behavior. “In the case of behavior interdependence, the activities are themselves dependent on the actions of another social actor” (ibid., p.41). The organizing of a poker game may illustrate behavior interdependence. At least two individuals are required to make the game take place. Concerning outcome interdependence different situations are possible. Two of those will be discussed here. Competitors struggling over resources owned by a third party are subject to outcome interdependence because if one of the actors gets more of the business (the resources) the other gets less – the situation can be characterized as a ‘zero sum game’. But the competitors are not subject to behavior interdependence as they perform their respective activities independently of each other (unless they collaborate by upholding some kind of cartel or trust). Counterparts involving in business exchange may be subject both to outcome and behavior interdependence as the output of the “upstream” party constitutes the input of the “downstream” party. If there are no alternative counterparts available whom to turn to should the business fail, and if exchange is crucial for keeping the operations of both parties going, they are both simultaneously subject to outcome as well as behavior interdependence, but, most
likely, the parties also benefit from the so called ‘team effect’ (Alchian & Demsetz, 1972). A fundamental reason that actors increase behavior interdependence is their aim to reduce uncertainty regarding outcomes. If uncertainty and unpredictability are perceived as unacceptably high due to interdependence regarding outcome actors attempt to better coordinate their activities, and then they accept an increased level of behavior interdependence in order to reduce outcome interdependence. “The typical solution to problems of interdependence and uncertainty involves increasing coordination, which means increasing the mutual control over each others’ activities, or, in other words, increasing the behavior interdependence of the social actors” (Pfeffer and Salancik, 1978, p.43). In case the outcome of the supplier doesn’t fit the customer’s operations both fail to mobilize support for their respective operations. (Ibid., p.41 ff)

It is probably true, however, that power is never (or at least very seldom) distributed in such a way that one of the two parties in a power-dependence relation is all-powerful whereas the other party finds itself entirely dependent on its counterpart. Weber ([1922], 1978, p.212) refers to “a minimum of voluntary compliance … an interest in obedience” for domination to materialize and Emerson (1962, p.31) considers authority to be “legitimized power”. While referring to uncertainty as regards technologies and task environments Thompson (1967, p.143) maintains that the omnipotent individual at the top of the organization is a rare bird. Giddens (1984) effectively holds the same standpoint.

Power within social systems which enjoy some continuity over time and space presumes regularized relations of autonomy and dependence between actors or collectivities in contexts of social interaction. But all forms of dependence offer some resources whereby those who are subordinate can influence the activities of the superiors. This is what I call the dialectic of control in social systems. (p.16)

Stinchcombe (1965, p.181 ff) elaborates the same problem area. His discussion concerns the organizational elite’s relative degree of dependence on the organization on the one hand, and the subordinates’ relative degree of dependence on the organization on the other hand. He maintains that “[i]n general, the fate of the organizational elite is more closely tied to the fate of the organization than is that of their ‘inferiors’.” This is so because the personal prestige of the superiors is usually more closely tied to the prestige of the organization than is the prestige of the inferiors. The latter may quite easily change their employment to another organization without losing much while the former would loose a lot if changing. The less the inferiors depend on the organization the more the superiors depend on the consent of the inferiors for their success, because if the superiors are not considering the wish of the inferiors the latter may satisfy their needs and wants elsewhere. The more the needs and wants of the inferiors are met by the organization and the more difficult it is for the inferiors to satisfy their needs and wants elsewhere the more they depend on the organization and the less the superiors have to take into account the consent of the inferiors.
Obviously there is no effective standard pattern showing the distribution of
dependence, and implicitly the distribution of power, in relationships made up of
superiors and subordinates. It may well be that the superior sometimes is more
dependent on the inferior that the reverse. Barnard ([1938] 1968) discusses the issue in
relation to the “zone of indifference”, which he explains as follows:

If all the orders for actions reasonably practicable be arranged in the order of their
acceptability to the person affected, it may be conceived that there are a number which
are clearly unacceptable, that is, which certainly will not be obeyed; there is another
group somewhat more or less on the neutral line, that is, either barely acceptable or
barely unacceptable; and a third group unquestionably acceptable. This last group lies
within the “zone of indifference”. The person affected will accept orders lying within
this zone and is relatively indifferent as to what the order is so far as the question of
authority is concerned. (pp.168-169)

The width of the ‘zone of indifference’ is differently conceived of by different persons
but is also determined by the way a person conceives of the inducements and sacrifices
connecting to his organizational role. The more inducements exceed sacrifices the
more willing the person will be to accept a wider scope. But a person’s willingness to
obey to an order also depends on “the belief in legitimacy” (Weber ([1922] 1978,
p.213) held by the person in relation to the authority claimed by the executive giving
the order, or, otherwise expressed, “[t]he determination of authority lies with the
subordinate individual” (Barnard, [1938] 1968, p.167). Authority may radiate from an
organizational position, i.e. ‘authority of position’, which is authority existing
independently of the ability of the person that is upholding the position and is thus
impersonal, or authority may be the result of a person’s superior ability, which appears
in case a person commands respect regardless of which is his organizational position,
i.e. ‘authority of leadership’. ‘Authority of position’ could also be discussed in terms
of ‘structural-institutional authority’ as it is founded in historically established rules,
norms and values. It is authority claiming legitimacy on rational and traditional
grounds irrespective of who is the person occupying the position (Weber [1922] 1978,
p.217). ‘Authority of leadership’ on the other hand shows up as the superior ability to
mobilize the support of others for various missions. It depends on personal trust and
confidence of those others and a strong belief in legitimacy in relation to the
authorized person, which makes it link closely to the Weberian concept of ‘charismatic
authority’ (ibid.). “When the authority of leadership is combined with the authority of
position, men who have an established connection with an organization generally will
grant authority, accepting orders far outside the zone of indifference. The confidence
engendered may even make compliance an inducement in itself” (Barnard, [1938]
1968, p.174).

Authority lacking support is weak no matter the presentation format of the rhetoric.
Giddens (1984, p.175) contends that “power is the means to get things done” but most
achievements are accomplished through the collective action of subordinates, which
implies the directives given by a superior have to be thus constrained that they “hit”
the ‘zone of indifference’ of the various subordinates concerned. It seems that power materializes through the collective action of those performing the activities (Holmblad Brunsson, 2002, p. 99 ff). The well-informed superior will have a better understanding of the organization’s strengths and weaknesses, i.e. what can realistically be achieved from the available base of resources, but also of how to develop the organization’s capabilities for the future, than will the less well-informed one. Thus, it seems that the amount of authority granted to a superior can be partly explained by the relative quality of the organization’s information handling system whether that system is automated or operated by humans (Barnard, [1938] 1968, p.174 ff). Maybe the true role of the superior is to gain insight into what can feasibly be carried out rather than commanding subordinates to do things they are not prepared to do. If that is the case power is rather to be considered the consequence of collective action than the factor making collective action occur (Latour, 1986). Then the concept of power translates into coherent collective action realized. Although the argument is patently extreme it underpins the position held that every social relation per definition comprises an element of interdependence, interdependence then apprehended as mutuality both as regards dependence and power.

The discussion demonstrates a strong consensus in the literature of organization theory supporting the idea that interdependence is an integral part of social relations, i.e. that one party is never all-powerful leaving the other party entirely dependent. It is basically so that interdependence constitutes relationship cohesion. But it seems clear as well, that relations commonly display an uneven distribution of power and dependence between the parties. Emerson (1962, p.34) proposes the cohesive force of a relation to amount to the average of A’s dependence on B and B’s dependence on A. The power advantage of the stronger party, say A, is calculated by withdrawing B’s power from A’s power, the rest making up the net power of A. If one party finds itself in an unfavorable power-dependence position it may (if possible) embark upon ‘balancing operations’ in order to even out some portion of the perceived inequality. While discussing the issue of ‘asymmetric dependence’ and ‘countervailing power’ Pfeffer & Salancik (1978) claim that “some concentration of power is inevitable to achieve collective outcomes” but they also maintain “the concentration of force to accomplish something is more likely to cause those in opposition to concentrate and coordinate their actions” (p.52). The propositions fit in nicely with Emerson’s (1962) discussion of coalition formation and ‘balancing operations’, i.e. various possibilities for a weaker party to counterbalance the power position of its stronger counterpart. If both actors in a relationship heavily depend on each other each of them also possesses a strong power position in relation to its counterpart. The balanced interdependence in such a symmetric relationship makes both parties vulnerable and powerful at the same time, which may help keep undesired surprises at distance. If interdependence is extensive the actors are closely interconnected (Pfeffer and Salancik, 1978, p.40 ff).

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1 If elevated to the level of the business organization this circumstance is a strategic matter of major concern.
6.6 Social relationships and networks

Sociology and social anthropology nurture long traditions of studying social relationships and networks. A brief inventory along these traditions constitutes a point of departure for a closer penetration and clarification of the two concepts. Studies elaborating social relationships and networks are commonly performed in the name of social network analysis. Building on the first two chapters of John Scott’s book “Social Network Analysis - A Handbook” (1991) a brief review of the historical development of social network analysis is forwarded in order to prepare the reader for the subsequent discussion – of relevance for the further analysis to be developed in this thesis work – addressing the nature of social relations and networks.

6.6.1 Social network analysis – a historic outlook

Scott (1991) divides the development of social network analysis into three main lines: “the sociometric analysts, who produced many technical advances by using the methods of graph theory; the Harvard researchers of the 1930s, who explored patterns of interpersonal relations and the formation of ‘cliques’; and the Manchester anthropologists, who built on both of these strands to investigate the structure of ‘community’ relations in tribal and village societies” (p.7).

Before initiating the travel into the historical development of social network analysis a datum of particular interest is mediated. In the early 20th century British social anthropologist Alfred Radcliffe-Brown1 created the concept of ‘social structure’ and associated metaphors such as ‘fabric’ and ‘web’ to illustrate social life. His ‘structural-functional’2 approach should later form the foundation for the development of social network analysis taking place from the 1930s through to the 1970s as several sociologists and social anthropologists adopted his ideas. Scott (1991, pp.4-5) writes:

From these textile metaphors, aimed at understanding the ‘interweaving’ and ‘interlocking’ relations through which social actions were organized, the metaphor of the social ‘network’ came to the fore, and researchers began to investigate the ‘density’ and ‘texture’ of the social networks which they studied.

*The sociometric tradition*

Sociometric analysis closely relates to the ‘Gestalt’ tradition3 in psychology evolving during the 1920s. Thoughts and perceptions are supposed to be organized into patterns.

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1 Already in 1908 Alfred Reginald Radcliffe-Brown (1881-1955) performed ethnographic field research on the Andaman Islands (“The Andaman Islanders”, 1922). Strongly inspired by French sociologist Émile Durkheim he advocated a structural-functionalist (see foot-note 2) approach to social anthropological research. (Nationalencyklopedin, 1994, band 15; The Swedish National Encyclopedia, 1994, volume 15;)

2 “structural-functional: combining the approaches of the structuralist and functionalist schools of sociology and social anthropology; *specifically*: analyzing established institutional relationships and their societal functioning” (Webster’s Third New International Dictionary, [1961] 1993).

3 Here Scott (1991) refers to Köhler (1925).
“These organized patterns are regarded as ‘wholes’ or systems which have properties distinct from those of their ‘parts’ and which, furthermore, determine the nature of those ‘parts’” (Scott, 1991, p.9). Thus, such systems are meant to have an impact upon the way reality is perceived at the level of the individual. As these conceptual schemes (systems) are supposed largely to be determined by the social environment there is an influence on individual perceptions also from “group organization and its associated social climate” (ibid.).

In the mid 1930s Jacob Moreno¹ and others developed a gestalt-influenced social psychology. Moreno’s interest was directed towards investigating how psychological well-being is related to the structural features of what he termed ‘social configurations’. These configurations are formed from the concrete patterns of interpersonal choice, attraction, repulsion, friendship and other relations in which people were involved, and they are the basis upon which large-scale ‘social aggregates’, such as the economy and the state, are sustained and reproduced over time. (Ibid.)

Moreno’s main innovation was to develop the ‘sociogram’ in which individuals are represented by ‘points’ and the social relationships between them by ‘lines’, a visualization of the social network metaphor that is still today appreciated as most valid. Kurt Lewin, a colleague of Moreno, argued “that group behavior was to be seen as determined by the field of social forces in which the group was located” and that “a social group … exists in a ‘field’, a ‘space’ which comprises the group together with its surrounding environment” (Scott, 1991, p.10)².

The aim of ‘field theory’ is to explore … the interdependence between group and environment in a system of relations. ... the social field is seen as comprising ‘points’ connected by ‘paths’. The points represent individual persons, their goals, or there actions, and the paths represent the interactional or causal sequences which connect them. The field model, therefore, describes causal and interactional interdependencies in social configurations. The paths which run between points tie them together, and the pattern of paths divide a field into a number of discrete ‘regions’. Each region is separated from the others by the absence of paths between them: paths run within but not between the regions. (Scott, 1991, p.11)³

Fritz Heider, contemporary to Moreno and Lewin, “was especially concerned with how a person’s various attitudes towards others are brought into a state of ‘balance’. The different attitudes which an individual holds are balanced in his or her mind when they do not produce a state of psychological tension” (ibid. pp.11-12). Contradictory attitudes create unbalance according to Heider, who meant that the simplest way of distinguishing between various attitudes was to see them either as positive or as negative. Thus, as both Heider and Lewin based the idea of ‘balance’ on the individual’s perception of the world their approach to social behavior was basically psychological (or phenomenological).

¹ Scott (1991) refers to Moreno (1934) among others.
Based on the work of Moreno, Lewin and Heider graph theory to group behavior took a major step forward in the 1950s. The “breakthrough consisted of moving from the concept of cognitive balance in individual minds to that of interpersonal balance in groups” (Scott, 1991, p.12), and it was completed as Cartwright and Harary generalized Heider’s theory in the article “Structural Balance: a Generalization of Heider’s Theory” (Cartwright & Harary, 1956). The breakthrough made possible the building of models for the investigation of social phenomena such as “group cohesion, social pressure, cooperation, power and leadership” (Scott, 1991, p.12). The model components are points for individuals, lines for relations, and + and – respectively for ‘positive’ and ‘negative’ relations. Arrow heads are used to indicate the direction of relationships. Cartwright and Harary also contended that studying triadic structures could aid an understanding also of larger social structures.

Simple triadic structures are the building blocks of larger social structures, and the properties of complex networks of social relations can ... be derived from an analysis of these building blocks. In the simplest case, for example, a whole network is balanced when all of its constituent triads are balanced. (Scott, 1991, p.15)

The reverse, though, is not necessarily true. Much of mathematical work on balance in social networks has dealt with techniques concerning how to decompose a network into its constituent sub-groups.

The Harvard researchers in the 1930s and 1940s

Anthropologist W. Lloyd Warner and psychologist Elton Mayo are the most important representatives of this development line. They investigated factory and community life in America while working in the structural tradition of Radcliffe-Brown. Especially their Hawthorne studies making use of sociograms to report on group structure have become classics in social investigation. Informal relations were analyzed reflecting the informal organization of a group of people opposed to the formal organization drawn in the official organization chart. The analysis identified informal sub-groups by the researchers denoted as ‘cliques’. Those ‘cliques’ were recognized also by those individuals that had been partaking as respondents in the investigation. A ‘clique’ is "an informal association of people among whom there is a degree of group feeling and intimacy and in which certain group norms of behaviour have been established ” (Warner and Lunt, 1941, p.32 as quoted in Scott, 1991, p.20).

People are integrated into communities through ‘informal’ and ‘personal’ relations of family and clique membership, not simply through the ‘formal’ relations of the economy and political system. Any person may be a member of several different cliques, and “such overlapping in clique membership spreads out into a network of interrelations which integrate almost the entire population of a community in a single vast system of clique relations” (Warner & Lunt, 1941, p.111). This is undoubtedly one of the earliest, if not the earliest use of network terminology to describe the structuring of whole societies into sub-groups. (Scott, 1991, p.21)
Based on their understanding of these ‘cliques’ Warner and his associates claimed that “they were second in importance only to the family in placing people in society” (ibid.).

George Homan, a sociologist at Harvard, rearranged the data gathered by Warner and Mayo and combined their findings with the sociometric tradition of Moreno. By reshuffling the data he revealed new patterns and new understanding of the informal organization studied. “His theoretical synthesis centred around the idea that human activities bring people into interaction with one another, that these interactions vary in their ‘frequency’, ‘duration’, and ‘direction’, and that interaction is the basis on which ‘sentiments’ develop among people” (Scott, 1991, p.23).

The contributions of the Manchester anthropologists

The social anthropologists at Manchester University approached the area of social network analysis from a new and different angle while focusing on conflict and change rather than integration and cohesion. For Max Gluckman, who held a central position at Manchester, “conflict and power were integral elements of any social structure, and his analyses stressed the ever-present activities of negotiation, bargaining and coercion in the production of social integration” (Scott, 1991, p.27). The interest of the researchers at Manchester was directed towards the configuration of relations arising from power and conflict elements rather than from formally institutionalized norms and institutions of society.

With reference to Mitchell (1969) Scott (1991, p.28) writes: “[he] set out a body of sociological concepts which, he believed, could adequately grasp the structural properties of social organization. Intriguingly, Mitchell’s translation of graph theory and sociometry into a sociological framework led him to concentrate on exactly those features of ‘informal’ and interpersonal organization that had been highlighted by Warner, Mayo, and Homans”. Barnes (1954, p.43) contends that “the whole of social life” could be seen as ‘a set of points some of which are joined by lines’ to form a ‘total network’ of relations. The informal sphere of interpersonal relations was to be seen as one part, a ‘partial network’, of this total network. Nadel (1957) claims that “social structure is ‘an overall system, network or pattern’ of relations” (p.12), and that a network is “the interlocking of relationships whereby the interactions implicit in one determine those occurring in others” (ibid. p.16).

1 Warner was also influenced by Simmel (1908), “who pioneered the analysis of dyads and triads as the building blocks of social life” (Scott, 1991, p.20).
2 In this part Scott (1991) refers to Homans (1951).
3 Mitchell (1969) reports on work done by himself and colleagues since the early 1950s.
4 During the 1950s John Barnes worked closely together with Elizabeth Bott, a Canadian psychologist associated with the Department of Social Anthropology at Manchester University.
5 As quoted in Scott (1991, p.29).
The ‘sphere of interpersonal relations’ conceptualized by Barnes’s was generalized by Mitchell into that of the ‘personal order’, i.e. the pattern of “personal links individuals have with a set of people and the links these people have in turn among themselves” (Mitchell, 1969, p.10 as quoted in Scott, 1991, p.31), and, according to Mitchell, network analysis should address these patterns of interaction. He proposes two types of activities to be the basis for the formation of such interaction networks, i.e. communication and the transfer of material goods and services between people. Communication leads up to the transfer of information and the establishment of shared values and norms. The ‘instrumental’ part of the activities comprises the exchange of goods and services. Mitchell contends that social networks embody both kinds of activity - the social and the instrumental. His is also the view of society as a large all-embracing network, which he describes as "the general ever-ramifying, ever-reticulating set of linkages that stretches within and beyond the confines of any community or organization" (Mitchell, 1969, p.12 as quoted in Scott, 1991, p.31).

When analyzing interpersonal networks Mitchell proposes ‘reciprocity’, ‘intensity’, and ‘durability’ as appropriate variables, to be compared with ‘direction’, ‘frequency’, and ‘duration’ as pointed out by Homans (1951). Interestingly, substituting ‘reciprocity’ for ‘direction’ in the model opens for the analysis of two-way flows, e.g. financial transfer can compensate for the transaction of goods or services, or friendship can be reciprocated by friendship. “‘Durability’ is a measure of how enduring are the underlying relations and obligations which are activated in particular transactions” (Scott, 1991, p.32). Underlying relations that are repeatedly activated are highly durable. “‘Intensity’ refers to the strength of the obligations involved in a relation” (ibid.). Some additional measures were proposed by Mitchell for use in network analysis, i.e. ‘density’: “the extent to which all possible relations are actually present” (here Barnes and Bott proposed the denotations ‘mesh’ and ‘connectedness’); ‘reachability’: “how easy it is for all people to contact one another through a limited number of steps”. (Scott, 1991, p.32-33)

6.6.2 Social relationships and networks conceptualized

“[h]uman activities bring people into interaction with one another … [i]nteraction is the basis on which ‘sentiments’ develop among people.” The quotations are collected from Scott (1991, p.23), who refers to Homans (1951). It is fundamental to social theory that interaction drives the development of ‘sentiments’ among people. The ‘sentiments’ make up the connecting glue determining, to a large extent, the reciprocal behavior of people involving in interaction with one another more than accidentally. Social anthropologist Siegfried Frederick Nadel writes:

For ‘determinate ways of acting towards or in regard to one another’ we usually say ‘relationships’, and we indicate that they follow from rules by calling them ‘institutionalized’ or ‘social’ … relationships. We identify the mutual ways of acting of individuals as ‘relationships’ only when the former exhibit some consistency and
constancy, since without these attributes they would merely be single or disjointed acts. (Nadel, 1957, pp.8-9)

Holding a position involving the idea that social relationships are real, that they exist in the empirical world, stimulates the idea extension that individuals are simultaneously related, directly and indirectly, to other individuals, and, thus, to accept the existence of relationship aggregates that may be expressed in terms of ‘social networks’. The total social network of a society may be thought of as “the general ever-ramifying, ever-reticulating set of linkages that stretches within and beyond the confines of any community or organization” (Mitchell, 1969, p.12). Although, the social network may lack an outward limit at the societal level, according to Mitchell network analysis should address ‘partial networks’ only, i.e. analyses should be confined to certain network aspects. Organization theorist Göran Ahrne holds a similar stance but involves also the proposition that human beings affiliated with an organization are acting partly on human and partly on organizational inducements. He argues:

A network is based on personal relations and thus recognition, but a network must not be confused with an organization. There may be networks inside organizations or between different organizations. Networks relay more on the human parts than on the organizational parts of actions. … Affiliates of organizations are parts of larger networks stretching beyond the organizational context. … To be affiliated with an organization is a different type of relationship than to be part of a network. Networks are complementary to organizations. … Sometimes the concept of network is used instead of, or as an alternative to, organization, because it gives connotations to personal relations between people rather than to bureaucracy and hierarchy, and it is perceived as more dynamic and creative. (Ahrne, 1994, p.77)

The concept of ‘social relationship’ is understood as the linking of individuals into pairs. As individuals usually involve in more than one relationship they become related, both directly and indirectly, to other people. An aggregate of relationships may be referred to as ‘social structure’ (or ‘social network’) but it has been argued that ‘social structure’ is something more than just an aggregate of relationships.

The orderliness of a plurality of relationships differs radically from the ordering of a plurality of individuals through relationship. And whatever the precise nature of the former, we can see that it must correspond to something like an overall system, network or pattern…. We arrive at the structure of a society through abstracting from the concrete population and its behaviour the pattern or network (or ‘system’) of relationships obtaining ‘between actors in their capacity of playing roles relative to one another’. (Nadel, 1957, p.12)

According to Nadel a network is “the interlocking of relationships whereby the interactions implicit in one determine those occurring in others” (p.16). Choosing the term ‘network’ is motivated as follows:

I do not merely wish to indicate the ‘links’ between persons; this is adequately done by the word relationship. Rather, I wish to indicate the further linkage of the links themselves and the important consequence that, what happens so-to-speak between one pair of ‘knots’, must affect what happens between adjacent ones. It is in order to
illustrate this interrelatedness or interlocking of the relationships (each a ‘link’ between two ‘knots’), that we require an additional term, and ‘network’ seems the most appropriate. (Nadel, 1957, pp.16-17)

6.6.3 Social capital, a strategic asset

Now, ‘social capital’ resides in the interlocking of relationships. It arises, grows, decreases and dissolves in a network context and it is in such a context that various actors nurture and exploit ‘social capital’. But then, what is ‘social capital’? A general understanding of ‘social structure’ and ‘social knowledge’ guides an understanding of the concept of ‘social capital’. With reference to Bourdieu (1986) and Burt (1992b) Nahapiet and Ghoshal (1998) define ‘social capital’ as:

[the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit. Social capital thus comprises both the network and the assets that may be mobilized through that network. (Nahapiet & Ghoshal, 1998, p.243)]

Implicitly the definition renders ‘social capital’ a strategic flavor. Either the resource owner is a human being or a social unit social capital is considered an asset to be used or exploited for a purpose. Burt (1992a) provides some clarification as to social capital:

Relations [between individuals] within and beyond the firm are social capital. (Burt, 1992a, p.58.)

The social capital of people aggregates into the social capital of organizations. (Ibid.)

Social capital is at once the structure of contacts in a network and resources they each hold. (Ibid. p.61.)

The first quotation says that social relations are social capital, a stance implicitly categorizing social relations as a certain type of resource. The second quotation deals with the problem of aggregation. Burt maintains that there is a link between social capital at the level of people and at the level of organizations, a point that is informative. The third quotation states that social relations, in themselves resources, make other resources available. The third quotation qualifies as the overall definition of social capital to be used in this work. Although not explicitly expressed implicitly the “interrelatedness or interlocking of the relationships” (Nadel, 1957, pp.16-17) is presumed to contribute to the stock of ‘social capital’ possessed by an individual or an organization.

To Burt ‘social capital’ has an obvious strategic flavor, which makes him use the term ‘players’ for people and organizations operating in the competitive arena. Richard Swedberg, who transformed into the article format a chapter from Burt’s book “Structural holes” (Burt, 1992b), proposed him to substitute ‘players’ for ‘actors’. Burt’s explanation why not adhering to Swedberg’s proposal was:

In earlier writing I have used the more neutral term for general discussion (Burt 1982), but for the topic of competition I prefer to use player. It better fits my felt-reality of
the phenomenon. More than implying activity, it is a term of peer recognition: ‘Yes, he’s a player.’ He’s a presence in the game. If you have the motivation, resources, and skills to compete, you’re a player; otherwise you’re scenery. Everyone is a player in some arenas, scenery in most. This chapter is about the social structural conditions that give certain players a competitive advantage. (Burt, 1992a, p.87, footnote 1)

Following the reasoning of Burt it becomes obvious that ‘social structure’ and ‘social knowledge’ both qualify as ‘neutral’ terms (or concepts) whereas ‘social capital’ includes more of strategy thinking. When employed in a business context the term ‘capital’ implicitly invites a strategic perspective because ‘capital’ that is not activated for a purpose is not really taking part in the business process. In his discussion about various types of capital Burt discerningly notes that physical capital and human capital are both basically the property of individuals whereas social capital appears as an asset that is jointly owned by participants involving in relationships with one another. An effect of relationship withdrawal is the dissolution of ‘social structure’, and implicitly of ‘social capital’, and, as ‘social capital’ dissolves the number of coordination options in the network decreases, which in turn impacts negatively upon the possibilities to combine existing and to develop new resources.

6.7 Conceptual framework

In chapter 5 it was concluded that technological change appearing in the main case of this thesis work was traceable to a number of sources, viz. ‘strategic intention’, ‘emergent developments’, ‘chance’, and ‘necessity’. To some extent the findings put at a disadvantage the often articulated “truth” maintaining that all achievements ever accomplished in business firms are the outcome of the work of omnipotent managers. However, already a minor portion of common sense actually suffices to conquer such a view, but, still in these days, it seems that most popular management literature does not involve much common sense. On the contrary, literature of the kind (written in the tradition of North-American managerialism), but also consultants making their living from producing and utilizing such literature, maintain “that the destiny of organisations is a function of the management’s behaviour” (Furusten, 1995, p.168). The analyses carried out so far in this thesis work point in another direction, and the analyses to be performed in the next chapter further strengthen this alternative view where ‘strategic intention’ brought forward by the management certainly appears as one important source of technological change, but where also the ‘strategic intention’ of other actors as well as various institutional phenomena have a voice in the matter, as technological change is studied in a context appreciating the interaction between various individuals and groups of individuals as well. The conceptual framework developed below prepares for the analyses.
6.7.1 Heavy industries in an institutional perspective

Before a discussion about change sources can be performed it is necessary first to consider “what is it that is changing?” Industrial systems are inert, which implies they are difficult to change. Heavy industrial systems in particular are markedly inert, which is explained by the fact that such industries regularly employ production facilities that are expensive, have long working life, and are integrated in complex production lines. The stainless steel industry is such an industry and so are the mining and metals industries. That production facilities are expensive implies they cannot easily be dismissed because then considerable sunk costs would arise. That production facilities have long working lives implies that investments will be there for a long time unless high sunk costs are accepted (Håkansson & Waluszewski, 2002). That production facilities are integrated in complex production lines implies that change in one of those integrated facilities usually influences other facilities in the same line. Thus, resource and activity interdependences make the industrial system less amenable to change (Håkansson & Snehota, 1995). The last point deserves some further elaboration.

Process and long-linked technologies involve interdependencies, i.e. resources and activities are interconnected (Thompson, 1967). If taking a closer look at these types of technology, while assuming that the production facilities employed are technological artifacts and the activity structures that interrelate with the production facilities are techno-human routines, interdependency is better understood. Technological artifacts as well as techno-human routines are institutions in their own right. Technological artifacts make up a genuine subset of material artifacts and as such they are the “fourth candidate as a carrier of institutions” that Richard Scott (1995, p.61, footnote 5) is pointing at. Techno-human routines constitute a genuine subset of all routines and procedures that exist in an organization and as such they are part of the “genes” of organization that Winter (1990, pp.274-278) discusses. “Institutions can be … defined as collections of stable rules and roles, and corresponding sets of meanings and interpretations” (Czarniawska & Sevón, 1996, pp.3-4), and the rules (and roles) that are captured in the technological artifacts and the techno-human routines that make up a production line or a production system have to match for the line or the system to operate smoothly. That is so because the rules guide (control) the activities performed and if the activities are closely complementary, i.e. upstream and downstream activities are reciprocally dependent, the rules have to guide the activities in such a way that they guarantee frictionless redefinition of output into input in every “area-between-events” along the production line or through the production system. Non-matching rules will cause friction in the line/system.

1 The discussion performed in this section builds on the conceptualization of ‘technology’ and ‘technological change’ made in chapter 3 above, where ‘technological artifacts’ and ‘techno-human routines’ are presented as major manifestations of technology.
Technological artifacts utilized in heavy industrial systems commonly accommodate many rule sets and rule set interfaces that are carrying a high level of permanency. The artifacts are designed to perform some but not other activities, and, as the artifacts are usually both expensive and have long working lives, they cannot easily be dismissed. These are circumstances that contribute to making the various systems in which they operate inert. Techno-human routines involve both formal prescriptions and practice-based experience. By repetitively activating formal prescriptions operators become familiar with them. The prescriptions get institutionalized as they eventually are conceived of as “the right way to go about”. Practice-based experience completes (or opposes) the formal prescriptions as a guiding device. It evolves over time and fills out the voids between the formal paragraphs (alternatively substitutes them). Experience-based rules emerge gradually and are “taken-for-granted” by those concerned. Such rules may or may not be formalized into prescriptive rules. Both formal prescriptions and rules acquired by way of experience include a certain portion of inertness as both become “taken-for-granted” after having been used for quite some time, and more often strong arguments are needed to change what is “taken-for-granted” (Schutz & Luckmann, 1973, pp.8-15). Attempts to erase what is “taken-for-granted” usually mobilize a number of actors who raise arguments in favor of the existing order. The institutional approach referred to here for the explanation of techno-human routines is claimed also to be valid for the explanation of routines that are not thought of as techno-human, e.g. administrative routines of various sorts, or other types of repetitive behavior.

The conclusion is that the heavy industrial system as an arena for change agents to conquer is markedly inert, as in many situations the very first reaction to a change initiative is the mobilization of forces opposing change. The phenomenon has been observed by Håkansson and Waluszewski (2002, p.229), who claim: “We have seen how companies wrestle with forces aimed at change, and how these forces always create a reaction in relation to the existing structure.” Although the authors do not introduce the institutional aspect into their discussion, but stay at a rather superficial level of reasoning, the observation is certainly interesting and appropriate as well. The relationship between forces aiming at change and forces resisting change has been closely studied by Kurt Lewin (1952)\(^1\), who claims that proactive forces are always met by resisting forces and that a certain amount of change promoting resultant force is needed for change to occur, i.e. the forces that are actively aiming at change have to overcome a certain ‘resisting threshold’ in order to make change come about (ibid., pp.199-207). It seems reasonable to think that this ‘threshold’ to a certain (often major) extent is institutional. Melin (1989) has adopted Lewin’s “field-of-force-metaphor” while adapting it to an industrial context as an alternative/complementary

\(^{1}\) The publication is a compilation of selected theoretical papers written by Kurt Lewin through the years 1939 – 1947. It is edited by Dorwin Cartwright. Lewin’s “field-of-force” concept was originally developed in the field of psychology (Lewin was primarily a psychologist), but his ideas have had a tremendous impact upon social science (Lewin, 1952, p.vii – in the foreword by Dorwin Cartwright).
approach to that of business networks. He writes: “The industrial field of force represents the context in which an individual industrial firm operates and of which it is an integral part” (p.168).

6.7.2 Change agents and sources of power

Achievements are important to most people (Lawrence & Lorsch, 1967, p.17), and in order to “get things done” most human beings want to influence their work as well as the environment in which they are working. Some people are in a position that renders them the possibility to influence their own work to a large extent but also the work of others. Other people have to do what they are told to do. People may also do what they do by force of habit. “The means to get things done” are unevenly distributed in any industrial context where different individuals are assigned different roles and work tasks, and where hierarchical structures put one role on top of the other (Weber, [1924] 1947). Those people who are in a position to influence their own work and the work of others have at their disposal enough power to enforce intention-based action. People, who have to do what they are told to do, depend on those, who are telling them what to do. People who do things by force of habit are guided by predetermined rules. Out of all the people that work in an organization only a few have at their disposal “the means to get things done” to a greater extent, whereas most people have access to little or nothing of those means.

“Power is the means to get things done” – Giddens’ (1984, p.175) statement serves as a common denominator in this instance. As things are done change occurs indicating that some type of domination (power to act) – no matter which – is activated. It is actually as simple as that. “Domination depends upon the mobilization of … transformative capacity … generating command over objects, goods or material phenomena … [and] … persons or actors” (ibid. p.33). In business firms management is the locus where power is usually strongly concentrated. That is so because business firms regularly apply some sort of hierarchical organization structure in which the transformative capacity of the firm is unevenly distributed between organizational levels and roles so that “[a]uthoritative resources … types of transformative capacity … generating command over persons or actors” are more easily mobilized at the top of the organization, whereas “[a]lllocative resources … forms of transformative capacity … generating command over objects, goods or material phenomena” are left to those at the bottom to mobilize (ibid.). But as upper level employees commonly generate command over lower level employees the former indirectly also generate certain command over objects, goods or material phenomena. Major investments, for instance, are decided at the top, whereas everyday routine operations are usually controlled at lower levels. However, as the transfer of information from one level to another is more or less distorted the freedom to act at lower levels is often greater than people at upper levels anticipate, i.e. the actual distribution of transformative capacity through the
organization to a certain degree deviates from the one given in directives (Hennart, 1982, p.51 ff).

Weber ([1922] 1978) contends that domination can be exerted either “by virtue of a constellation of interest (in particular: by virtue of a position of monopoly)” or by “virtue of authority, i.e. power to command and duty to obey” (p.943). He divides ‘authority’ into the three categories ‘legal authority’, ‘traditional authority’ and ‘charismatic authority’ (ibid., pp.215-216).

‘The interest/monopoly argument’ has later been further elaborated by Emerson (1962) who argues that “the power of A over B is equal to, and based upon, the dependence of B upon A” (p.33) where both A and B are actors. “[a]n actor can be either a person or a group” (p.32). Basically Emerson relates the degree of dependency of an actor to the two variables ‘motivational investment’ and ‘availability’, while claiming that the higher the ‘motivational investment’ of an actor in a particular “something” and the more constrained the ‘availability’ of that “something” the more dependent the actor is on a counterpart capable of providing that “something”. Thompson (1967, p.30) offers a most simple summary description of the idea with reference to organizations:

[a]n organization is dependent on some element of its task environment (1) in proportion to the organization’s need for resources or performances which that element can provide and (2) in inverse proportion to the ability of other elements to provide the same resource or performance.

Implicitly ‘the interest/monopoly argument’ as a power source may well support ‘strategic intention’ as a source of technological change.

‘Legal authority’ refers to authority ascribed to a particular organizational position or role. With the role follows legitimized rule-based rights (power) and obligations (constraints), and with the former follows the right (within limits) to generate command over material phenomena and persons. Subordinates that are not obeying to commands given within the limits specified for the role may be subject to disciplinary action. ‘Legal authority’ as a “means to get things done” may be discussed in terms of ‘managership’. It relates to the regulative pillar of institutions (Scott, 1995) and is a means to guide and control human behavior. Implicitly ‘legal authority’ exercised through ‘the managership argument’ may well support ‘strategic intention’ as a source of technological change.

‘Traditional authority’ evolves over time and is “resting on an established belief in the sanctity of immemorial traditions and the legitimacy of those exercising authority under them” (Weber [1922] 1978, pp.215-216). It is rooted in an acceptance of “taken-for-granted” traditions and rules and materializes through the legitimizing of persons (or actors) that are advocating these rules and traditions. A person that is granted ‘traditional authority’ by others is probably more often a defender of the existing order. Although “taken-for-grantedness” could well be discussed in relation to the
empirical case of this thesis work, while linking to ‘traditional authority’, I will refrain from doing so. The reason is that elements that build traditions, viz. agreed upon rules, habits, routines, norms, values, etc., are supposed to be broadly spread in the industrial system, and then it is reasonable to assume that many employees at various level of organization now and then, without being aware of it, refer to traditions (and ‘traditional authority’) when claiming why a certain way to think or act is to be considered appropriate. Expressions such as: “This is the right way to do it, we know, because we have done it several times before”; “We have always done it like this and we always will”; point at the occurrence of “immemorial traditions” or “taken-for-granted” rules inherited from the past. Whether (or rather to which degree) such rules constitute a source of domination depends on whether those exposed to them take them for granted and whether those exercising authority under them are ascribed legitimacy by those exposed to them. The influence of “taken-for-granted” rules on the process of change is certainly discussed in the analysis performed in chapter 7 but then it appears as a particular aspect of ‘structural inertness’.

‘Charismatic authority’ is acquired by way of “the exemplary character of an individual person, and of the normative patterns or order revealed or ordained by him” (ibid.). Other people follow and support the charismatic person because they are devoted to him. By their free will the followers grant the person legitimacy as they have faith in him and in his way to go about. Irrespective of which is the amount of ‘legal authority’ the person has at his disposal ‘charismatic authority’ grants the person a certain amount of power in the form of “transformative capacity … generating command over persons or actors” (Giddens, 1984, p.33). As people accept being dominated by ‘charismatic authority’ they are also willing to mobilize those allocative and authoritative resources they have at their disposal. It follows that ‘charismatic authority’ may be “the means to get things done”, and then utilizing ‘charismatic authority’ is getting things done by way of ‘leadership’. Authority manifesting in the form of ‘leadership’ relates to the cognitive pillar of institutions (Scott, 1995) and as such it is guiding human behavior. Implicitly ‘charismatic authority’ exercised through ‘the leadership argument’ may well support ‘strategic intention’ as a source of technological change.

Thus, three different arguments, viz. ‘the interest/monopoly argument’, ‘the managership argument’ and ‘the leadership argument’, appearing with reference to ‘power-dependence relations’, ‘legal authority’ and ‘charismatic authority’ respectively, have been proposed, and it is argued that all three arguments have the potency to support ‘strategic intention’ aiming at technological change. However, as different arguments, which may appear at the same time in the same place, may represent different endeavors the outcome of argument activation is uncertain, and suddenly a glimpse of Lewin’s (1952) “field-of-force metaphor” is seen flashing by. If introducing the dimension of time into the picture the “field” becomes most dynamic as various arguments forwarded at different points in time representing different
endeavors strive to have their respective voice in the matter along the time track. And the outcome of those negotiations emerges as technological change, it is argued.

6.7.3 Coalitions, networks and social capital

Thus, on different grounds and to various extent actors may dispose of “the means to get things done”. An actor can be either an individual or a group of individuals. Actors interact while developing relationships. Relationships interconnect into networks. When actors are defined at group level the coalition phenomenon must be considered. Any group involves role-prescriptions and group norms, implying that different members of a group have different roles, though all members share the norms of the group. A group member that is acting beyond the role-prescriptions assigned to the member, or operates outside the norms agreed upon by the group, will be corrected by other group members coalescing. A group member on which other group members depend is ascribed authority by the other members as they grant him or her legitimacy to act on behalf of the group. That individuals form coalitions implies that two or more than two individuals go about as one actor, which sometimes may even out or even switch the balance of power in social relations. (Emerson, 1962)

As individuals coalesce they merge into becoming one actor, one “voice”. It follows that coalescing implies increased power for the coalition members as a group in relation to external actors as the ‘availability’ factor for those external actors goes down. The difference between a coalition and a network is that the former is kept together by shared group norms and role-prescriptions, a circumstance that makes the coalition members operate as one man with one “voice” in relation to external parties, whereas a network manifests as an aggregate of interlinked actors each one with its own “voice”. A coalition is established around a certain purpose rendering its operations a certain direction, whereas a network is missing out both on purpose and direction. Network actors may form coalitions by uniting their different purposes into one purpose and by so doing expressing one clear direction.

Relationships link actors together. Depending on which is the main “content” of a relationship it may be categorized as a ‘social relationship’, ‘professional relationship’, ‘business relationship’, or another type of relationship. Actors, both individuals and groups, control resources. Actors may get access to resources belonging to other actors by forming relationships with them. As relationships are interconnected an actor’s access to resources may be far-reaching. However, not only those “things” that are made available to an actor through the involvement in relationships are considered resources, but also the relationships as such. Thus, as part of a social network an

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1 Members must not necessarily be human beings for the coalition principles to apply. In politics, for example, the members of a coalition are usually different political parties.

2 This was actually the main argument raised by Karl Marx in his call “Workers of the world” (Emerson, 1962, p.37).
individual may have at its disposal a comprehensive ‘social capital’ constituted by all the interrelated social relations of the network that are “finding their way back” to the individual as well as all those resources that are potentially accessible through these linkages, and “the social capital of people aggregates into the social capital of organizations” Burt (1992a, p.58) maintains. It follows that also coalitions and groups otherwise described have a certain amount of social capital at their disposal. Coalitions come and go. Some coalitions are stable over time while other coalitions exist for just a short period of time. Sometimes groups are organized for a particular purpose in order to cope with a particular task. A person or a firm may involve in more than one coalition as long as the purposes of the coalitions are not in conflict with each other. Should that occur tension arises.

6.7.4 “Bringing the pieces together”

Now, if aiming at developing a useful theoretical framework it seems appropriate to relate the elements of ‘network’ and ‘coalition’ to the set of arguments introduced in section 6.7.2, viz. ‘the interest/monopoly argument’, ‘the managership argument’ and ‘the leadership argument’. Both social networks and coalitions may be thought of as reservoirs of social capital (resources), and from those reservoirs different individuals may have access to different resources.

Social relations build on power and dependence albeit those two elements are usually asymmetrically distributed between the interrelated parties. Typical for close relationships is that they include interdependencies and trust as integral parts, and that these two elements serve as effective door openers for individuals to get control over resources possessed or controlled by others. The dependent party is usually willing to give up something in order to keep its powerful counterpart happy (the monopoly argument). Trust involves mutuality, i.e. reciprocal interest in another party and willingness to do something for one another (the interest argument). No matter if social capital is found embedded in the individual’s network, or if it attaches to the role-prescriptions and norms that constitute a particular coalition with which the individual is affiliated, in both cases different combinations of interdependency and trust ascribe ‘the interest/monopoly argument’ strength as it is activated for a particular purpose, and, as ‘the interest/monopoly argument’ to a certain extent addresses the mobilization of social capital, the stronger the argument the larger the possibility it

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1 Analogously it would be possible to talk about ‘business capital’ as business firms involve in relationships with other firms, but so far the concept has not been proposed.
2 For reason of simplicity in this paragraph the discussion will focus on the actor as an individual human being. Based on Emerson’s (1962) discussion about the formation of coalitions where several human beings coalesce into one “voice” the discussion could easily be extended to comprise actors such as groups of people as well.
3 The power-dependence logic is also most applicable on e.g. the principal-agent relationship where the strength of the argument refers to who is the more dependent party; whether it is the employer or the employee – the answer is certainly not a given (Stinchcombe, 1965, p.181 ff).
It is reasonable to assume that an individual that is activating ‘the leadership argument’ depends, by and large, on his/her social capital for the exercise of power. As leadership is not based on rational but charismatic grounds, the amount of power that can be exercised by the individual depends on which is the legitimacy the person and his ideas are granted by others. According to Weber ([1922] 1978, pp.215-216) ‘charismatic authority’ is “resting on devotion to the exceptional sanctity, heroism or exemplary character of an individual person, and of the normative patterns or order revealed or ordained by him”. It follows then that irrespective of a person’s hierarchical position in an organization the person may be in possession of more or less capacity to exercise power by activating ‘the leadership argument’ – as a matter of fact, some people have it, i.e. charisma, whereas other people do not have it. It is also a given that the charismatic person operating at the top of an organization is likely to have at his disposal more “means to get things done” than has the worker operating on the shop-floor, as the charismatic manager has at his disposal both ‘the managership argument’ and ‘the leadership argument’ and by that the position from which he can influence the course of events is particularly good (Barnard, [1938] 1968).

The charismatic worker on the other hand usually operates at a level of organization from which he can activate ‘the leadership argument’ only. His hierarchical position is such that he has small if any possibilities to come through with a message to the upper levels of the organization. He may scream out loud, but still nobody at the top may listen to him. However, also at lower levels of organization ‘the leadership argument’ may make a difference. Difficulties to convey information vertically (both upwards and downwards) through large organizations leave room for activities that are not controlled or monitored from above (Williamson, 1970; Galbraith, 1973). It is argued that there are a number of “working class heroes” (middle-management included) that make use of ‘the leadership argument’ – “take the lead” – in the everyday work of organizations, and that those individuals probably do more for the survival of many business firms than do some well-paid top managers. Be it by network contacts or through coalitions, the social capital they have at their disposal is a most valuable resource offering “the means to get things done”, it is argued. And a major share of the knowledge available on the operational level is inherited from the past and is the result of “hands on” learning and past experience (Penrose, 1959).

Industrial systems are inert and heavy industrial systems are particularly inert. In an attempt to improve the effectiveness and/or efficiency of industrial systems actors strive to change the ‘technological artifacts’ and the ‘techno-human routines’ making up such systems. Different actors striving for change might have different ideas as to the way things should be or what would be the proper way to do things. Usually their ideas also change over time. The theoretical model to be used in the chapter 7 analysis...
focuses on the ‘strategic intention’ of actors aiming at bringing about technological change in industrial systems and on the ‘structural inertness’ of such systems that has to be overcome for change to materialize. A most generic model comprising these components and their interrelationships is presented in Figure 6:1 where the circular shape and the bent arrows inside the circle represent “the arena for negotiations and change”. In the model ‘strategic intention’ is driving change whereas ‘structural inertness’ is restraining change from occurring. It is a given that the ‘strategic intention’ of different actors may go in different directions, a circumstance rendering “the arena for negotiations and change” characteristics similar to that of a battlefield, although the comparison should not be taken literally.

The actors, whether single individuals or groups of individuals (here the network and coalition phenomena should be considered when applicable), back their intentions by referring to various power sources. As they do, they commonly use the three arguments, viz. ‘the managership argument’, ‘the leadership argument’ and ‘the interest/monopoly argument’, which are usually combined in various ways in everyday life. ‘The managership argument’ may appear along with ‘the interest/monopoly argument’ but also along with ‘the leadership argument’. And ‘the leadership argument’ may well be combined with ‘the interest/monopoly argument’. Power thus activated manifests as force on “the arena for negotiations and change”. Force thus mobilized by an actor may encounter more or less strong countervailing or supporting forces emanating from other actors or from the prevailing institutional setting as such. The description indicates that technological change may appear as a most dynamic and unpredictable process, which might be both complex and complicated. The main empirical case presented in chapter 2 is a pertinent example of such a process of technological change. It had certainly been impossible to anticipate its progress in advance, and even afterwards it seems somewhat problematic to understand and describe what actually happened. The analysis performed above in chapter 5 offers certain insights into the course of events, but as it is held at a fairly high level of

Figure 6:1 Negotiating technological change – a generic schematic model

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1 The considerations coincide with those of Weber ([1922] 1978, p.216), who claims that the three types of authority he proposes, i.e. ‘legal authority’, ‘traditional authority’ and ‘charismatic authority’, are ideal types that are usually not observed in pure form in everyday life. They are rather constructs developed for the purpose of analysis, he claims.
aggregation where organizations and their interrelationships are given priority actors and processes appearing at lower levels of aggregation are largely left without notice.

The chapter 5 analysis appreciates four sources of technological change, i.e. ‘strategic intention’, ‘emergent developments’, ‘chance’, and ‘necessity’. The generic scheme presented in Figure 6:1 highlights ‘strategic intention’, ‘structural inertness’ and negotiations as the prime elements impacting upon the process of technological change. Figure 6:2 offers a more detailed model specifying arguments commonly used when aiming at intention-based action, i.e. ‘the managership argument’, ‘the leadership argument’ and ‘the interest/monopoly argument’, and again it is emphasized that different actors may resort to different arguments as they meet on “the arena for negotiations and change”, and the result of the negotiations performed is difficult to speculate about as the various arguments may go in different directions and may be underpinned by different sources of power. The developed model also specifies two most common sources of inertness, i.e. ‘physical resource “heaviness”’ and “taken-for-grantedness” (see section 6.7.1). The latter is assumed to be broadly dispersed in any organization. It represents all those “this is the way we operate here”, “don’t tell us how to do it, because we all know this is the right way to do it”, “we have tried other solutions but all of them were inferior, so that’s it”, etcetera, etcetera. This stance appears in all branches and at any organizational level. People advocating

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**Figure 6:2** Negotiating technological change – a developed schematic model
this kind of standpoint contribute to structural inertness no matter which is the existing structure they are defending. ‘Physical resource “heaviness”’ as a source of structural inertness has to do with size of investment in relation to company size and size of operations. Large investments in physical resources make change processes inert. The final piece of the puzzle concerns “what is it that is changing?”, i.e. the change object as such. In chapter 3 it was concluded that technological change is change in ‘technological artifacts’ and/or ‘techno-human routines’, and those two elements make up the last two pieces of the developed model.

“How does technological change come about in an international, industrial system?” In search for a further enriched answer the main empirical case will be subject to analysis at a micro level of aggregation in the next chapter, and the analysis will be guided by the conceptual framework summarized in Figure 6:1 and Figure 6:2.
7 NEGOTIATING TECHNOLOGICAL CHANGE (ANALYSIS)

Strategic intention as a most viable source of technological change is further investigated while appreciating the institutional character of the industrial system. By studying critical events along with the forces that created them, and those that made them dissolve, deeper understanding is gained about the process of technological change – a markedly dynamic process where negotiations appear as a most salient process element.

The macro analyses performed in chapter 5 identified four sources of technological change, namely ‘strategic intention’, ‘emergent developments’, ‘chance’, and ‘necessity’. The influence of ‘strategic intention’ on technological change is further investigated below. The reader should notice, though, that the source of change here denoted ‘emergent developments’ inevitably includes a certain portion of ‘strategic intention’, as the everyday activities performed in business firms at operational level, sometimes leading up to ‘emergent developments’, are actually, more often than not, intention-based thoughts turned into action.

“Power is the means to get things done” – Anthony Giddens (1984, p.175) statement serves as a starting point for the analysis to be performed in this chapter. When projected on the empirical case the statement immediately triggers the question: Who dispose(s) of and make(s) use of the power to get things done? The search for those who will be performed by identifying and studying critical situations appearing along the business process, while aiming at revealing which were the actors making the situation come about, and/or which were the actors that initiated/promoted corrective action, and what was the effect of the steps taken. The power of choice is much different for different actors, and the power resources at hand for different actors to act upon are certainly also much different.

The phenomenon of inertness is an important factor closely relating to change, and it is beyond debate that the world we conceive of is palpably inert. Inertness makes the existing resist change, which implies force is needed to make change come about.¹

Before moving on to the analysis part, i.e. before approaching the who and the what questions as well as the phenomenon of inertness, a few preparatory steps will be taken.

¹ This is at least true for stable systems. Fortunately systems surrounding everyday life in contemporary society are usually stable, a circumstance making them predictable without further notice. Some systems are unstable though. Such systems miss out on inertness, and they are unpredictable unless controlled by stabilizing forces. The Swedish fighter aircraft JAS Gripen may serve as an example. Unless its movement through the air is continuously monitored and corrected it is not possible to predict which will be its immediate future direction. A conventional aircraft on the other hand will, due to the impact of inertness, proceed along a set direction until it is influenced by external forces. Thus, the unstable system has to be stabilized in order to avoid unpredictable change, whereas the stable system has to be destabilized for any change at all to occur.
7.1 Staging the empirical case

As the empirical case is markedly rich on information the reader might find it difficult to comprehend all the various bits and pieces involved. Criticism might be raised as to the richness of description but as the analysis in this thesis work is performed at two different levels of aggregation – at the macro level in chapter 5 and at the micro level in chapter 7 – it has been judged appropriate to include quite many details along with the broader lines. To prepare for the micro level analysis below the empirical case will be given certain staging by which some areas are highlighted whereas other areas are played down or excluded.

7.1.1 Organization and staffing

The analysis concentrates on human beings and groups interconnecting with the focal relationship of the empirical case, i.e. the business relationship between Unit Cold Rolled (UCR) and Metal Extraction Ltd (MEL). The time period studied is framed by the years 1993 and 2001. The industrial context thus specified involves many people relating to technological change in connection with the cathode plate route1. Table 7:1 lists the more important individuals appearing in the narrative of the case. The period studied spans eight to nine years and muster three successive plant managers in the UCR organization, viz. (PL), (FH), and (JL), as well as three individuals carrying the responsibility for marketing and sales, viz. sales manager (SJ), and the two marketing managers (WN) and (KL). During the period there is also a shift of managing director in the Avesta Sheffield sales company in X-land (ASX) as the managing director ("the Swede") is replaced in mid 1996 by the managing director ("the Brit"). In the MEL organization there is a shift at the turn of 1997/1998 when the process technology manager (LN) is taking over the responsibility of his previous successor, the process development manager (MM), as to the ‘MEL refinery process’.

Two persons, namely the inside sales administrator Hanna Almgren (UCR), and the area sales manager Hank Kennyson (ASX), actively participate in cathode plate business through the entire period. Carl Juhlin (UCR), the production line manager of the cut-to-length line participates in the business from its inception up to mid 1998 when he is reallocated to shoulder the responsibility for a new slitting line under construction at UCR. Some individuals influencing cathode plate manufacturing and the development of the UCR-MEL business are not listed in Table 7:1. One of those is the logistics manager of UCR, who was involved in the business from its inception up to the end of 1997.2 Another figure is the quality manager. The man held his professional role at UCR through the 1990s as far as is known. Still another is the development engineer/purchaser of MEL who is doing the everyday administrative

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1 The cathode plate route is outlined in Table 5:3.
2 Perhaps he participated in the business also after 1997 but that is of minor interest as the problems relating to his area of responsibility were resolved by the end of 1997.
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<td>Product quality</td>
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<td>Delivery performance</td>
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<td>Some employees central to cathode plate business</td>
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<td>Plant Manager (PL) – from the 1980s up to 1996</td>
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<td>Plant Manager (FH)</td>
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<td>Sales Manager (SJ)</td>
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<td>Marketing Manager (WN)</td>
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<td>Marketing Manager (KL)</td>
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<td>Inside Sales/Order Administrator – Hanna Almgren</td>
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<td>Production Line Manager CTL – Carl Juhlin</td>
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<td>Liaison role – Product Manager (OJ)</td>
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<td>Project group – led by Product Manager (OJ)</td>
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<td>Discussion forum – led by Mark Develop Man (LL)</td>
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<td>Telephone conference UCR/ASX</td>
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<td>Liaison role – Quality Assurance (QA) “guy”</td>
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<td>Managing Director (“the Swede”)</td>
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<td>Managing Director (“the Brit”)</td>
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<tr>
<td>Area Sales Manager – Hank Kennyson</td>
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<td>Process Development Manager (MM)</td>
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<tr>
<td>Process Technology Manager (LN)</td>
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Table 7:1 Unit Cold Rolled-Metal Extraction Ltd cathode plate business through time – some critical situations, formal staffing, special integrating arrangements
work as to cathode plate supply. Also this man was involved in the business through the entire 1990 as far as is known.

The individuals mentioned so far relate to cathode plate business on a permanent basis as part of their respective professional roles. A few other persons are appointed temporal responsibilities for the enhancement of cathode plate business. In the end of 1995 product manager (OJ) is put to shoulder a liaison function as to cathode plate business in general, and in mid 1996 he is appointed the role to lead a cross-functional project group ascribed the task to come to grips with UCR’s manufacturing and quality problems. During the early autumn of 1997, at a time when all warning lights have been twinkling constantly for more than half a year, marketing development manager (LL)\(^1\) is appointed the task of chairing a temporal discussion forum addressing the cathode plate issue. The forum activates a broad group of people in the UCR organization. Lately, in the mid of year 2000 when the business suffers from an emergency situation, a liason and integrating task role is given to a quality assurance (QA) “guy”. And finally, all the bits and pieces as to cathode plate manufacturing in the UCR production system come together.

As the above discussion and Table 7:1 show many individuals take part in cathode plate business during the 1990s. It should be noted, though, that the people mentioned make up just a small part of all those people that contribute to the business in various ways. However, those not mentioned do not hold core positions in relation to the business. It is a given, for instance, that many blue and white collar employees engage in various ways in the manufacturing and administration of the business both in UCR and MEL. If taking a closer look at Table 7:1 a most interesting observation can be done. From 1995 up to the end of 1997, which is the most intensive development period of the UCR-MEL relationship concerning technological change and problem solving, new top managers arrive both in the UCR and the ASX organizations. It follows that neither does the plant manager of UCR nor does the managing director of ASX have the full historical picture at their disposal as to the cathode plate business with MEL. The same goes for the marketing manager of UCR. In the MEL organization continuity is better cared for. The process development manager is upholding his position through the entire period of intensive problem solving. At the turn of 1997/1998 his predecessor, the process technology manager (LN), becomes his successor.

The various companies and business units appearing in the empirical case seem to employ a vertically oriented organization structure, where each function is represented by a functional manager. That is at least true for UCR where the plant manager is carrying the overall responsibility for all operations of the unit. At the next level the production manager is responsible for manufacturing, the quality manager for quality issues, the marketing manager for marketing and sales activities, and so on. Each

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\(^1\) The author of this thesis work.
manager organizes a number of subordinates that report to the manager. All production facilities (the lion’s share of the physical resources of the UCR unit) are put under the control of the production manager, who reports to the plant manager. The production manager also organizes the largest share of the unit’s employees (probably 60-70 % of the total number of employees). Thus, the functional organization structure renders the production manager a strong power position as a major share of the unit’s resources, both regarding people and physical objects, such as production facilities and products in progress, are put under his command. The formally distributed potency to mobilize ‘allocative resources’ and ‘authoritative resources’ adheres to the hierarchical, vertically oriented, organization structure, and, as the production manager (under guidance of the plant manager) is assigned the greater part of all those ‘resources’ on which other actors, both internal (e.g. other managers and employees in general) and external (e.g. customers) depend, his power position is particularly strong (Pfeffer & Salancik, 1978). The functional managers along with the plant manager make up the management team of the unit. The management team of UCR inevitably qualifies as an important change agent in the business context of the empirical case. It may be considered the dominant coalition of the case (Cyert & March, [1963] 1994). Although supposed to be a coherent group the analysis will show that coherence is not a given in regard of the management team. Temporally formed coalitions shift the power balance within the team and by that “the means to get things done”. Besides, except for the management team of UCR other “centers of dominance” influencing the process of technological change are identified in the below analysis.

7.1.2 Critical situations and episodes in cathode plate business

Roughly eight years of business evolution between UCR and MEL are studied. During that time period several critical situations turn up, the critical character of which is traced back to various sorts of mismatch or gaps appearing in the interface between the parties involved.1 Between the critical periods it is business as usual involving several individuals in the various organizations. Everyday business operations bring about change, no doubt, and change thus created is referable to as ‘emergent developments’. The importance of this kind of change should by no means be underestimated, although it commonly emerges without too much of excitement, and it is argued here that the everyday work performed by operational people is, more often than not, the (hidden) source of business success, because it includes a large portion of social interaction generating social structure (Homans, 1951; Nadel, 1957), which is one of the most valuable assets there is when it comes to problem solving taking into account more than one human being (Coleman, 1988; Burt, 1992a; Nahapiet & Ghoshal, 1998). Everyday operations and incremental change are certainly much important elements of any business development process. Notwithstanding, the below analysis will focus on some critical situations and episodes while omitting much of the everyday (normal) business operations appearing (more or less visibly) in the case.

1 The phenomenon is thoroughly discussed in section 5.4.2 above.
### Table 7:2 Critical situations in cathode plate business

<table>
<thead>
<tr>
<th>Time</th>
<th>PQ</th>
<th>DP</th>
<th>PR</th>
<th>Description of the critical situation</th>
<th>Corrective action (proposed – taken)</th>
<th>Initiator/promoter of correction proposals</th>
</tr>
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<tbody>
<tr>
<td>95Q1</td>
<td>PQ</td>
<td></td>
<td></td>
<td>First delivery; problems relating to flatness, surface finish, and transportation;</td>
<td>Various ad hoc activities, among those piece-mal roller levelling at DSL;¹</td>
<td>Hank Kennyson and the Managing director (“the Swede”) of ASX;</td>
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<tr>
<td>95Q3</td>
<td>PR</td>
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<td>’Firm price’ needed by MEL, ’rise &amp; fall clause’ offered by UCR;</td>
<td>Reintroduction of ‘firm price’;</td>
<td>MEL through Kennyson;</td>
</tr>
<tr>
<td>96Q1</td>
<td>PQ</td>
<td>DP</td>
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<td>Reoccurring problems with flatness, surface finish, surface defects; Short and late deliveries²;</td>
<td>Visualization of problems; Start-up of a liason role and a project group in UCR; UCR assigns MEL ‘key customer’ status;</td>
<td>Carl Juhlin and Hank Kennyson visualize the problems; Marketing manager (WN) initiates corrective action;</td>
</tr>
<tr>
<td>96Q3</td>
<td>PR</td>
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<td>Pricing problems; uncertainty on the financial and raw materials markets;</td>
<td>Sensible pricing formula worked out by Product manager (OJ);</td>
<td>Managing director (“the Brit”) of ASX and Kennyson;</td>
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<tr>
<td>96Q4</td>
<td>DP</td>
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<td>Poor delivery performance;</td>
<td>Safety stock proposal;</td>
<td>Managing dir. (“the Brit”) of ASX and Kennyson;</td>
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<tr>
<td>97Q1</td>
<td>PQ</td>
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<td>Product quality problems caused by insufficient performance of the new cold rolling mill;</td>
<td>Intensified work in the project group within UCR with focus on manufacturing issues;</td>
<td>Several people in the UCR organization as well as Kennyson;</td>
</tr>
<tr>
<td>97Q3</td>
<td>PQ</td>
<td>DP</td>
<td></td>
<td>Manufacturing problems, insufficient product quality, poor delivery performance;</td>
<td>Start-up of a discussion forum; Start-up of a telephone conference;</td>
<td>Marketing manager (KL); Order administrator of ASX;</td>
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<tr>
<td>97Q4</td>
<td>PR</td>
<td></td>
<td></td>
<td>Price competition puts UCR at a disadvantage at MEL;</td>
<td>Proposed – no action taken;</td>
<td>Kennyson and Managing director (“the Brit”) of ASX;</td>
</tr>
<tr>
<td>99Q3</td>
<td>PR</td>
<td></td>
<td></td>
<td>An order lost to Outokumpu on price shows that UCR’s cathode plate business with MEL is put on risk;</td>
<td>A formal supplier agreement between UCR and MEL including transparent pricing is claimed for;</td>
<td>Kennyson;</td>
</tr>
<tr>
<td>99Q3 - 00Q2</td>
<td>PQ</td>
<td>DP</td>
<td></td>
<td>The ‘new thin strategy’ of UCR puts the cathode plate business at a disadvantage; product quality and delivery performance successively go down;</td>
<td>A Quality Assurance (QA) “guy” is assigned the task to follow up the cathode plate business of UCR as to manufacturing procedures;</td>
<td>Kennyson;</td>
</tr>
</tbody>
</table>

¹ Roller levelling is subcontracted to DSL from 1995 to 1997.
² The allocation of input material (hot band) for the manufacturing of cathode plate in the UCR mill is based on standard yield numbers. As a consequence each order expedited for MEL up to 1997 is undersupplied.
Some problem situations concerning product quality, delivery performance, and pricing connecting to cathode plate business are identified. The upper rows of Table 7:1 notify those situations and episodes in relation to time. The markings in the table (the black squares) denote the troublesome appearances. Some of them may even be conceived of as “crises” although the character of crises may vary from “soft to dramatic”. The critical situations shown in Table 7:1 are repeated in Table 7:2 where more information is given about their content. The information includes a short description of the situation, the corrective action proposed and/or taken, and the initiator/promoter of correction proposals. The shaded areas in the table denote situations suffering from product quality problems. They immediately connect to the process of technological change. The table is meant to serve as a structuring guide preparing for the analysis to be carried out. The pattern shown in the tables indicates that most problems relating to business interaction between UCR and MEL appear through the years 1995 to 1997. During this period of time the critical situations that arise are met quite soon by attempts to correct them for the better. In some cases the measures taken are effective, in other cases they are not. And some problems remain unresolved for many years. For a period of almost two years from mid 1999 to mid 2000 UCR’s business with MEL is markedly problematic. This is the time when the new plant manager (JL) goes for the new “thin strategy”, which is putting cathode plate business at a disadvantage. As a matter of fact the business is largely ignored over a long period of time.

The analyses of the critical situations to be performed below will address the situation as such, the various arguments raised to make change come about, the actors raising the arguments, and the structural obstacles involved. The idea is to have a close look at “the arena for negotiations and change” (see Figure 6:2). As the approach emphasizes critical events rather than drawn-out processes a summary discussion will be performed with focus on various coalitions that emerge and operate over time along the line of technological change

7.2 Analyzing some critical situations appearing in cathode plate business

As various change agents operate in the industrial system of the case they leave imprints, which sometimes impact upon the process of technological change, but as the industrial system is assumed to be markedly inert many attempts to make change come about fall short. Moreover, as various defenders of the existing order will do what they can to prevent change from occurring, those striving to create change have to mobilize enough resources to overcome the “resisting threshold”. This is what the analysis will be about as some of the critical situations and episodes outlined in Table 7:1 and Table 7:2 are elaborated. Critical situations concerning product quality are given priority in the analysis because those are the situations relating most closely to the issue of
Long-term close and frequent interaction as to cathode plate business

Normal professional and/or social interaction as to cathode plate business – more or less close-loose/frequent-sporadic interaction from time to time depending on actor roles and business situations

**Figure 7:1** Professional and social connections between individuals in cathode plate business
technological change, but as most of these situations also contain problems relating to poor delivery performance this particular issue will be discussed at the same time. Thus, the situations 95Q1, 96Q1, 97Q1, 97Q3 and 99Q3-00Q2 are those that will be explicitly elaborated. The pricing issue showing up in the critical situations 95Q3, 96Q3, 97Q4 and 99Q3 will be briefly covered as groups and individuals influencing technological change in regard of cathode plate business are discussed in section 7.3. Figure 7:1 is a schematic view showing the professional and social connections interrelating individuals concerned. The scheme aims at supporting the discussions performed in the below analysis.

7.2.1 Critical situation 95Q1 – product quality

This situation is characterized by severe problems regarding product quality (plate flatness, surface finish) to which are linked inconsistencies when it comes to methods of testing and measurement. Initially there are also problems relating to packaging and transportation. Immediate action is taken by area sales manager Hank Kennyson (ASX), who inspects the material on site after arrival in X-land, engages with emphasis in the problems concerning transportation and packing, and actively participates also in the exchange of information between MEL and UCR as well as the clearing of inconsistencies concerning testing and measurement. The most troublesome problem following on the initial critical situation relates to the fifty tons of material suffering from imperfections regarding flatness, material waiting on X-land ground for corrective action. The problem gets its resolution as Domestic Steel Ltd (DSL) accepts to take on the roller leveling job at their X-landian production site. But why did DSL accept to support UCR, who is actually MEL’s main competitor, at a time when the early relationship between UCR and MEL had encountered severe product quality problems? And how did this critical situation get its resolution?

Some answer proposals have been forwarded in section 5.4.1 above as the case was analyzed in a business network perspective. Here the discussion will focus on the various individuals and groups involved and their respective possibility to influence the situation. At the time the critical situation 95Q1 emerged the ASX organization was still governed by the managing director ("the Swede"), engineer by education. In the past the man had held the marketing manager position in UCR. Thus, he was sort of a “mill man”. As such he was well informed about manufacturing procedures and practices, and he meant that the fifty tons of defect cathode plate had to be flattened, no doubt. But on X-land ground the only roller leveler available was controlled by DSL and going outside X-land was not an issue as transportation costs would rise high, and, even worse, time was too short for such operations. Thus, the only realistic solution was to get access to DSL’s manufacturing equipment, but how to accomplish that? Now, the actors that met on “the arena for negotiations and change” comprised Kennyson, the managing director of ASX (“the Swede”), and some representatives of DSL. The marketing department of UCR and the people in charge of hot band
production at BSS(f), one of UCR’s sister units in UK, were present in the periphery. Another most interesting inquiry goes: Which were the various arguments that were raised during the negotiations? Before approaching that question a few words about the phenomenon of structural inertness relevant to the critical situation 95Q1 will be forwarded.

When discussing the precarious situation it seems relevant to refer also to ‘physical resource heaviness’ (Håkansson & Waluszewski, 2002). Roller levelers certainly represent heavy industrial equipment that cannot easily be moved from one place to another, and neither can the rules that are inscribed into such technological artifacts be easily modified. “You have what you have, and what you have is where it is!” These are ‘resource heaviness’ aspects affecting the process of change. Concerning the empirical case the inertness of the industrial system and the fact that the resources required were controlled by a competitor of UCR could well have jeopardized the entire development of the MEL-UCR business relationship had DSL not placed their roller leveler at UCR’s disposal. Also the fifty tons of inferior cathode plate were coupled with a certain portion of inertness. Moving the material over large distances for corrective action to be taken was actually not a realistic alternative, and as corrective action had to be performed by activating a special type of rare equipment, viz. a roller leveler, and no other equipment could do the job the cathode plate material also showed traits of inertness. The ‘resource heaviness’ showing up in the case was a most constraining factor that could not be conquered. By-passing the obstacle seemed to be the only accessible way to manage the situation.

Hank Kennyson and the managing director of ASX decided that the latter should approach DSL in an attempt to establish a provisional subcontractor agreement with DSL as to roller leveling capacity. Now, what arguments could possibly be effective in such a negotiation? A most obvious argument relates to DSL’s procurement of hot band from BSS(f). As the managing director of ASX was well informed about the practice of stainless steel manufacturing he could easily run a professional discussion in the area with DSL’s production manager, and as he did he referred to the argument that “friends are helping friends”. Though competitors to some extent in relation to the MEL business, DSL and ASX were more of complementary suppliers on the X-land market the managing director of ASX maintained, and he emphasized that ASX aimed at more specialized products in X-land whereas leaving for DSL to cover the market for standard products. The fact that DSL since years secured hot band supply from BSS(f) may have influenced the outcome of the negotiations, as it can not be left out of account that DSL might have felt that their feedstock supply was threatened. Although threats were never raised by the managing director of ASX\(^1\), but rather a wish for cooperation, it is difficult to know how the situation was interpreted by the DSL people. Threat or no threat conceived of, the effect is the same. It is ‘the

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\(^1\) When interviewed in a short telephone call on May 24, 2007 the former managing director of ASX, “the Swede”, made clear that threats were never used in the negotiations with DSL.
interest/monopoly argument’ operating although its strength might vary due to which are the forces underpinning it.

Some conclusions can be drawn from the discussion. First, ‘resource heaviness’ makes industrial systems inert and inertness impedes change (Håkansson & Waluszewski, 2002). The above analysis shows that an obstacle posed by ‘resource heaviness’ early in the process of relationship development could have interrupted the interaction between MEL and UCR, but in the actual case particular circumstances, and also a significant portion of entrepreneurial thinking and acting, facilitated continuation and further interaction, which was a necessary prerequisite for technological change to materialize at UCR in regard of the manufacturing of cathode plate. Second, the people at DSL obviously applied the logic of “friends are helping friends” as they opened for a subcontractor agreement with UCR/ASX. Their position was forwarded by Hank Kennyson in a fax to the UCR people. An excerpt from the fax reads: “They [DSL] indicated that in the interest of our good relationship they will not ‘rip us off’ with a high rate.” At this point in time DSL secured their input of hot band from BSS(f), and it is probable that this circumstance influenced the decision to take on the roller leveling task in relation to UCR/ASX. As a matter of fact, in this particular situation DSL and the Avesta Sheffield group showed most obvious signs of interdependency, because short term none of them was in a position to mobilize an alternative counterpart able to solve their respective problem (Campbell & Cunningham, 1983). The individuals negotiating for DSL and ASX were perfectly aware of that. The episode shows ‘the interest/monopoly argument’ in operation, but this time both parties face a monopoly-like situation. The analysis performed concerning the ‘Critical situation 95Q1 – product quality’ combines ‘resource heaviness’ and ‘the interest/monopoly argument’ to explain what happened (Håkansson & Waluszewski, 2002; Weber, [1922] 1978; Emerson, 1962).

7.2.2 Critical situation 96Q1 – product quality and delivery performance

Although improvements were made during 1995 concerning packing and transportation, as well as regarding methods for testing and measurement, at the end of the year UCR’s product quality as to cathode plate still suffered and the unit’s delivery performance was poor in relation to MEL, who several times during the year had raised complaints about it. In the summer of 1995 a new marketing manager (WN) was employed at UCR and the man soon developed an interest in cathode plate business in general, both from a price/profit and a volume point of view. He decided to make product manager (OJ) responsible for the application. With the responsibility followed the task to find out about the current and future market for the application, but also to closely engage in UCR’s business with MEL. The assignment was meant to go into effect in the beginning of 1996.
In late 1995 a crises situation is under way. The production manager of the CTL line, Carl Juhlin, in a written report raises claims about UCR’s inability to produce enough flat material. The report is dated December 17 and addresses three upper officials of the UCR organization. Juhlin proposes that quality inspection ought to be introduced as an integral part of the manufacturing procedures as to cathode plate. A few months later in March 1996 Hank Kennyson forwards severe complaints about UCR’s deficiencies both as regards product quality and delivery performance. This is the first time Kennyson claims that “we should ‘extend back’ into the processing line” and “the corrective action needs to be taken at the source ...”. The message is clear, future business is not likely to materialize unless improvements are made. Now, the UCR marketing manager (WN) takes two important steps. He assigns MEL “key customer” status and he forms a cross-functional “cathode plate project group” to be led by the product manager (OJ). Throughout the year 1996 the project group works on a modified production route for the MEL product, and on January 31, 1997, the production manager of UCR in a written report announces: “We have now developed a reasonably safe process route for [MEL] material”\(^1\).

It seems that the main obstacle for successful business to develop in the UCR-MEL relationship is coupled with the procedures employed by UCR for the manufacturing of cathode plate, which is also indicated by the product quality and delivery performance problems that UCR is suffering from. But who are the actors that are entering “the arena for negotiations and change”, and which are the arguments they mobilize in order to solve the problems encountered? In the critical situation 96Q1 the following individuals appear as central figures: the marketing manager of UCR (WN), the production manager of the CTL line Carl Juhlin, the area sales manager of ASX Hank Kennyson, and the product manager (OJ). Several members of the “cathode plate project group” also contribute to resolving the problem situation.

Carl Juhlin is the one person in the production department of UCR that first seriously considers and openly communicates upwards in the organization the severe quality problems that the cathode plate product is afflicted with. As he does he also announces that he is surprised that the product still suffers from flatness problems, as “we know what is required and we know what to do if things go wrong”\(^2\). At the time Juhlin still believes that appropriate manufacturing procedures (formal and/or informal) are in place at UCR for the production of cathode plate, and based on that assumption he concludes that the quality problems must derive from nonconforming operator behavior. Consequendy he proposes quality inspection to be integrated in the manufacturing procedures, a message that is communicated up the lines to the plant

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1 The new process implied that more material was withdrawn in the form of ‘arisings’ in the cut-to-length line, and, as a result, the yield dropped significantly. As no compensation was accounted for on the input side of the process route (input of hot band) future orders should regularly be undersupplied. This side-effect was not properly managed until mid autumn 1997. (See section 7.2.4 below.)

2 Excerpt from Juhlin’s written report of December 17, 1995.
manager, the marketing manager and the quality manager. It is not surprising that Juhlin is the first person to strongly react on the quality problems in the UCR production department as he controls the finishing operations performed in the cut-to-length line. This is “the eye of the needle” through which all cathode plate products have to pass on their way to the customer, and, as a matter of fact, several times in the past product quality has been sorted out at this “terminal station” of the UCR production route. As Juhlin strongly believes that nonconforming (and thus inferior) operator behavior upstream the production route is the “villain of the piece” he turns to upper level managers, who are in a position to mobilize the appropriate ‘authoritative resources’, i.e. to command the employees concerned to act properly when performing their respective tasks (Giddens, 1984). By reasoning he aims at stimulating those managers to use ‘the management argument’ to remedy the critical situation (Weber, [1922] 1978).

Hank Kennyson is the second person in this critical episode to enter “the arena for negotiations and change”. In a comprehensive fax arriving at UCR in mid March 1996 he gives detailed recommendations about what is needed and what could be done to save UCR’s business with MEL. In his endeavor to make his voice heard (i.e. to dominate the situation) at this particular point in time Kennyson has at his disposal only one substantial argument and that is calling upon the risk for UCR to lose the business with MEL. In his fax, which is directed to the marketing personnel of UCR, he claims “we may not get many more chances”, a statement equivalent with “we may lose this business”. This is ‘the interest/monopoly argument’ in operation. But should the business with MEL disappear which would be the loss for UCR? The strength of the argument is directly proportional to the interest (dependency) of the party the argument is addressing (Weber, [1922] 1978; Emerson, 1962) and at this point in time the interest of UCR is probably quite low. Several reasons can be forwarded underpinning such a statement, (1) the UCR-MEL business relationship is still under development, (2) business exchange has not yet reached particularly large volumes, and (3) through the years 1994-95 the Avesta Sheffield group (UCR included) perceived one of its most prosperous business periods ever (see Table 2:1)\(^1\). So one may question: Who is the more dependent party of the two? It seems clear that MEL is the more dependent one as their requirements are obviously difficult to satisfy by turning to another stainless steel supplier. UCR on their hand can probably quite easily fill out the short fall should the business with MEL disappear. Thus, it is likely that the ‘the interest/monopoly argument’ raised by Kennyson is not particularly effective in early 1996.

\(^1\) Particularly the last item would point in a direction of low interest at this point in time due to the fact that the profitability of average business in standard products through the years 1994-95 hits the same level as that of the MEL business. Later on during periods of recession, though, the profitability of the MEL business by far exceeds business in standard products.
It is interesting to note that both Juhlin and Kennyson call for improvements to be performed upstream the process route in the production system of UCR as many “inherited” defects cannot be corrected for in the CTL line. It is also interesting to recognize that complaints are raised both internally and externally; by Juhlin from within the UCR organization and by Kennyson from the outside (with reference to MEL). However, neither Juhlin nor Kennyson dispose of the ‘legal authority’ to command the personnel they think are not performing well enough. That is why they resort to reasoning (Juhlin) and interest (Kennyson) to influence those in a position to exercise such command. It is clear that Juhlin is not in a position to command production facilities outside the CTL line, but, as he is much familiar with most manufacturing procedures in the UCR plant, and, as his reputation is highly valued in the UCR organization, he holds a position from which he can exert certain influence on other people in the mill, people holding positions from which they can mobilize both ‘allocative resources’ and ‘authoritative resources’ for the improvement of the upstream part of the cathode plate process route (Giddens, 1984). People trust Juhlin and they rely on him. He is not a person that is talking with a loud voice, but people listen to his arguments. He certainly operates from some kind of leadership position as other employees seem to ascribe him and the ideas he puts forward a high level of legitimacy (Weber, [1922] 1978; Barnard, 1939; Selznick, 1957). His relations with various employees in the UCR organization along with the resources these people control constitute a considerable social capital that can be mobilized in order to make things happen (Burt, 1992; Nahapiet & Ghoshal, 1998). Now, the importance of Carl Juhlin in this respect shall not be exaggerated but it is clear that his social and professional links to various employees in the UCR organization, both inside and outside the sector he is controlling by way of his professional role, involve a lot of trust and confidence (Blau, 1964; Hannerz, 1996). And ‘the leadership argument’ becomes particularly effective when operated by Carl Juhlin, because in his endeavor “to get things done” he can make use of a strong charismatic personality as well as an extensive stock of social capital.

Marketing manager (WN), a newcomer in the UCR organization, is a strong believer in cathode plate business and he assigns product manager (OJ) responsibility for further developing the business, a responsibility originally meant to develop new businesses for the application. Before the man shoulders his new assignment the critical situation 96Q1 is brewing, and with the arrival of Kennyson’s fax in March 1996 the assignment is reformulated to focus primarily on unit internal process development rather than market development for the application. This is the point in time when the cross-functional “cathode plate project group” is formed, a group involving four works managers representing different sectors of UCR’s production department, the quality manager, the inside sales administrator Hanna Almgren, and the product manager (OJ). The initiative is taken by marketing manager (WN), who now enters into “the arena for negotiations and change” by assigning group coordinating responsibility to the product manager (OJ). By so doing he uses ‘the
managership argument’ at his disposal and the group is doing a tremendous job through the year 1996 ending up in a “reasonably safe process route for [MEL] material” as announced by the production manager on January 31, 1997.

The work of the “cathode plate project group” revealed that the critical situation 96Q1 appeared because UCR used several non-optimal or inadequate manufacturing procedures for the manufacturing of cathode plate. Although people had believed that the various procedures were appropriate for the purpose the specialness of the product had not been seriously considered. Manufacturing had been performed in accordance with UCR’s standard operating procedures, by and large, procedures that were meant to be applicable on a general basis for the steel grade, width and thickness. The appropriateness of those standard procedures had been “taken-for-granted” as the indicators (i.e. steel grade, width and thickness) pointed in that direction (Schutz & Luckmann, 1973; Cyert & March, [1963] 1994; Nelson & Winter, 1982). As the outcome did not regularly meet MEL’s product specification the risk for friction to appear along the “full” cathode plate route (including MEL and MEL’s customers) was most obvious, and with deficient product quality followed lousy delivery performance. The critical situation triggered reactions from inside the UCR organization (Carl Juhlin) as well as from the outside (Hank Kennyson). After a few years with cathode plate business Carl Juhlin finally objected to repeatedly having to work with inferior material in the CTL line, and from the outside Hank Kennyson continued his fight for the customer and for keeping the business alive.

The above analysis shows that “taken-for-grantedness” is sometimes a most poor and unreliable adviser for feasible action to occur. For a long time both Carl Juhlin and Hank Kennyson, and with them also many other people in the UCR organization, thought that the manufacturing procedures employed were appropriate for the production of cathode plate. How wrong they were! Several months of cross-functional interaction work in the “cathode plate project group” made them change their minds. To be suitable for the task the standard procedures had to be modified, and step by step the necessary modifications were carried out through the year 1996. The case also shows how “taken-for-grantedness” manifests as a source of ‘structural inertness’. As everybody thought that everything was well (agreed upon the appropriateness of the manufacturing procedures employed) they looked into other directions in order to find valid explanations for the observed product quality deficiencies. As “the lie” was institutionally embedded it survived almost two years until it was finally disclosed, and as long as information was missing about the actual circumstances the things at hand, i.e. standard operating procedures, were utilized (Scott, 1995; Cyert & March, [1963] 1994). Basically, that was actually a most reasonable choice as standard operating procedures are usually all that is available in the first place. Changing such procedures to better fit the manufacturing of a special product takes both willingness and effort. Changing what is “taken-for-granted” is changing the way of thinking before changing the way of acting. It is overcoming
inertness residing in peoples’ agreements about the way things are. “Taken-for-grantedness” when guiding behavior serves as a most palpable change impeding element. The work of the “cathode plate project group” made technological change come about as they erased the “taken-for-grantedness” interconnecting with the manufacturing procedures used for the production of cathode plate. They actually modified some of the ‘techno-human routines’ operating together with ‘technological artifacts’ in the production department of UCR, while making them suitable for the manufacturing of cathode plate (Nelson & Winter, 1982). Their work did not impact upon the production facilities as such, but it certainly affected the way the facilities were utilized. As a matter of fact the group actually exploited resource heterogeneity as they drew new services from existing resources, services that were better fitting the purpose at hand (Penrose, [1959] 1995).

The analysis of the critical situation 96Q1 and the episode following upon the situation shows how ‘techno-human routines’ may be subject to change as various actors raise arguments about what ought to be done. “Taken-for-grantedness” is shown to be a change impeding factor whereas all the three arguments presented in the model ‘negotiating technological change’ (Figure 6:2), i.e. ‘the managership argument’, ‘the leadership argument’ and ‘the interest/monopoly argument’, come to the fore mobilized by various actors aiming at making change come about. It seems also that Carl Juhlin and Hank Kennyson come rather close to each other in the episode while sharing a similar enacted view of the critical situation and the problems embedded in it. To a certain extent they also share ideas about how to handle the problems. By the work of the “cathode plate project group”, which involves various employees from different organizational sectors, learning about the cathode plate product and its manufacturing is enhanced. When assigning MEL the epithet ‘key customer’ the marketing manager (WN) performs a symbolic act seemingly meant to add certain specialness to business exchange with MEL.

7.2.3 Critical situation 97Q1 – product quality

It was good news when the UCR production manager in the end of January, 1997, announced that a reasonably safe production route was now developed and implemented for the manufacturing of cathode plate. By that the “cathode plate project group” that had started almost a year earlier had fulfilled its task. Ironically enough, this was also the point in time when UCR brought a new cold rolling mill into service, a piece of equipment that should come to cause more problems than anybody could ever anticipate beforehand. The emerging troublesome situation nurtured the decision to keep the project group in place, and the product manager (OJ) was asked to do his utmost to save the business with MEL although the new mill seemed to do its best to make it collapse.
The first half year of 1997 was a disaster. Through this difficult time Kennyson kept close and frequent contact with personnel at UCR. His two-way communication with Carl Juhlin was particularly intense during this period. He also worked closely together with Hanna Almgren, who contributed most substantially to the survival of the business with MEL by finding and allocating, time after time, additional hot band into the working orders running for the customer, as now the yield numbers achieved in production had dropped far below the normal for cathode plate. Almgren’s access to the coil reservation system of UCR opened for “innovative logistics”. She picked up half a heat\(^1\) here, another heat there, and so on. The modified process route, in operation since the beginning of the year, implied that all MEL orders were undersupplied as no adjustments had been done on the input side of the process. This circumstance raised further pressure on Almgren to manage “innovative logistics” on an ad hoc basis. She actually saved many situations from developing into a total disaster, and that was something that Kennyson was most grateful for. Inside the UCR organization Almgren and Juhlin worked closely together in order to do the best out of a most troublesome situation.

The critical situation 97Q1 evolved as a result of one major strategic act, i.e. the establishment of the new cold rolling mill at UCR. The act emanated from ‘legal authority’ in operation, i.e. ‘the managership argument’, (Weber, [1922] 1978) as the Avesta Sheffield group management approved the investment proposal raised by the local management of UCR concerning a new cold rolling mill. Moving the project from the stage of request to that of final decision certainly involved a lot of negotiations between local management and group management (Cyert & March, [1963] 1994). In an attempt to save money, and by that getting approval for the project, local management proposed the new mill to be erected on the foundation of the old mill, a solution that should substantially reduce the magnitude of the investment. The request that was finally approved by group management included that solution. Unfortunately the “smart solution” also introduced a particular weakness into the project because at the time the new mill had replaced the old mill the old mill was no more available to bring service as a backup resource. Had the new mill been erected on a separate foundation the old mill could have stayed on duty during the running-in period of the new mill. Now, if the new mill had been operating to satisfaction from the very first day, as was anticipated, everything had been just fine, but unfortunately it didn’t. ‘The managership argument’ and the negotiations performed by the management of Avesta Sheffield at different levels, with bearing on the new cold rolling mill project, put the manufacturing operations of UCR at a great risk and jeopardized the entire business with MEL. The conclusion is that management when introducing new technology embedded in a new ‘technological artifact’ actually introduced substantial friction into the ‘area-between-events’ along the ‘cathode plate route’. Technological change taking place during the critical episode 97Q1 did not

\(^1\) One heat comprised roughly 80 or 120 tons of hot band depending on which was the steel mill that had produced the material.
bring improvement to the ‘cathode plate route’, on the contrary, it made it deteriorate. The episode illustrates how different strategic intentions and different endeavors may go in different directions. Change that is beneficial for one particular project may be detrimental to another project. Various individuals, groups and organizations may have different goals and different endeavors. It follows that change realized may be beneficial for one project/interest whereas at the same time it may be a disaster for another project/interest (Cyert & March, 1963; Lawrence & Lorsch, 1967).

Another phenomenon observed in relation to the sustained troublesome situation, here referable to as critical episode 97Q1, is that Kennyson and Almgren gradually came closer to each other during the first half of 1997. The relationship between the two, which was friendly and familiar already prior to this drawn-out process of poor delivery performance, now further developed as Almgren did her utmost to keep the customer happy. To claim that she practiced “innovative logistics” is actually an understatement. The two developed strong mutual trust between themselves. In parallel to this development Kennyson and Juhlin further developed their relationship with focus on the manufacturing difficulties that appeared. (Nadel, 1957; Ford et al, 1986).

It seems that “something more” and different from just strong autonomous relationships evolved. As the purpose of these three individuals was so strongly directed towards “making it”, i.e. saving the business with MEL, it is rather appropriate to refer to the three as a coalition advocating a common purpose (Emerson, 1962; Cyert & March, [1963] 1994; Pfeffer & Salancik, 1978). And this coalition did not emerge at random. It grew out of a need to make certain things happen and its triadic structure interconnected both physical resources and individuals in such a way that the “means to get things done” were available, within limits, although none of the three coalition members formally had at their disposal enough ‘legal authority’ (‘the managership argument’) to mobilize actors and physical objects for the task at hand (Weber, [1922] 1978; Giddens, 1984). However, Kennyson, backed by MEL, was in a position to use ‘the interest/monopoly argument’ to a certain extent. Almgren, operating at the legitimacy boundary relative to her role as an inside sales administrator, took advantage of “innovative logistics” rendering her a position from which she was capable of mobilizing ‘allocative resources’ by way of ‘the managership argument’ (commanding input of hot band into the manufacturing process) beyond the actual limit of her role-prescription. Juhlin, widely respected for his broad knowledge, good arguments, and charismatic image, was in a position to influence activities far beyond ‘the managership argument’ he disposed of from his formal organizational position. In addition to the authority that was formally assigned to him through this position the man also had at his disposal a most obvious portion of ‘charismatic authority’ that supported his use of ‘the leadership argument’. Thus the coalition constituted by Kennyson, Almgren and Juhlin actually had at their disposal much more “means to get things done” than anticipated at the first glance (Weber,
[1922] 1978; Emerson, 1962; Thompson, 1967; Giddens, 1984), and those means also included a substantial portion of social capital, it is argued (Nahapiet & Ghoshal, 1998).

7.2.4 Critical situation 97Q3 – product quality and delivery performance

In spite of all the problem solving efforts that were done by several UCR employees and others during the first half of 1997 in early June MEL’s patience is exhausted. In the past the customer had believed in UCR’s ability to improve its performance (and from time to time UCR had performed quite well), but now they had lost all their confidence in UCR. The MEL people believed no more that UCR should be able to improve and stabilize their manufacturing capabilities for long-term duty. This is also the time when Hank Kennyson for the first time proposes UCR to settle down in writing the process route for cathode plate manufacturing. In a fax to the quality manager of UCR, with copies to the new plant manager (FH) and several functional managers in the UCR organization, as well as to his own boss, i.e. the managing director of ASX, Kennyson writes: “My idea is that the document should contain details of the production route with a step by step description of how each operation is to take place and the relevant test/check procedures at each stage.”

1997 was the year that saw two important changes in the management team of UCR. The new plant manager (FH) had begun his employment in the beginning of the year and in mid 1997 marketing manager (KL) replaced marketing manager (WN). At the time the former entered into his new position the UCR-MEL relationship was going through its most severe crisis ever. A salient factor making the situation so precarious was that MEL negotiated a gigantic two-year project with a major customer at the same time as UCR’s performance was miserable. The decision of the new plant manager (FH) to airfreight 14 tons of cathode plate over the entire globe for the account of MEL in early August serves as a most significant illustration of the extremely difficult supply situation. The new marketing manager (KL), most annoyed about the situation, decides to establish a cross-functional “discussion forum”, which is starting its operations in mid October under the guidance of marketing development manager (LL). Its mission is similar to that of the “cathode plate project group” that had been ended a few months earlier. The forum operated for two months and managed to (1) convince the UCR management and others concerned about the importance of the MEL business for UCR, (2) reinforce and improve manufacturing procedures for the successful production of cathode plate, and (3) balance the input of hot band to the actual yield numbers achieved when manufacturing the product in accordance with the modified procedures. A prerequisite for item (2) to materialize

\(^1\) Employed at UCR since the beginning of 1997.
was the circumstance that the new cold rolling mill gradually improved its performance through the second half of the year 1997.

The two critical situations 97Q1 and 97Q3 actually link closely to each other. The difficulties go back to UCR’s investment in the new cold rolling mill that was about to close the cathode plate business with MEL (but also other businesses of UCR). A major difference between the two situations is that in the latter situation much more is put on stake as MEL is negotiating a new gigantic two-year project. Also another most obvious difference appears as in the latter situation the management team of UCR involves two new managers, i.e. the new plant manager (FH) and the new marketing manager (KL). For those two persons the MEL business is new and they are both eager to do something about the troublesome situation. By introducing the “discussion forum” the marketing manager (KL) aims at getting to the bottom of the performance problems of UCR relative to the MEL business. By so doing he utilizes ‘the managership argument’, but at the same time he anticipates that the “discussion form” will also motivate employees in other departments to take their responsibility for the business, i.e. that shared values might be a source for action (Parsons, [1956] 1960; Nohria & Ghoshal, 1994). It should be considered, though, that at the time the “discussion forum” is formed the cathode plate production route had already been developed, but with the new cold rolling mill it all went wrong, so the route had to be reinforced. During the autumn 1997 the new rolling mill gradually reached normal operation which made it possible quite easily to reinforce and to a certain extent also to improve the manufacturing procedures.

The logistic problem that had harassed the MEL business since the very beginning was also finally resolved. As the marketing development manager (LL) could show (by using ABC analysis) that the MEL business was much more profitable than the average business in the steel grade, width and thickness, the logistics manager and the quality manager, who both for years had resisted to accept the low yield numbers emanating from the manufacturing of cathode plate, while claiming that the numbers had to come up for the business to be profitable, now finally accepted to increase the relative amount of input material for the manufacturing of cathode plate. The logistics problem had been an obstacle for about three years. It had been one of the main sources of poor delivery performance and as such it had caused a lot of pain. The observation shows how “taken-for-grantedness” may guide decision-making and action (Schutz & Luckmann, 1973; Cyert & March, [1963] 1994; Nelson & Winter, 1982). As a matter of fact the logistics manager and the quality manager had hampered the MEL business for years as they had “taken-for-granted” that the yield numbers must be at a given (standardized) level for profitable business to emerge. They had measured the business from their perspective and by their goals and standards while forgetting about goals calculated in terms of price and profit over a full economic
cycle (Cyert & March, [1963] 1994). “Product specialness” was never considered by them nor was the market.

7.2.5 Critical situation 99Q3-00Q2 – product quality and delivery performance

The work that was done in the UCR organization concerning cathode plate manufacturing during the autumn 1997 made everything come together, and as MEL secured the gigantic two-year project business between UCR and MEL flourished through the entire 1998 and the first half of 1999. In mid 1998 a new plant manager (JL) replaced plant manager (FH) in UCR. The newcomer, experienced as he was in the area of precision strip\(^2\) manufacturing, took the lead in the process of developing and implementing a new strategic direction for the unit with focus on thin material. A year later the new ideas began to settle. Product applications comprising thicker material were put at a disadvantage and among those was the cathode plate business. Preparation for the investment in a new slitting line designed for the slitting of thin material gradually absorbed more and more of the time of Carl Juhlin. Later the man was transferred to the project on full time. Reshuffling of employees, withdrawal of quality inspection people, and not the least implementation of the new product strategy made cathode plate manufacturing suffer. A new works atmosphere gradually evolved where “thin” was considered good, special and highly profitable, and “thick” was looked upon as less good, standard (bulk) and less profitable. Consequently, in this new atmosphere the manufacturing of cathode plate was meant to be performed according to standard manufacturing procedures with as little effort as possible. The outcome was a disaster. Product quality soon rock bottomed, delivery performance suffered, and the confidence that had characterized the UCR-MEL relationship after years of successful business exchange soon deteriorated. The future looked dark for the cathode plate application at UCR, and no support from Carl Juhlin could be taken into account, as he was now lost for another assignment.

The disastrous situation remained for more than a year. The turning point arrived as Hank Kennyson in the mid of year 2000 succeeded in recruiting a volunteer, i.e. the QA guy “eyes and ears”, to become “his man” in the UCR mill. The proposal Kennyson had made three years before about having the cathode plate manufacturing route written down on paper was now reactivated, but, as the knowledge about how to properly manufacture cathode plate had been fragmented and dispersed in the meantime as a result of several reorganizations, bringing the pieces together took the job of a detective. Step by step the QA guy brought the pieces together and as he did he cross-checked the appropriateness of the information by studying the product output as cathode plate was manufactured in the works. Thus, though the interest of

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1 Also see Table 2:1 and Appendix 2 for further information in this matter.

2 Precision strip material is usually thinner than 1,0 mm but more often it hits the range of 0,20 - 0,50 mm. Superthin material may be rolled down to 0,05 mm or thinner.
the UCR management was low in relation to the mapping of proper manufacturing procedures as to cathode plate, the QA guy “eyes and ears”, anxiously supported by Kennyson, managed to reestablish the procedures and put them down in writing. Soon after the merger between Avesta Sheffield and Outokumpu in year 2001 the plant manager (JL) suddenly changed his mind about the importance of UCR’s business with MEL, and at this point in time, when the business regained its previous status in UCR, effective manufacturing procedures were already in place.

Basically, all problems relating to manufacturing and logistics had been resolved already in the autumn of year 1997, and all the knowledge and skills needed for the smooth manufacturing of cathode plate was available embedded in the UCR organization at that time (Nahapiet & Ghoshal, 1998). Business success reported for the years 1998 and 1999 is a most convincing datum supporting the statement. However, little of the procedures had been written down in documents and instructions. Instead most of the knowledge resided in the minds of those that were running the operations. This was an obvious weakness of the concept. At the time the new plant manager (JL) is turning the strategy from “thick” to “thin” by activating ‘the managership argument’ he removes the foundation for successful manufacturing of cathode plate. As he gradually implements the new strategy he simultaneously deducts personnel and other resources from the ‘cathode plate route’ and initiates the infusion of new values into the organization (Selznick, 1957). By so doing he turns both to instrumental and institutional means to make change come about and the effect is devastating for the cathode plate business. It doesn’t take long until the manufacturing of cathode plate collapses like a house of cards. It is clear that the new plant manager (JL) makes use of ‘legal authority’ while activating ‘the managership argument’, but it is also much obvious that the man has at his disposal a certain charisma, which he activates as he operates ‘the leadership argument’. As a matter of fact, in the end of the 1990s, within just a few years of time, the new plant manager (JL) manages to infuse new values (the philosophy of the “thin strategy”) into the UCR organization, and a large number of employees follow him while adhering to the new strategic call.

The course of events described has actually little to do with technological change in relation to the cathode plate product and its manufacturing, because at the time the new strategy was initiated all technologies relating to cathode plate manufacturing were already in place in UCR (although little was documented in writing). The strategic change that was imposed just blocked the existing technologies from being exploited for the purpose for which they were meant. At this point in time the technologies could well have been lost hadn’t it been for the work of the QA guy “eyes and ears”, who compiled and coded most of the knowledge that had been dispersed as a result of reorganizations made in connection with the introduction of the new “thin strategy” (Penrose, [1959] 1995; Polanyi, [1966] 1983; Nahapiet & Ghoshal, 1998). It seems that Kennyson was considering himself caught in a situation of powerlessness at

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1 The merged company got the name Avesta Polarit Stainless.
the time he appealed to “anybody” to pick up the responsibility for the cathode plate application at UCR. He had lost Juhlin, and, ruled by the plant manager (JL), the UCR management had clearly shown that they had little if any interest in cathode plate business. It is difficult to judge whether Kennyson mobilized ‘the leadership argument’ or if he succeeded in activating ‘the interest/monopoly argument’ as he recruited the QA guy “eyes and ears” for reconstructing the cathode plate route (Weber, [1922] 1978; Emerson, 1962). Probably both arguments were active at work. Whether Kennyson’s inquiry is to be considered an entrepreneurial act or just a last cry for help is difficult to say.

It is most interesting to note how ‘the managership argument’ at work in the hands of the new group management of Avesta Polarit Stainless changed the mind of the plant manager (JL) as to the cathode plate business with MEL. His attitude instantly changed from “not interested” to “enthusiastic”. Certainly ‘the interest/monopoly argument’ had a say in the matter as it usually goes along with ‘the managership argument’ in situations involving hierarchical logic. And that is probably particularly true in the wake of a merger because then managers at different organizational levels may conceive of a threat (real or apparent) in regard of their future position. The influence from group management made cathode plate business regain its former status (and more) and technological change as to the cathode plate product and its manufacturing had finally been brought to a successful close.

7.3 Groups and individuals influencing technological change as to cathode plate

The analyses of the critical situations and episodes of the empirical case involve two occurrences where ‘legal authority’ (‘the managership argument’), activated at corporate level (group level), makes a difference as to technological change in relation to cathode plate business. The first involvement concerns the involvement of group management in the investment process when UCR is requesting money for the construction of a new cold rolling mill. The second involvement is when group management (after the merger in 2001) determines that the cathode plate business is to stay with UCR and that the unit must care well for it. Relative to cathode plate business the impact of the former involvement is negative (at least through a phase of transition), whereas that of the latter is most positive.

The management team of UCR is certainly a much powerful change agent as to cathode plate business. Its various managers in many ways and in many situations impact upon the course of events and technological change. In some cases they contribute in a positive way to the development of the business, e.g. through the establishment of the “cathode plate project group” and the “discussion forum”, whereas in other cases their decisions and steps are negatively impacting upon the
healthy development of the product application, e.g. through the erection of the new cold rolling mill and the introduction of the “thin strategy”. The point here is that the responsibility of those people is functionally oriented and not task-oriented. That implies their interest is in the proper treatment of a function and not of a particular customer, i.e. to the production manager production is important, to the logistics manager materials flows are important, to the marketing manager markets (groups of customers) are important, and so on. The interest of a functional manager is dispersed over all customers along the particular function for which the manager is responsible. This situation often ends up in an impersonal treatment of each single customer. The functional manager cannot afford to give each customer particular attention. As part of a hierarchical system the authority of the manager rests on rational grounds. It manifests through ‘the managership argument’ and is referred to as ‘legal authority’ (Weber ([1922] 1978, pp.215-216). It legitimizes the manager to issue commands and to be obeyed within his or her area of responsibility. As shown in the analysis the management team may operate as one coherent unit, and when it does it is omnipotent within its area of responsibility, or it might be that various members of the team coalesce while striving to reach goals that other members oppose (Emerson, 1962). An example of the latter is when the logistics manager and the quality manager of UCR for several years block the necessary proportional increase of input material to cathode plate manufacturing, and by so doing hampers the entire business.

Now, it is clear from the case description that the functional organization of UCR is not able to handle all the problems that cathode plate business suffers from over an extended period of time. To improve the performance of the unit’s manufacturing of cathode plate the cross-functional “cathode plate project group” is instigated and that group is operating for almost one and a half year. Later a “discussion forum” is established for the same reason. Both attempts are obviously aiming at sorting out existing problems by increasing the level of lateral communication and information exchange in the organization (Galbraith, 1973). Neither of the two formations is in a position to mobilize ‘allocative resources’ or ‘authoritative resources’ beyond those that the participants of the various functional departments bring with them as part of their respective formal position in the organization (Giddens, 1984). Both formations are formally established but operate in an informal way. The most important result of the informal work performed in the “cathode plate project group” and in the “discussion forum” is the learning emerging from interaction across functional (departmental) boundaries in the organization. As various positions are challenged and discussed the learning process also comprises a certain portion of negotiation (Cyert & March, [1963] 1994). To the extent that authority is demonstrated as a result of the work performed within these two temporal formations it is in the form of ‘charismatic authority’ where “the normative patterns or order revealed or ordained” (Weber [1922] 1978, pp.215-216) are likely to influence the course of action in regard of the various members of the two formations. Influence might as well arrive from an increased interest in cathode plate business in general (ibid.).
A most interesting group identified in the case is the “cathode plate operational team” that is gradually emerging as the business process proceeds. The team is constituted by the inside sales administrator Hanna Almgren (UCR), the product line manager CTL Carl Juhlin (UCR), and the area sales manager Hank Kennyson (ASX). The team is not formed deliberately but emerges as a result of interaction (Homans, 1951; Nadel, 1957). Interaction between Kennyson and Almgren is frequent with several communication rounds per week although the two are situated on each side of the globe. Information exchange between Kennyson and Juhlin is frequent during periods characterized by much turbulence but goes down during periods when manufacturing is running smoothly and product quality arrived at is acceptable. Both Almgren and Juhlin work in UCR and they meet almost every day. The “cathode plate operational team” doesn’t exist as a formal group, and most people in the UCR unit probably never consider it a group or a team. From an analytical point of view, though, it is a distinct group or coalition. The individuals making up the group adopt most distinct and different roles. They gradually develop group norms while putting the MEL business in focus. The three members develop social relations between themselves saturated with trust, and at several occasions the members of the group coalesce, while acting as one man for the good of the MEL business. In her professional role Hanna Almgren is in a position to mobilize ‘allocative resources’ as to feedstock supply as she is operating UCR’s coil reservation system. She is also the omnipresent communication channel prepared to handle or further transmit any matter relating to the cathode plate business with MEL. Finally, she keeps up on strategic and tactic matters as to cathode plate business by relating closely to the sales/marketing manager of UCR. Carl Juhlin can mobilize both ‘allocative’ and ‘authoritative resources’ within his area of responsibility, i.e. the cut-to-length line and some slitting facilities in the production department. However, Juhlin’s close links to other functional managers, works managers, and supervisors in the production department of UCR renders him the capacity to influence operations far beyond his formal area of responsibility.

In the case still another group appears, an informal group made up of the area sales manager Hank Kennyson at ASX, the managing director (“the Brit”) at ASX, the process development manager (MM) at MEL, and the development engineer/purchaser at MEL. This constellation now and then appears in the empirical case and more often it is addressing the issue of pricing. The case offers limited information about this group. It is certainly true that the group is able to mobilize ‘allocative resources’ as to cathode plate business, because the money that is driving the entire business emanates from MEL. Should MEL cease to buy material from UCR the business would come to an end. From the case narrative it seems that the group members now and then coalesce in order to put pressure on UCR concerning the issue of pricing. While referring to ‘the interest/monopoly argument’ this group strives to impact upon the business between UCR and MEL albeit with varying success.
The discussion reveals that various individuals and groups have the potency to bring about change, i.e. to operate as change agents in the industrial context of the case, but some special attention will be given here to Hank Kennyson and his various roles in the system. Based on his formal organizational position he can neither mobilize ‘allocative’ nor ‘authoritative resources’. However, a closer look at Figure 7:1 reveals that Kennyson is holding a most central position in the system of individuals and groups relating to cathode plate business. He has close access to the various managers at MEL. Early in the business process he was actually assigned the role as their “ears and eyes” when dealing with people at UCR. The MEL people deeply trust Kennyson. Within the emerging “cathode plate operational team” he is closely related to Carl Juhlin and Hanna Almgren. Through Almgren he can influence feedstock supply at UCR and through Juhlin he receives inside information about manufacturing matters in the UCR plant, but he can also to some extent influence operations performed in UCR’s production department. Moreover, Kennyson involves in direct communication with the various functional managers as well as the plant manager at UCR, the managing director of ASX, and various managers at DSL. He is actually bridging the various sub-networks appearing in cathode plate business. His position as a “spider in the overall net” to a certain extent renders him the possibility to mobilize both ‘authoritative resources’ and indirectly also ‘allocative resources’ in the industrial system (Giddens, 1984). He has at his disposal a most valuable ‘social capital’ that can be activated for the development of cathode plate business in line with his intentions (Burt, 1992a).
8 TECHNOLOGICAL EVOLUTION (CONCLUSIVE SUMMARY)

The findings are summarized and discussed. The issue of entrepreneurial activity in relation to the thesis work is commented upon. Some reflections forwarded close the chapter and the thesis.

The thesis research question goes: How does technological change come about in an international, industrial system? A credible investigation of the research question presupposes that reasonable answers are given in regard of two most basic questions, viz. What is technology? What is technological change? In chapter 3 ‘technology’ is conceptualized and so is ‘technological change’. The result of these conceptualizations is summarized in section 8.1 below. The research question leads up to the aim of thesis: To explore and describe how technological change comes about in an international, industrial system by investigating intra- and inter-organizational sources and processes that organize technological change. This is actually what is elaborated in the chapters 4 to 7. The findings are summarized and discussed in the sections 8.2 and 8.3 below. It is assumed that crises and conflicts involve as integral elements of the process of technological change. The issue is discussed at some length in chapter 7 and a few summary conclusions are mediated in section 8.2 below.

Several theoretical concepts and models utilized in this thesis work are collected from the existing stock of knowledge in the field (relevant academic literature). To the extent that model utilization has enhanced understanding, i.e. has contributed to an improved understanding of the way technological change comes about in an international, industrial system, the models are validated, albeit validation is constrained to the context in which the models are used. In some cases concepts and models used are subject to modification as a result of findings made in the research process and in this part the thesis work shoulders a conceptualizing role offering new or modified concepts and models to be used and challenged by others. As findings are presented and discussed below theoretical contributions are emphasized.

8.1 Technology and technological change

The basic definition of ‘technology’ as referred to in this thesis work reads: ‘knowledge and skills applied for a practical purpose’. An additional condition for ‘knowledge and skills applied’ to manifest as technology is that they are utilized on a repetitive basis. This condition is not particularly constraining as most types of knowledge and skills applied for practical purposes are made use of again and again. This is actually the true guiding spirit behind any attempt to develop a particular technology, that the technology when established can be activated time after time for a clearly defined purpose. The discussion performed in chapter 3 ends up in a conceptual
framework contending that technology manifests in the form of ‘technological artifacts’ and ‘techno-human routines’. A ‘technological artifact’ is past thoughts inscribed into physical matter (objects), the thoughts serving as rules guiding current and future use of the “thing”. A ‘techno-human routine’ is a mixture of procedures and practices interconnecting with one or more ‘technological artifacts’ while aiming at a practical purpose. The procedures and practices are made up of rules and roles developed and agreed upon over time.

It is difficult to think of any contemporary industrial system that doesn’t utilize one or several production facilities, and per definition each such facility is a ‘technological artifact’. It is equally difficult to think of any contemporary industrial system that doesn’t make use of ‘techno-human routines’ as such routines to a certain extent control (or are controlled) by the ‘technological artifacts’ contained in the system. However, it is possible to think of production facilities that are developed for one time use’, and it is equally possible to think of activity patterns that are established for one time activation, but to the extent that such phenomena occur their significance is certainly negligible in relation to any viable industrial system. The conclusion is that conceptualizing ‘technology’ as the intertwining of ‘technological artifacts’ and ‘techno-human routines’ is both adequate and significant for this thesis work. It follows that ‘technological change’ arrives as the alteration of those rules and roles that form the constituting elements of technology, and the question “how technological change comes about” immediately directs those “who, what and which” that are in a position to alter those rules and roles. With reference to the writings of Barley (1986), Orlikowski (1992), and Scott (1995) ‘technology’ may well be considered a carrier of institutions, and by taking on that position the way is paved for an effective analysis of technological change, it is argued.

8.2 The organization of technological change

Technological change comes about along two most different routes. Either it is organized by a “visible hand”, or it appears as a result of various circumstances. The either-or categorization is extreme and is not meant to represent the “true” description of the way technological change comes into being in an empirical context. It is drawn for the purpose of illuminating two main sources of technological change, and the analyses performed in the chapters 5 and 7 show that technological change appears along both routes, the former reflecting a strategic posture, the latter holding a more defeatist profile, i.e. “what will be will be”. The conclusion is that technological change results from consciously organized activities in combination with various

1 The situation shall not be confused with that typical for mass-produced items adhering to a “use and waste” type of activity pattern. For such items many “cloned individuals” exist. Wasting one of those “individuals” is not wasting the rules inscribed into it as many equivalent “individuals” carry the same inscription.
circumstances appearing beyond the control of those aiming at making technological change come about.

8.2.1 Sources of change and preservation

The conceptual framework developed in the end of chapter 4 lists four sources of technological change, viz. ‘strategic intention’, ‘emergent developments’, ‘chance’, and ‘necessity’. The analysis performed in chapter 5 renders support to the four factors as viable sources of change. If starting the discussion by focusing on three of those four factors technological change occurs as a result of ‘strategic intention’, ‘chance’, and ‘necessity’. Whether to refer a particular course of change to one or another of these three sources depends on which is the actor perspective selected. For example, when the owners (the board of directors) of two large multinational companies decide to merge the two companies together, and subsequently go on completing the merger, from their point of view change follows on ‘strategic intention’, but from the perspective of the businessman, who by accident is getting access to a new technology in the wake of the merger (an opportunity that the company owners were entirely unknowledgeable about when deciding about the merger), change is the result of chance. The same goes for ‘necessity’, which also closely relates to the chosen perspective.

‘Emergent developments’ as a source of technological change evolve over time and manifest as incremental alterations of the existing order. Change is driven by the logic of the business process as such and comes into being as various individuals interact within and between the business organizations making up the industrial system. It seems reasonable to assume that ‘emergent developments’ if studied at a “micro-micro” level comprise ‘strategic intention’ as well as ‘chance’ and ‘necessity’ (but also ‘structural inertness’), as many (most) individuals, one way or another, are driven by ‘strategic intention’ (though circumscribed to a greater or lesser degree in most cases), but that ‘chance’ and ‘necessity’ also play an important part in the course of events. When discussing the internationalization process of the firm Johanson and Vahlne (1990, p.12) contends that “the firm is viewed as a loosely coupled system in which different actors in the firm have different interests and ideas concerning the development of the firm”. A similar position is held by Lawrence and Lorsch (1967) who claim that the growing firm differentiates into parts, which each of them orientates towards a particular part of the environment while taking on the responsibility of performing a certain sub-task.

The contention is supported by observations done in relation to the empirical case where the “cathode plate operational team”, consisting of three individuals strongly devoted to the “cathode plate sub-task”, fight hard to support their particular business, while rendering other sub-tasks less attention and interest. There is reason to believe that other similar groups operating in the same industrial context clash with the
“cathode plate operational team”, as they strive to carry through their respective missions. The observation is supporting an open system view of the business organization, where the organization is considered a fragmented whole, the resources of which are activated for a variety of sub-tasks defined by individuals formally organized inside and outside the organization, each sub-task interconnecting the individuals concerned by way of group norms and the sharing of a common goal. In such an industrial context where each one of several conflicting forces strive to make use of resources available while favoring a particular mission, the problem of integration becomes much obvious. In the empirical case the problem surfaces as the new plant manager (JL) of the focal business unit UCR introduces the new “thin strategy”, which is favoring some sub-tasks while putting cathode plate business at a disadvantage.

Four sources of technological change were identified as the empirical case was analyzed in chapter 5. A fifth source of change, or rather one of technological preservation, refers to the institutional “ballast” that well-established organizations carry with them, and particularly so organizations operating (in) heavy industrial systems. The analysis performed in chapter 7 identifies ‘structural inertness’ manifesting in the form of ‘physical resource “heaviness”’ and “taken-for-grantedness”. The former refers to inertness linking to heavy industrial investments, whereas the latter refers to ingrained positions defended by organizational members guided by institutional rules and norms.

Thus, the analyses of the empirical case render support to the proposition that the process of technological change links to five sources, viz. ‘strategic intention’, ‘emergent developments’, ‘chance’, ‘necessity’, and ‘structural inertness’, and that this particular set of sources may serve as a theoretical tool suitable for the analysis of technological change, but it is likely to apply also for other processes of change appearing in institutional settings. Figure 8:1 gives a brief overview of the various sources influencing the process of technological change. ‘Emerging developments’ are

![Figure 8:1 Sources influencing the process of technological change](image-url)
the result of everyday business operations. ‘Strategic intention’ and ‘structural inertness’ show up as “antipodes”. As a source of change the former expresses a clear will to bring about change but also a clear change direction, whereas the latter on a stimulus response basis operates as the preserver of the existing order. ¹ ‘Necessity’ and ‘chance’ are also akin in a way. Both assume the existence of a focal actor able to conceive of ‘necessity’ and ‘chance’, and both operate beyond the control of this focal actor. An important difference between the two is that the former enforces the actor to act in accordance with “certain given instructions” in a situation that is familiar to the actor, whereas the latter leaves for the actor to choose how to go about in a new situation that is usually unfamiliar to the actor as it was not anticipated.

8.2.2 Strategic intention, structural inertness, and factual outcome

The ‘five sources model’ sketched in the previous section identifies five sources of technological change. Three of these sources render the actors concerned² no power of choice, namely ‘chance’, ‘necessity’, and ‘structural inertness’, as these three sources, when “activated”, operate beyond the control of the actors. By generating ‘strategic intention’ and by participating in ongoing ‘emergent developments’ actors may strive to prevent future undesired change from occurring, but once ‘chance’, ‘necessity’, or ‘structural inertness’ factually impact upon the course of events it is already too late to prevent that from happening. Thus, now and then ‘chance’, ‘necessity’, and ‘structural inertness’ factually impact upon the process of technological change, while rendering the actors concerned no power of choice as to their appearance. But the actors can and do react upon various emerging situations though they might have at their disposal different “means to get things done”.

Domination depends on the mobilization of ‘allocative resources’ and ‘authoritative resources’, and those attaining a dominant position have at their disposal certain possibilities to change or preserve the existing order (Giddens, 1984). Resources may be mobilized in different ways and three arguments aiming at resource mobilization have been proposed, i.e. ‘the managership argument’, ‘the leadership argument’ and ‘the interest/monopoly argument’ (see the sections 6.7.2 and 6.7.4. and particularly Figure 6:2), and used in the analysis (chapter 7).

Anybody can command people to do things or physical objects to operate. The problem is whether or not the command will be obeyed. If not, it is useless. An

¹ As has already been argued ‘strategic intention’ may strive to preserve an existing order under attack, i.e. actors may consciously (based on critical reflection) act to defend “what is” in situations where the current order is challenged. This effort shall not be confused with forces deriving from ‘structural inertness’ as such forces are controlled by “frozen thoughts” inherited from the past, “thoughts” that operate in present time without having been critically reviewed. ‘Strategic intention’ striving to preserve the existing order is still per definition categorized as a ‘source of change’ as it consciously aims at recreating “what is”.
² The respective source category is identified from the perspective of the actors concerned.
individual assigned ‘legal authority’ through a hierarchical position is given a certain right to issue commands (and to be obeyed) within the limits specified for the role (Weber, [1922] 1978, pp.215-216). Such a person may resort to ‘the managership argument’ “to get things done”. Individuals that are not in a position to rely on undisputable ‘legal authority’ “to get things done” usually have to involve in negotiations with others in an attempt to mobilize appropriate ‘allocative’ and/or ‘authoritative resources’.

‘Charismatic authority’, constitutes a viable base for activating ‘the leadership argument’ where obedience is achieved because people are devoted to “the exemplary character of the individual person and the normative patterns or order revealed or ordained by him” (ibid.). ‘The leadership argument’ may be used by any member of the organization no matter which is his or her hierarchical position, although a charismatic person operating at the top of an organization probably has greater possibilities “to get things done” than does a charismatic person operating on the shop-floor. That is so because the former would be able to effectively combine ‘the leadership argument’ with ‘the managership argument’, whereas the latter would have to rely more or less solely on ‘the leadership argument’. However, as the two individuals enact different views of the world they would influence different issues.

Arguments founded in power-dependence relations, i.e. ‘the interest/monopoly argument’, may as well be employed by any individual (or collective actor). The argument is based on the idea that what one actor possesses/controls is desired by another actor (ibid.). The strength of the argument depends on which is the ‘motivational investment’ of the actor being interested in the resource and which is the ‘availability’ of the resource (Emerson, 1962). A rare resource that is strongly desired by a counterpart renders the argument a high level of strength.

All three arguments may be activated on “the arena for negotiations and change”, and all three arguments may be backed by forming coalitions, which is actually a means to move the power balance in a desirable direction (Emerson, 1962). Negotiations may contain any argument or combination of arguments supposed to be effective for the mobilization of ‘allocative’ and ‘authoritative resources’ needed. As various actors move their arguments to “the arena for negotiations and change” battles are fought, the outcome of which is sometimes anticipated, sometimes not.

‘Structural inertness’ appears in the form of ‘physical resource “heaviness”’ and “taken-for-grantedness”. Heavy production systems are inert, and inertness resists change. The rules and roles contained in the technologies operating in such systems are usually difficult to change as they are embedded in the ‘technological artifacts’ and the ‘techno-human routines’ constituting the system. The ‘heaviness’ aspect becomes particular salient in those cases where ‘technological artifacts’ represent large, long-life investments as in the steel and mining industries of the empirical case. Both
‘technological artifacts’ and ‘tech¬no-human routines’ contain “frozen thoughts” inherited from the past guiding current and future action. Changing them usually implies large costs, and commonly their existence is defended by those who have once agreed upon their appropriateness and eligibility. “Taken-for-grantedness” may be referred to as the “no-change-alternative”. It is actually granting safe-conduct to the rules and roles that are embedded in the industrial system. It is usually prolonging the use of standard operating procedures, which may well involve the mobilization of ‘allocative’ and ‘authoritative resources’ in defense of the existing order. There is reason to believe that what is “taken-for-granted” in an organization more often than not links to what employees of the organization usually think is fair to do, i.e. various tasks that are “taken-for-granted” more often hit the ‘zone of indifference’ as conceived by the individual employee than do tasks that are not “taken-for-granted”. Asking people to do what they think is fair to do usually have them perform better.

The potency of various actors, be it individuals or groups of individuals, “to get things done” differs in the empirical case. Corporate management certainly has at their disposal great potency to mobilize both ‘allocative resources’ and ‘authoritative resources’, but as their understanding about what goes on at an operational level in the company is usually most circumscribed their possibility to influence everyday business operations in a constructive way is usually small if any. In the empirical case corporate management decides about mergers, major investments in new production facilities, and the employment of top level managers. At a business unit level the UCR management team is (almost) omnipotent within their area of responsibility as long as they act as one united group (coalition). In the empirical case it is most obvious that two members of the management team (the logistics manager and the quality manager) ran their own race through several years regarding the issue of how much input material to feed into the “cathode plate route”, and that their posture stood in stark conflict with that of the marketing manager. The conflict could have been settled earlier than happened had the plant manager and/or the production manager involved in the discussions, but both obviously preferred to keep a low profile in the matter (most likely due to lack of information). When running their managerial roles the members of the UCR management team, empowered by their respective hierarchical position, commonly turn to ‘the managership argument’ when striving to influence the course of events. One episode, though, seems to involve also a significant portion of ‘the leadership argument’. That is when the plant manager (JL) succeeds in infusing the idea of the new “thin strategy” into the minds of the UCR employees during the last few years of the twentieth century. It seems that many employees actually began to “think thin” rather than just obeying to commands issued by the plant manager (JL). The man obviously succeeded in changing their minds about what ought to be considered “good business” for the future.

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1 The ‘zone of indifference’ is discussed in Barnard ([1938] 1968, pp.168-169).
The members of the “cathode plate operational team” were certainly not that enthusiastic about the new “thin strategy” due to the fact that the new strategic direction of UCR influenced their “darling”, i.e. cathode plate business, most negatively. The coalition, constituted by Hank Kennyson, Carl Juhlin and Hanna Almgren, had strongly impacted upon the course of events through the years of technological change as to the “cathode plate route”, from 1994 up to 1998. As a group they had been able to mobilize both ‘allocative’ and ‘authoritative resources’ to “get things done”. At the time the members of the coalition, and particularly so Hank Kennyson and Carl Juhlin, successfully utilized ‘the leadership argument’. Juhlin had at his disposal also a comprehensive stock of social capital underpinning an effective utilization of ‘the leadership argument’. The conclusion is, no doubt about it, the development of the “cathode plate route” largely resulted from the operations of the “cathode plate operational team”.

The potency to “get things done” appears at several levels of aggregation in the empirical case; at corporate level, at business unit (managerial) level, and at operational level. At the higher levels of aggregation ‘the managership argument’ is most salient. At the operational level ‘the leadership argument’ and ‘the interest/monopoly argument’ are activated more often although those arguments now and then also appear at the managerial level. At all levels ‘structural inertness’ constrains what can be done.

8.2.3 Continuous and discontinuous change

The model forwarded in Figure 8:1 is a viable platform for a discussion about continuous and discontinuous change. Continuous processes of change appearing in an international, industrial context have been credibly explored and described under headings such as “the internationalization process of the firm” (Johanson & Vahlne, 1977), “internationalization in industrial systems – a network approach” (Johanson & Mattsson, 1988), “the mechanism of internationalization” (Johanson & Vahlne, 1990), and “business relationship learning and commitment in the internationalization process” (Johanson & Vahlne, 2003). The publications referred to share one common process mechanism here called ‘the gap reducing mechanism’. The analyses performed in chapter 5 show that the mechanism offers a credible description of continuous change as driven by ‘emergent developments’, and that such change links to the everyday business operations of the business units involved in interaction. When appearing in an industrial context, change of the kind commonly includes technological adaptation, which may be one-sided or reciprocal. It evolves in small steps (incremental change) that combine into continuous processes, which are gradually emerging in industrial systems while hampered by ‘structural inertness’. Thus, incremental change evolving at an operational level of organization manifests as a result of ‘emergent developments’ constrained by preserving forces emanating from

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1 See paragraph 4.7.2.
‘technological artifacts’ and ‘techno-human routines’ (but also other types of routinized behavior) that constitute the industrial system.

‘Learning’ and ‘uncertainty’ are two elements elaborated in relation to the ‘gap reducing mechanism’. Common knowledge in the field (Ford, 1980; Johanson & Vahlne, 1977) contends that increased learning results in decreased uncertainty. The discussion performed in paragraph 5.4.2 shows that increased learning may well result in increased (and not necessarily decreased) uncertainty as business interaction proceeds. This happens when the interacting parties start out from an illusion of certainty. Such ‘apparent certainty’ is the result of inappropriate and/or too little information at hand (Cyert & March, [1963] 1994). Then, the problem description may be much too simplified or biased. This is probably a most common phenomenon appearing in such cases where industrial business operations are complex and complicated at the same time. The illusion of certainty is gradually dismounted as the parties go on learning, and as a result they conceive of increasing uncertainty. As the process of information exchange and problem solving proceeds, uncertainty goes down, and finally the parties enact one more or less common view of the problem and its solution (Weick, [1969] 1979). However, sometimes this stage is not reached and uncertainty remains high. The introductory case¹ of this thesis work sketches such a situation where the process of technological development and adaptation is interrupted.

The ‘gap reducing mechanism’, appearing as the core mechanism both in theories addressing “the internationalization process of the firm” (Johanson & Vahlne, 1977), and theories approaching the development of business relationships in general (Ford, 1980), builds on the assumption of an initial (large) ‘distance’ existing between the parties approaching each other by way of business exchange. According to the theories the distance decreases over time as the parties go on interacting. Thus, “remoteness” is identified as an obstacle that has to be overcome. In this thesis work a complementary approach is proposed. Observations done in relation to the empirical case indicate that significant understanding can be gained by looking for “nearness” rather than “remoteness” as interacting business parties of an industrial system are studied. The term ‘proximity’ was introduced as a complement to ‘distance’. ‘Proximity’ may appear along several dimensions, e.g. the spatial, relational (social or business), legal, technological, cultural, knowledge, temporal, preferential, industrial, and so on, and when ‘proximity’ is attendant information and goods are supposed to flow easier and more smoothly in industrial systems. The concept was applied when analyzing technology development in a domestic actor circle as well as when elaborating diffusion of technology into foreign markets.

Longer periods of incremental change rendering the change process a character of continuity are now and then interrupted by sudden radical change bringing about

¹ See section 1.3.
discontinuity. Such change is usually generated by ‘strategic intention’ transformed into action somewhere in the integrated industrial system. The empirical case mediates a few situations of the kind. The most subversive one is when Avesta AB and British Steel Stainless merge in 1992. By the merger many things are turned inside out. Several ‘proximities’ suddenly establish by ‘chance’ (coincidence), ‘proximities’ that become crucial for the development of the focal business relationship of the case, i.e. the relationship between Unit Cold Rolled (UCR) and Metal Extraction Ltd (MEL). The analysis performed shows that the ‘proximity’ concept is a most viable complementary tool suitable for the study of business situations appearing as a result of discontinuous change, but the concept can also be used more broadly in various business situations where the elucidation of “nearness” is assumed to be of importance.

8.3 Technological change as evolution

Technological change is commonly discussed either in terms of technological development or as the diffusion or transfer of technology. The former is much at innovation and transformation whereas the latter is more at interaction and exchange. The main thesis forwarded in this work is that technological change embraces the simultaneous involvement of development and diffusion, and that the two sub-processes are interconnected. Looking upon technological change as either development or diffusion is constraining the richness of the concept.

8.3.1 Gaining technological legitimacy

As the cathode plate business of the empirical case is analyzed two main areas of change are identified, viz. change as to technological functionality and change concerning “economic” aspects, i.e. aspects relating to value, productivity, price, cost, etc. The two are iteratively approached by the actors engaging in business exchange, but initially functionality is rendered prime attention. MEL’s product specification is scrutinized by UCR and a lot of interaction and information exchange is carried out in order to prepare for the manufacturing of the first order. Later price and cost issues are emphasized and intensively elaborated by the parties. As problems relating to functionality are not fully resolved at the time the first order is expedited there is later a shift back to functionality. And this movement back and forth between functionality and economy is repeated several times in the empirical case as business interaction proceeds through the eight years studied. Over time various issues are penetrated and as a result of learning and adaptation some of them come closer to their resolution. As an increasing number of issues are resolved, and the parties agree upon certain arrangements, they build a common view of what is appropriate technology – the course of events has reached a point characterized by ‘technological legitimacy’. There are backlashes, no doubt, as, for instance, when the new cold rolling mill is introduced into UCR and functionality suffers, or when the new plant manager (JL) in year 1998
introduces the “thin strategy” in UCR while putting cathode plate business at a disadvantage, a move that is also affecting functionality negatively, or when a major order is lost to Outokumpu on price as late as in year 1999 because the principles of pricing are not yet well regulated. But as time goes by ‘technological legitimacy’ gradually evolves and the “cathode plate route” becomes increasingly integrated in the industrial system.

8.3.2 Technological change and process phases

From a different angle the process of technological change may divide into three process phases, viz. ‘innovation’, ‘interaction’ and ‘institutionalization’ (Figure 8:2). Early development signifying the idea phase of development may be referred to as ‘innovation’ and this phase is supposed also to include some early local interaction. In the empirical case this phase is illustrated by the early activities of the “engineering entrepreneurial type of guy” and people around him appearing in the DML Group in the late 1970s. A second phase may be denoted ‘interaction’ and comprises interaction between various organizational actors bringing different resources to the process of technological change. The technological development emerging in the domestic actor circle in X-land during the late 70s and early 80s fits in with this description, and interaction occurring between UCR and MEL for a few years in the middle of the 1990s also suits the description. The final phase, ‘institutionalization’, comprises the gradual settlement of ‘technological artifacts’ and ‘techno-human routines’ making up the “cathode plate route” crossing the entire industrial system stretching from the backyard of the Avesta Sheffield steel mill and the storing of raw materials down to the refineries operating the MEL refinery process.

![Figure 8:2 The three I-phases triangle](image)

The division of technological change into the three phases is a theoretical construct. In the world of business the three processes are intertwined. However, looking upon the process of technological change from three different angles, may serve as an effective analytical tool when approaching empirical information about technological change. One may ask whether the process at a given point in time is still in the phase of innovation or if it has reached the interactive or institutional phase. Navigating in the ‘three I-phases triangle’ may unfold as follows. The positions (a), (b), and (c) represent pure ‘innovation’, ‘interaction’, and ‘institutionalization’ respectively. Position (d) makes up the transition phase between ‘innovation’ and ‘interaction’, which means that technological change is now just about to mobilize resources from one or more network actors. Position (e) implies the early settlement of agreements involving more
than one party as to technological change. Position (f) represents a situation when established rules and roles are challenged by new innovative ideas. Position (g) finally denotes such appearances where ‘innovation’, ‘interaction’, and ‘institutionalization’ all three of them simultaneously involve in the process of technological change. If accepting that the three process elements are not fully symmetrically represented, the mixed phase of technological change involving all three elements is probably the one appearing most frequently in business practice.

8.3.3 Technological change as an evolutionary process

Technological change appearing in international, industrial systems may take on the form of evolution rather than development or diffusion. Implicitly evolutionary processes comprise development and diffusion or rather transformation and transaction at the same time. The contention involves the idea that technology that is traveling through space and time is influenced by a variety of sources that are either driving change or preserve change from occurring. Five such sources of technological change have been identified, viz. ‘strategic intention’, ‘emergent developments’, ‘chance’, ‘necessity’, and ‘structural inertness’. Attempts to alter the existing order address various aspects of functionality but commonly also aspects relating to economy are affected. On its route to completion technological change moves through three phases, viz. innovation, interaction and institutionalization. Before change has become institutionalized, i.e. before it has settled in ‘technological artifacts’ and ‘techno-human routines’, it is vulnerable to further change and may be lost. Technological change moving through the rim of institutionalization gradually becomes more and more stable as its existence is increasingly accepted and defended in the context where it appears. However, no matter how stable its position sudden strategic strikes, necessities or coincidences may turn the situation upside-down as the strength of ‘structural inertness’ along with the power of those that are defending the existing order might not suffice to prevent it from being dismounted. Figure 8:3 summarizes the various elements making up technological change as an evolutionary process.

<table>
<thead>
<tr>
<th>Process phase:</th>
<th>Innovation</th>
<th>Interaction</th>
<th>Institutionalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change aspect:</td>
<td>Economy</td>
<td>Functionality</td>
<td></td>
</tr>
</tbody>
</table>

Figure 8:3 Technological change as an evolutionary process

8.4 Entrepreneurial activity as a change driving engine

Although this thesis work does not aim at elaborating entrepreneurial activities but rather addresses systemic phenomena and interaction between various collective and
individual actors it is impossible not to comment upon one most significant driving force making technological change come about in the empirical case. In the case area sales manager Hank Kennyson represents the prime “change driving engine”. Time after time he invents new ways to come through when strong forces oppose change from occurring. He forms various temporal coalitions and he strongly contributes to the development of the “cathode plate operational team”, which is reaching far into the operations of UCR. In situations when all possible solutions seem to have been tried and all ideas are exhausted he finds new ways to go about. Finally he also has a voice in the matter when it comes to formalizing the informal ‘techno-human routines’ that had slowly evolved as a result of several years of interaction.

Operating as an intrapreneur in a heavy industrial system is encountering much of ‘structural inertness’ as well as various forces defending the current order. As a matter of fact the ‘technological artifacts’ constituting the physical part of the production system of UCR were never changed to better match the requirements of the cathode plate application, but several ‘techno-human routines’ were certainly modified for the purpose. The existing production facilities were manipulated to operate in new ways making them offer new productive services better suited to satisfy the needs of the cathode plate application. This is a most apposite illustration of entrepreneurial activity as it shows how resource heterogeneity is exploited by way of entrepreneurial thinking and acting (Penrose, [1959] 1995). By interstitially incorporating the modified routines into the manufacturing system of UCR the “cathode plate route” was finally made to operate smoothly and efficiently while delivering a most appropriate cathode plate product.

8.5 Some closing reflections

“Things do not always unfold the way you want them to, neither in peace nor in war.”
The standpoint was expressed by my battalion commander at the time I went through my recruit training in the military at the age of twenty. The statement has stayed in my mind since and it may serve as a most apposite summary of business life in general and as an overall conclusion of this thesis work in particular. Sometimes things happen although you don’t want them to happen, whereas at other times things are not happening although you strive hard to make them happen. For managers practicing business, as well as for businessmen in general, a certain amount of humbleness may help when things are not unfolding the way you want them to.¹

Although managerial power is usually most circumscribed managers can certainly do a lot to “get things done”. A good starting point is “wondering what happened” rather than prescribing what to do. By understanding a situation or a process the manager

¹ This position of mine is certainly most contradictory to that claimed in most popular management literature where managers are supposed to be able to make everything happen according to plan.
may substantially increase his or her possibilities to do something constructive about it. This treatise offers several theoretical tools possible to use to stimulate the process of “wondering” as managing business is not just about ‘strategic intention’ but also about ‘emergent developments’, ‘necessity’, ‘chance’, and ‘structural inertness’. Sudden shifts in the wake of a merger, for example, may bring about ‘proximities’ not previously conceived of and such ‘proximities’ may bring new business opportunities to actors alert enough to see them and make use of them. Understanding the dynamics of uncertainty is certainly also most valuable to any actor aiming at investing in a business project as more often success is distinguished from failure by the way uncertainty (and risk) is approached.

The findings presented in this thesis work underpin the conception of business as something that sometimes happens beyond the will and intention of actors who strive to make change come about. As collective actors interact within the frame of business relationships and networks they contribute to the change process in various ways, but intention-based action performed by one actor may well contradict other actors’ endeavor. It follows that the outcome arrived at is not always the one anticipated. In the micro-level perspective individuals and groups resort to various arguments to make their voice heard, and, as they do, they turn to those arguments that are most likely to render them a dominant position on “the arena for negotiations and change”. Again various interests may be more or less contradictory rendering the resultant force a direction somewhere “in-the-middle”.

The conceptual framework used in this treatise aiming at bringing significance and meaning to data collected in a particular industrial system, where actors in the stainless steel industry interrelate with actors in the metals and mining industries, may be used also in other contexts. Future research utilizing the framework may approach other industries and other actors while illuminating similarities and detecting differences. By extending research into various industrial contexts the appropriateness, reach and interpretative strength of the concepts and models of the framework can be evaluated.
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APPENDIX 1

LIST OF ABBREVIATIONS AND PSEUDONYMS

**Country**

X-land  The home country of DML, MEL, and DSL; the country is situated on the other side of the globe in relation to Sweden;

**Companies and industrial groups**

ALZ  A Belgian producer of stainless steel products; ALZ is their real name;

ASX  The Avesta Sheffield sales subsidiary operating in X-land; ASX was established a short time after the merger between Avesta AB and British Steel Stainless in 1992;

BSS  British Steel Stainless; the stainless steel division of British Steel Plc. until the merger with Avesta AB in 1992;

BSS(f)  Former British Steel Stainless; the abbreviation is used for the British operations of the Avesta Sheffield Group after the 1992 merger;

CER  Continental European Refinery Ltd; a European refinery company part-owned by DML;

C&PD  Coil & Primary Division; a unit within the Avesta Sheffield Group supplying feedstock for the production of (among other things) cold rolled products; C&PD controls the steel mills and the hot coil rolling facility of Avesta Sheffield;

DIS  A distributor company belonging to the Multibranch Group; sister company to NEM; DIS distributes products for the Avesta Sheffield Group on a small North European market;

DML  Domestic Mining Ltd.; an industrial group located in the home country of MEL; active in the area of mining and metals; MEL’s first customer and cooperating partner on the demand side; single owner of MEL;

DSL  Domestic Steel Ltd.; located in the home country of MEL; a re-roller when it comes to stainless steel manufacturing; MEL’s first supplier of stainless steel cathode plate;

MBG  “Multibranch” Group; a North European industrial group active in several branches among those mining and metals;

MEL  Metal Extraction Ltd.; one of the actors making up the focal dyad of the case; an engineering company, constructor of refinery plants; developer of the MEL metal refinery process;

NEM  North European Mining Ltd.; a mining company; the customer of MEL tying together MEL and UCR; located in the Northern part of Europe; competitor of DML;

OTK  Outokumpu; a Finnish industrial group active in mining, metals and stainless steel; competitor of Avesta Sheffield up to year 2000; on the first
of January 2001 Outokumpu and Avesta Sheffield merged into AvestaPolarit; later Outokumpu Oyj purchased all the shares of the merged company and changed its name to Outokumpu Stainless; Outokumpu is the actual name of the company;

RPC  **Refinery Plant Construction Ltd.**; constructor of metal refinery plants; one of MEL’s competitors;

UCR  **Unit Cold Rolled**: the focal actor of the case, together with MEL making up the focal dyad; a cold rolling unit within the Avesta Sheffield Group;

**Human beings**

**UNIT COLD ROLLED (UCR)**

- **Plant Manager (PL)** from the 1980s up to 1996;
- **Plant Manager (FH)** 1997 up to mid 1998;
- **Plant Manager (JL)** from mid 1998 onwards;
- **Sales Manager (SJ)** a stainless steel business “oldtimer”; retires in mid 1995;
- **Marketing Manager (WN)** a Brit appointed marketing manager of UCR on a two year contract from mid 1995 to mid 1997;
- **Marketing Manager (KL)** an expatriate returning to Sweden after having worked abroad in the US and UK for several years; appointed marketing manager of UCR from mid 1997;
- **Product Manager (OJ)** is carrying a liaison role as to cathode plated business from 1996 up to mid 1997; leads a project group for cathode plate through the same period;
- **Mark Develop Man (LL)** active in stainless steel business in various position in marketing and sales from 1985 to 1998; is chairing a discussion forum in UCR in the late autumn of 1997 addressing cathode plate business; (the author of this thesis work);
- **Inside Sales/Order Administrator (Hanna Almgren)** the “administration spider” at UCR bringing together all administration as to the cathode plate business with MEL; operates closely together with Hank Kennyson at ASX through the entire 1990s;
- **Production Line Manager CTL (cut-to-length line) (Carl Juhlin)** the “production spider” at UCR taking special responsibility for the MEL business during the 1990s up to 1998; operates closely together with Hank Kennyson at ASX;
- **Quality Assurance (QA) “guy”** the person that finally “brought all the pieces together” and formalized the cathode plate route at UCR; (also called ‘QA guy “eyes and ears”’ in the thesis)
AVESTA SHEFIELD X-LAND SALES UNIT (ASX)

Managing Director ASX (“the Swede”) prior to the merger in 1992 marketing manager at UCR; appointed managing director of ASX after the merger; leaves ASX in mid 1996 for a position as plant manager for an Avesta Sheffield production unit in Wales;

Managing Director ASX (“the Brit”) comes from the British side of Avesta Sheffield; has no experience of manufacturing at UCR prior to his appointment in X-land; MD from mid 1996 onwards;

Area Sales Manager ASX (Hank Kennyson) “Mr Cathode Plate”; the person that contributed most to the development of the cathode plate business between UCR and MEL; working almost full time with the MEL account through the entire 1990s;

METAL EXTRACTION LIMITED (MEL)

Process Development Manager (MM) Hank Kennyson’s most important counterpart at MEL during most of the 1990’s; “the person who takes the decisions”;

Process Technology Manager (LN) predecessor and successor to Process Development Manager (MM); goes back to his previous position at MEL in the beginning of 1998 when (MM) moves to another job within the DML Group; “the person who takes the decisions”;

Development Engineer/ Purchaser at MEL purchaser at MEL; Hank Kennyson’s most frequent contact person as to cathode plate everyday business;
APPENDIX 2

ECONOMIC DEVELOPMENT IN THE EUROPEAN STAINLESS STEEL INDUSTRY DURING THE SECOND HALF OF THE 20TH CENTURY

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3  Raw materials supply – A critical factor 362
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Illustrations

Diagram A2:1 Price development British market; Cold rolled Type 304, thickness 2 mm
Diagram A2:2 Price development German market; Cold rolled Type 304, thickness 2 mm
Diagram A2:4 Price development German market; Total price = Price excl. AS + AS; Cold rolled material Tp 304, 2 mm thickness
Diagram A2:5 Base price development German market; Cold rolled Type 304, thickness 2 mm
Table A2:1 ASG: Cost raw materials/Turnover ratio 1987-1997
Table A2:2 ASG: Relative cost of various alloying elements.

1  Dynamism in the stainless steel industry

Change is and will remain a given component in the stainless steel industry. Sometimes change can be predicted sometimes it cannot. Change may challenge existing structures or may support them. Change renders some actors pain whereas others gain benefit. Two change patterns typical for the stainless steel industry will be discussed here, structural change with long term effect and price and demand volatility largely pursuing short-term impact.

Stainless steel production can be sustained only if supply of raw materials and energy are provided for. Both variables are at large beyond the control of the stainless industry itself, and missing out on one of them or both means production stops. Considerable price volatility as regards one of them or both implies soaring uncertainty about input costs. Conditions concerning energy supply are largely a political issue even if the size (and thereby implicitly the cost) of consumption to a certain degree can be influenced by those consuming the energy. Energy supply as well as energy costs are considered reasonably stable in the Western world nowadays.

1 The data presented in this appendix have been collected and stored over time by the Avesta Sheffield Group or companies with other names that are nowadays part of the Group.
but the picture may change rapidly. However, energy supply will not be further
discussed here at least not explicitly. The other input variable, i.e. raw materials, if not
more important than energy but certainly less predictable, will be discussed at length
below and concerns raw materials supply and cost.

2 Price and demand: from stability to volatility

Through a time period of approximately twenty years, commencing in the early 1950s
ending in the early 1970s, the nominal price of stainless steel was almost constant.
Competition in the industry was largely a national matter at least concerning
commodity supply. Diagram A2:1 shows the price pattern of the British stainless steel
market since 1953 but the pattern is similar for the entire Europe. Price became
volatile in the early 1970s at the time of the oil crisis. Escalating oil prices and
uncertainty about oil supply caused turbulence in the energy sector worldwide with
implications for the entire global economy.

![Diagram A2:1 Price development British market; Cold rolled mtrl, Tp 304, thickness 2 mm.](image)

From the early 1970s price and demand volatility has become the normal condition of
the stainless steel market. While Diagram A2:1 shows price changes on the British
market from 1953 up to 1997 by the year, Diagram A2:2 forwards the price
development on the German market from 1975 onwards by the quarter. The two
patterns are close to equivalent for the time period they have in common.

A good illustration of market demand volatility is the very strong upsurge in demand
during the spring 1995. Deliveries of flat stainless steel products for the first half of
1995 exceeded those for the same period 1994 with more than 25 % and then it should
be kept in mind that the average growth of stainless steel consumption has been 4 - 5
% per year over the last 40 - 50 years. The strong upturn was certainly not driven by a corresponding strong increase of the apparent consumption\(^1\) but was rather the effect of a substantial stock build-up. Pariser and Shaffer (1988) point out a similar pattern for the worldwide deliveries of stainless steel cold rolled flat products for 1987. They calculate the excess supply (i.e. deliveries minus apparent consumption) for the year and state that "the excess is unusually high - about 250,000 tonnes. We suspect that this represents speculative stockbuilding by merchants, stockists, and consumers in anticipation of high prices and shortages. In our view, it is not demand for consumption" (p.4). The apparent consumption for 1987 was calculated to somewhat below 4 million tonnes. While studying Diagram A2:2 it is interesting to note that the nominal price of 1 kg 2 mm thick Tp 304 cold rolled stainless steel appears to be at the same level in 1996 as it was in the mid of the 1970s i.e. DEM/kg 3.00\(^2\). During the first ten years of the period the price increased to a level somewhat higher than DEM/kg 4.00. The subsequent decline displayed wildly fluctuating prices. In the end of the twenty years period the price was again at the level of DEM/kg 3.00. In 1997 the average price dropped even further down to DEM/kg 2.50 - 2.70. Assume stable prices for raw materials supply during the study period and the long-term productivity of the stainless steel industry balances the long term inflation of the European economy. So it is reasonable to ask: What did happen with raw materials prices?

\(^1\) Apparent consumption is defined as deliveries plus imports minus exports plus/minus stock changes. Since statistics regarding changes in stocks are usually not available, or, if available, are often less reliable there is an inherent error in any figure on apparent consumption. The definition of apparent consumption is brought in from Pariser and Shaffer, 1988.

\(^2\) Deutsche Marks (German Marks) per kg.

Diagram A2:2 Price development German market; Cold rolled mtrl, Tp 304, thickness 2 mm
3 Raw materials supply – a critical factor

No doubt raw materials costs (scrap and alloying metals) is by far the largest single cost item for any producer of stainless steel. Statistics gathered by the Avesta Sheffield Group regarding costs for raw materials strongly supports the statement. Out of the Group’s total turnover of SEK18.7 billion\(^1\) for the financial year 1997/98 the total expenditure on raw materials amounted SEK 6.5 billion. Table A2:1 shows the development since 1987. Raw materials business comprises a large portion of the total business of the Avesta Sheffield Group. Since 1987 costs calculated on an annual basis for raw materials consumption has ranged between 22 and 44 % of the Group’s total turnover. The Annual Report of year 1997/98 states: ”Expenditure on raw materials, in the form of scrap and alloying metals, represents Avesta Sheffield’s largest cost item” (p.28). Similar statements can be read in every annual report issued over the period studied.

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Year} & \text{Turnover [billion SEK]} & \text{Cost raw materials [billion SEK]} & \text{Cost raw mtrls/Turnover} \\
\hline
1987 & 6.0 & 1.6 & 27\% \\
1988 & 7.7 & 2.7 & 35\% \\
1989 & 9.5 & 3.3 & 35\% \\
1990 & 8.2 & 2.4 & 29\% \\
1991 & 7.4 & 1.6 & 22\% \\
1992 & 7.6 & 2.1^{1)} & 28\% \\
1993 & 14.2 & 4.4 & 31\% \\
1994 & 16.8 & 5.6 & 33\% \\
1995 & 21.7 & 9.5 & 44\% \\
1996/97 & 17.2 & 5.9 & 34\% \\
1997/98 & 18.7 & 6.5 & 35\% \\
\hline
\end{array}
\]

\(^1\)Reported costs for raw materials in 1992 amounted SEK (Swedish kronor) 3.4 billion but the merger affected the raw materials stock dramatically during 1992. In the end of 1991 the stock amounted SEK 1.8 billion while noted to SEK 3.5 billion in the end of 1992. For comparison reasons here the build-up, SEK 1.3 billion, has been withdrawn from the raw materials cost accounted for as the turnover for 1992 was only marginally affected by the merger.

Table A2:1 ASG: Cost raw materials/Turnover ratio 1987-1997 - Source: Annual Reports ASG.

Costs for raw materials are crucial for any stainless steel producer. Ample price uncertainty concerns nickel (Ni) but also molybdenum (Mo). To some extent also chromium (Cr) is affected. Austenitic standard grades, the bulk of stainless steel production, contain 8 - 10 % nickel, a circumstance that makes stainless steel business extremely vulnerable to nickel price fluctuations, and it cannot be excluded that a sudden nickel price increase is an early indication of a long-term shortage of nickel.

\(^1\) Swedish “kronor”.

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Stainless steel producers have approached the problem of uncertainty as to raw materials supply in various ways. Medium-term contract agreements established with raw materials suppliers within stable long-term relationships are one way to secure supply. Such arrangements also function as price stabilizers. It follows that the establishment and maintenance of an appropriate supplier portfolio is a prioritized task. The aim is to stay in the business of stainless steel production and sales while avoiding involving too much in raw materials trading. Price stability can also be enhanced by securing raw material purchase on e.g. the LME (London Metal Exchange), a practice that has become increasingly frequent in recent years. Thus, managed uncertainty about raw materials prices can be eliminated for particular business contracts.

Table A2:2 shows the relative cost of the most important alloying elements used in the manufacturing of stainless steel. The percentage represents the ratio between ”cost of alloying element” and ”total cost of raw materials” for the Avesta Sheffield Group during a ”normal” year. The consumption of nickel amounts to about 55 - 60 % of the total cost for raw materials. But some years there are deviations from the normal. During the years of 1988 and 1989 the nickel price peaked at about SEK/kg 115 to be compared with the price of nickel a few years earlier when the price was SEK/kg 20. Thus during those two years the cost for nickel rose to about 65 - 70 % of the total cost for raw materials in stainless steel production.

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Cost share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nickel</td>
<td>55 - 60 %</td>
</tr>
<tr>
<td>Chromium</td>
<td>15 - 20 %</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>5 - 10 %</td>
</tr>
<tr>
<td>Other</td>
<td>Balance</td>
</tr>
</tbody>
</table>

Table A2:2: Relative cost of various alloying elements.

The movements in market prices for nickel (Ni), chromium (Cr), and molybdenum (Mo) are shown in Diagram A2:3 for the period 1980-1998. In the initial part of the period the Mo price was extremely high while the prices for Ni and Cr were quite normal. During the period there are two strong upturns in alloy prices, the first occurring 1988-1989 when Ni and Cr prices go high. The second peak takes place during 1994. The Mo price started to raise in early 1993 and late 1993 the Ni price followed pace. During the first half of 1994 both increased quite slowly but then the Mo price ran mad and peaked at a level about five times the normal. The Ni price also soared and stayed quite high during 1995. Cr reached its maximum level in mid 1995. From 1996 onwards the Ni price fell back and in the summer of 1998 it reached its lowest level ever for the entire period. Mo came down to a level somewhat higher than that before 1995 and Cr largely regained its normal level.

In order to compensate for the negative effect on profitability emanating from soaring alloy prices a certain alloy pricing system, the Alloy Surcharge (AS) system, was introduced on the European stainless steel market in 1988. All producers of stainless steel adopted the system because they all suffered from high nickel prices and they all encountered difficulties when trying to persuade resistant customers to suddenly pay 1.5 - 2 times the normal price for standard stainless steel. The AS system distinguished the anticipated long term ”normal” price level of various alloying elements and short term unusual price peaks. Different trigger points for different alloying elements turned the system on. It was construed to serve the dual function of (1) compensating for price disturbances on the raw materials market, and (2) aiding when informing customers that stainless steel producers were not to blame for high prices but rather the suppliers of raw materials and in particular those supplying nickel.

4 Technological development and structural change

Since the 1950s stainless steel consumption in the Western world has grown at an average rate of 4 - 5 % per annum albeit consumption has fluctuated substantially short term. Perhaps the strong long term growth is the boon and the bane of the stainless industry. On the one hand there seems to be available an ever growing market for stainless steel. On the other hand almost continuously new and increasingly effective production capacity has come on stream with implications on the balance of competition.

In the wake of the oil crisis uncertainty about price as well as supply rose to new high levels. But in the same time period many European industries recognised also another threat by the emergence of new and growing competition from the so called NIC-countries (Newly Industrialised Countries), some of them located in South East Asia, some other in South America. Old European core industries as mining, (mild) steel production, shipbuilding, and forestry, etc. were challenged. A large portion of the
European industry lived through a painful period of structural change during the 1970s and early 1980s. No doubt, several industries in Sweden suffered during this time period. The new competition outperformed its contestants by exploiting the cost side of its business no matter which cost parameters were manipulated. European industries responded by performing rationalization and restructure. This was the time period when mergers, acquisitions, off-sales, and shut downs occurred in the European stainless steel industry.

The restructure of the stainless industry concerned ownership issues, financing, physical resources, human beings, and ideas. The new shape of the industry demanded new interaction and new activity patterns to be developed. Former competitors suddenly found themselves organized within the same industrial group. All the change that occurred within quite a short time period affected many business relationships. At a human level people were forced sometimes to cooperate with people they had previously disliked or found hostile. The restructure resulted in new resource constellations. Some production units were enlarged or linked into larger business systems making them benefit from economies of scale. Other units were erased. New or improved production technologies were developed and implemented. New products were developed and diffused into the market. New distribution patterns were employed. Newness entered into the stainless business in different ways. The borderline between product development and process development was often blurred, as new products often needed new, improved or otherwise modified processes for their proper manufacture. But it could also be that new processes were developed for the production of old products, but then at lower costs. Sometimes in order to distinguish the new process from the old the product manufactured was just given a new name.

5 How come the “restless” stainless industry? – An explanation proposal

Avesta AB’s annual report 1989 forwards an explanation proposal concerning price and demand volatility on the stainless steel market (Swedish edition, p.30).2

Even if the production of stainless steel 1989 reached the same level as during 1988 (more than 10 million tonnes of ingot steel) 1989 became quite a different year for the stainless steel industry. During the first half of the year deliveries reached new peaks. During the second half a striking change occurred and the industry ended up in a cyclic dip. The main reason is to find in the exceptional development of the nickel price which led to speculative build-up of excessive stocks and subsequent de-stocking.

The substantial increase of the nickel price during winter 1987/1988 led to rapidly increasing prices on stainless products which in turn generated a strong buying rush which was followed by a more normal purchasing behaviour during the

1 The problems are discussed in e.g. Lundberg and Rydén (ed.), (1980).
2 The quotations are translated from Swedish into English by the author.
summer/autumn 1988. When nickel price once again started to rise in the end of 1988 and went on rising steeply during the first quarter of 1989 another buying rush materialised. Worries about future price increase in combination with anticipation of insufficient mill delivery capacity implied by forthcoming raw material shortage may explain customer behaviour. When the nickel price started to fall in the second quarter of 1989 many stockholders as well as end users carried excess stocks of stainless steel. Reduced mill orderload resulted in shorter delivery time when entering new orders which in turn further reduced the need for stockholding. Reduced purchase implied low order intake and low capacity utilisation in the steel mills. Prices for stainless products dropped and many products suffered a tough price war during the latter part of 1989.

The scenario painted can be studied in the Diagrams A2:1, A2:2, and A2:3 above. In Diagram A2:4 the data forwarded in Diagram A2:2 are combined with information from the Alloy Surcharge system for the period 1988 - 1997. Only Tp 304 material is represented in the diagram which implies price fluctuations as to molybdenum are not reflected.

Diagram A2:4 Price development German market; Total price = Price excl. AS + AS; Cold rolled mtrl. Tp 304, 2 mm thickness

The bold line at the right bottom end of the diagram shows the level of the Alloy Surcharge (AS) by the quarter. AS noted at zero means alloy market prices are equal to or below the trigger points applied for the Alloy Surcharge system. Market prices below respective trigger point are usually neglected i.e. negative AS is usually not calculated. Maybe it is no surprise that the curve for “total price”, i.e. the market price of the flat stainless product in grade Tp 304, increases when the curve for AS goes up

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1 The application of Alloy Surcharge was introduced in 1988.
and decreases when AS goes down. It confirms that steel producers compensate themselves for increased raw materials cost. What may be a surprise is that steel producers strongly overcompensate themselves during times when alloying elements are expensive and suffer from substantial undercompensation when alloying elements go cheap.

The line marked by empty squares represents base price development i.e. total price minus AS. The base price is supposed to be the major price component subject to negotiations between exchange parties while AS is meant to reflect fluctuating raw materials costs only. However, in practice any pricing element, be it the base price, AS, thickness extra, width extra, extra for surface treatment, or any other extras, may be negotiated although only rarely AS is subject to bargaining. It is amazing to note how closely the base price is following the shape of the AS curve and then it should be recognized that the AS curve reflects changes of an independent variable i.e. a variable largely beyond the control of the negotiating parties (steel producer and customer). The base price curve on the other hand is a reflection of negotiations between exchange parties and is thus here to be considered a dependent variable. If there is any relationship existing between the two it must be that changes in raw materials price impact upon stainless steel base price and not the reverse. Diagram A2:4 renders strong support to such a proposition.

Probably the AS system works as a base price destabilizer because it automatically transfers changes in raw materials prices onto the customer. It acts mechanically and there is usually no room for negotiating the compensation claimed for by the supplying party, i.e. the stainless steel producer. Price instability is amplified along the distribution channel. An anticipated raw materials price increase drives an increased stock building in the distribution channel as the price increase, if realized, is automatically passed on to the customer. Increased demand encourages steel producers to increase the base price of their products, which further stimulates stock expansion in the distribution channel, because of anticipated further price increases and so on. Price peaks at a point where enough many actors anticipate a price fall (for whatever reason). The price increase period may well extend into a year or more and the curve exhibits a fairly predictable, steady upward trend. Not so the price drop period which is usually extremely short, sometimes less than a month. Moreover, it is difficult to predict in advance its starting point or the inclination of the falling curve. The course of the price drop would probably slow down somewhat if several different systems were in use compensating for raw materials price changes. If that was the case, price comparison would at least become more difficult to perform.

**Short-term volatility:**

‘The short term base price of stainless steel largely follows changes in raw materials price.’ The hypothesis forwards the argument that rising raw materials prices cause rising base price and falling raw materials price causes falling base price. The
mechanism in operation short term is simply: When raw materials costs increase good times are forthcoming and when raw materials costs decrease times change for the worse. On a high level of aggregation that seems to hold true. At least the proposition is supported by the quantitative data presented in this appendix. However, at a lower level of aggregation the truth becomes less obvious. What appears to be a complete business failure or a total business success when studied at a high level of aggregation can at a lower level of aggregation usually be shown to be a combination of partial success and partial failure. The outcome is made up of a large number of business elements characterized by varying degrees of success and failure. This circumstance, I argue, may be explained by the fact that customers are different and so are customer needs and suppliers are different and so are the capabilities and competencies of different suppliers. Most data used in this chapter are aggregated data relating to standard grade 304 type of material, which represents the bulk of stainless steel business making up about 80 % of the entire consumption on a global basis. It is important to remember that the price information forwarded in the above diagrams are mean values, each one of them representing a spectrum of prices that have occurred on the spot market for stainless steel in the past. Its information value is poor if searching for data explaining the function of stainless steel business.

Long-term volatility:

Still another interesting hypothesis could be formulated based on the notifications in Diagram A2:4: ‘The long term base price of stainless steel will decrease.’ The proposed long-term effect on price is supported by the downward trend, shown in Diagram A2:4. The two price peaks, the first one in late 1980s and the second one in mid 1990s, were true surplus profit generators that created new resources for investment in new technology and capacity expansion in the stainless industry. The simple logic here is that new production technology and enhanced distribution facilities reduce costs and implicitly price. Demand increase stimulates capacity expansion but new capacity, employing new superior technology, comes on stream intermittently and thus affects the supply-demand balance in the market short term and consequently the market price.

The long-term development of price in the stainless steel industry is shown in Diagram A2:5 where a linear trend line for a time period of ten years from 1988 to 1997 has been drawn. It informs that the base price has declined from DEM/kg 4.30 down to a level of DEM/kg 2.50 for cold rolled standard grade Tp 304 material, thickness 2 mm, over these ten years. The price drop corresponds to an annual average base price reduction of DEM/kg 0.18 or 4 - 5 % in the earlier part of the period and 6 - 7 % in the latter part. If the base price development is reflecting the long-term productivity increase in the stainless steel industry Diagram A2:5 renders support to the proposition

\[1\] If the linear trend line format can be accepted as a reasonable approximation of the factual price development.
that there has been an accelerating increase in productivity over the last ten years. If studying Diagram A2:5 together with Table 2:1 in chapter 2 it becomes obvious that the Avesta Sheffield Group has arrived at a dangerous point. Only during periods of unusually favorable market conditions the Group is capable of generating profit.

So it seems that changes in the stainless steel price are driven largely by two major forces (1) short term by raw materials price volatility and (2) long term by cost reductions in the stainless industry caused by capacity expansion in combination with new, superior technology. But there is also a short-term effect on price emanating from the way new capacity is entering the market.

**Diagram A2:5** Base price development German market; Cold rolled mtrl, Tp 304, thickness 2 mm