On Stage

Acting for development of businesses and ergonomics in woodworking SMEs

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Abstract

This thesis reports findings and results from studies of development work and change processes in the secondary woodworking industry. The purpose with the research is to increase the knowledge on how companies can initiate change and to increase their ability to change. The dual aim of improving both business and working conditions served as a guiding condition for the research. Case studies and action research were performed in small companies, mainly with less than 100 employees and in some cases less than 20 employees.

The thesis encompasses six papers addressing different topics within the framework of development work and change processes. Topics elaborated are how performance concerning the ergonomic situation in a company can be measured and how the content and process of ISO 9000 implementation as well as standardisation influence system performance and working conditions. Furthermore, a framework for how change is enacted in SMEs and its effects on ergonomic considerations is suggested. A methodology for initiating change efforts in complex and ambiguous problem situations is presented. Finally the different expert and participant roles in an organisational change effort are elaborated and analysed with reference to experiences from previous case studies and theory.

Together, the papers and the thesis emphasize the importance of action and work activities as a base for change. It is in the conflicting work activities or work conduct of differing perspectives where many of the drivers of change can be found. I also argue that this is a main reason to give good working conditions utmost importance for organisation performance. Further, I conclude that the six papers together contribute to a theoretical basis for developing small firms and attractive workplaces. It is indicated that the results are relevant to small manufacturing firms, while neither organisational structure nor resources available are the same as in larger companies. Moreover, the organisational size has a number of implications on aspects like visibility, available theoretical knowledge, vulnerability, formalisation, institutionalised organisational inertia etc. that will alter the demands on the change process. Many of the results are not limited to woodworking industry; the technical content of the ergonomics problems will however be different in other firms.
Acknowledgements

When I was employed by Trätek, the Swedish Institute for Wood Technology Research, in 1991 it was with the promise that the project I should be working in made it possible to combine the work with research studies. That was however not a reason for me to take the job, I was more interested in working with production and ergonomics development in woodworking industry. After starting the work together with Jörgen Eklund at the Division of Industrial Ergonomics at Linköping University I realised that the possibility was something more than that, the work should be combined with research studies. In retrospect, that changed my life in many ways. However, I came to the conclusion that I didn’t mind, my family did not either and I found the courses I started to follow to be very stimulating. They opened my eyes to a world of knowledge my 12-year old M. Sc. in Mechanical Engineering did not include.

The 8 years at Trätek were followed by my employment at the School of Engineering in Jönköping with the task to establish the Department for Industrial Engineering and Management which I was heading until last year. During all these years I was a part-time research student and my identity as such is deep and I am now almost surprised that it will not be so any longer.

During this long time I have belonged more or less to three workplaces that are worth mentioning. The Trätek office in Jönköping, the Department of Industrial Engineering and Management in the School of Engineering at Jönköping University and the Division of Industrial Ergonomics in Linköping University. A large number of people at each workplace have meant much to me in different periods and it is impossible to mention them all. You are not forgotten and I deeply appreciate your friendship.

Some people have however had a larger role in supporting and inspiring me to write and finish this thesis.

Professor Jörgen Eklund, my supervisor, who actually took me in as PhD-student, has a tremendous patience, enthusiasm for the subject and for his students. Jörgen is always positive, having ideas and seeing opportunities. He has a broad and deep knowledge in many directions of ergonomics. Thank you, Jörgen!
Professor Gunnela Westlander, my co-supervisor, sharpened my views and drew my attention to weaknesses in my work through brilliant questions and remarks, often with a humorous twinkle in her eye. Thank you, Gunnela!

A special thanks to Dr Mattias Elg who acted brilliantly as opponent on my manuscript in the beginning of this summer. He gave me valuable comments and advice.

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Without all friendship and the way managers and employees in the studied companies obliged me in my research effort this thesis would not exist. I am deeply grateful for your will to open up parts of your lives to me.

From my time at Trätek I would like to mention Jan, Peter, Martina, Mai, Nisse, Leif and Veronika. At the Division of Industrial Ergonomics and CMTO I met Martina, Åsa, Eva, Jan, Linda, Tilmann, Gunilla, Elisabet and Lena as well as Göran, Ulf, Mikael and Per-Erik and Henrik among others and they all cooperated with me in different courses, projects and settings. Thank you all!

During the last years Martina Berglund and I have cooperated in research on schedulers work outside the scope of this thesis. This work expanded and sharpened my view of ergonomics and research. Thanks for inspiring collaboration!

Erik Havemose and I have been teaching “Applied management of change” each year since 2001. Erik’s dynamic personality and view of change processes has deepened my knowledge and understanding of the dynamics in change. Thanks Erik, not the least for the many laughs!

Some of my best friends and most inspiring people to work with are employees or guest lecturers at the School of Engineering. Karin, Olof, Siw, Annika, Claes, Madde, Siv, Anette, Christer, Mats and many, many others. Thank you all!

Roy Holmberg, former CEO and dean of the School of Engineering supported me patiently although my thesis always was to be finished “next year”. Finally, “next year” is here. Thank you, Roy!

Last but foremost I am deeply grateful to my family. It has changed and grown over the years but their support and love have always been there.

Anette, without your love, encouragement and insights it would have been much more difficult to finish this thesis. I will never forget!

Jönköping in August 2007

Johan Karltn
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Part 1

Part 1 introduces the contextual conditions forming the basis of the research performed. It also presents the research agenda.
1 Introduction

This thesis is based on research I carried out over more than a decade. The empirical work was conducted in the years between 1991 and 1999. During the same period I worked as a “research consultant” doing applied research and development. Studying processes of change during such a long period is of course a challenge but provides as well advantages in terms of longitudinal overview. Organisational and technological change was an intensely debated topic at the start of my research and it still is. Improved performance has always been a main focus in all types of organisations and the means for achieving this may vary not only between theories but between contexts and implicit values. The research reported here was based on the values and considerations of ergonomics.

The Swedish secondary woodworking industry

This thesis is concerned with studies in the Swedish secondary woodworking industry. This means that companies belonging to other industries or to the primary woodworking industry such as sawmills, board manufacturers etc. were excluded as research objects. All case studies were conducted in manufacturing companies making products like windows, doors, flooring, wooden houses, furniture, fittings and other wooden products for professionals or home market and delivered to furnishers, retailers or end customers. The following description is my personal view of the secondary woodworking industry and based on experiences of working in it and with it for a period of more than 15 years.

During the period when the research was performed the Swedish secondary woodworking industry could be described by some generalized and rough characteristics. The secondary woodworking industry was and still is to a large extent comprised of small firms with less than 50 employees, quite a few companies with up to 500 employees and very few larger companies. A large portion of these companies are situated in small rural communities where they often play a vital role for the employment. A restructuring process of the industry is discernable, sparked by financial investors as well as changes in markets and the presence of IKEA and its massive furniture purchases. The markets for products from the secondary woodworking industry are to a large extent subject to fashion and culture influences (furniture, building components) and to political influences like conditions for loans or subsidiaries (houses and building components).
During periods of low unemployment, the secondary woodworking industry has had problems of recruiting people to manufacturing. The ability or will to recruit graduated engineers has been considered to be low and far beyond the metal industry. The industry thus has had a general lower level of formal education than comparable industries, a factor believed to hamper the development of the secondary woodworking industry. This was a frequent topic on the agenda for the Committee for working conditions and education (a cooperative body with representatives for employers’ federations and unions for development of the industry concerning these issues) where I was a research representative during the years the empirical work was performed. Woodworking teaching programmes also had student recruiting problems signalling that young Swedish students did not consider woodworking to be of interest as a specialization area. Statistics from the employer federation TMF show that there is now an increasing interest in high school education specializing in furniture and woodworking and the number of applicants has doubled from 2003-2008 (TMF, 2007).

Some features of the manufacturing conditions are directly connected to the material itself. Compared to metal, cutting forces are low; cutting processes are fast and feeding velocities are high. This has some consequences. Hand feeding can be used and is used, especially in low volume production. This is the main reason behind the high frequency of hand injuries. Moreover, handling and automation equipment need to be fast in order not to slow down the manufacturing processes. This is one important factor why automation has been slower to propagate into woodworking industry. The availability of feasible and fast automation equipment has been limited with manual work often outperforming automatic equipment. Furthermore, the anisotropic and variant character of the material makes especially solid wood more difficult to handle in manufacturing processes. Manual sorting and grading is necessary and increases the direct labour cost. Hence, manufacturing of products of solid wood is difficult to maintain in Sweden if the products are sensible to pricing. The sorting and grading process is difficult to automate as well.

The character of solid wood also fosters the historically based and in my view romantic opinion that manufacturing products of solid wood are preferably produced in a handicraft manner with low levels of technology. This may be true in many cases but the argument is largely used also as an excuse not to be systematic and analytic in developing processes and technology to handle this material variance in a standardised and systematic way. The problem is of course less apparent in companies using wood-based materials like particle board, fibre boards or plywood where the variance of the material was reduced in a previous processing stage.

Another characteristic is the large flexibility needed in some businesses where customer order production is more or less standard. Window and some door manufacturers are among those with a high portion of customer-ordered manufacturing. A high variability in measures, in surfaces and in fittings, results in fewer identical products on average. For example, in the door manufacturer,
where I worked before going into research, about 200 000 doors in 50 000 variants were produced annually (1990). The company faced two problems at the time to cope with the situation, no software was known to handle the information in an efficient manner and the average value of a door could not bear the cost for sophisticated information system solutions.

However, and regardless of these distinct woodworking features described above, I am not convinced whether the problems of the woodworking companies studied could be related to the wooden material used or whether they should be related to other characteristics. The issue could be related to company size, social context of the company, complexity of product, manufacturing process configuration, customer relations, market features or other contextual factors affecting the businesses. In many cases I would regard the material being less important than such factors. There might however be an indirect connection to the material. It can be argued that there is a historical connection between the wooden material and some of the other characteristics of the woodworking industry such as the geographical location. These companies are mostly situated in rural areas because the material traditionally was easily available there. The general low level of formal education could in a similar manner be explained historically by the fact that the technological demands for starting a woodworking manufacturing business did not require the same amount of technological sophistication manufacturing businesses with other materials need. Instead, the practical knowledge required was available in the local society and could be achieved in for example master-apprentice learning systems which also explain the strong handicraft tradition in woodworking industry.

The time span, the 1990s, during which the research was done can be characterised as a recession period for many companies due to several reasons. One was the ongoing rationalization which many small and medium companies had difficulties to comply with. Another was a collapse of the domestic market for detached houses between 1991 and 1995 due to a huge shift in the stately subsidiary financing system. The financial magnitude of the market collapse was about SEK 30 billion and it affected primarily house builders but also door, window, stair and kitchen manufacturers as contractors and suppliers of furniture to new houses. A third reason was the recession in the computer and telecom industry that lead to a slump in the office furniture market. The number of employees in the industry was about halved during these 10 years. Many of the companies were situated in small communities outside the main population centres which made them important for the survival of jobs in these local communities. As described above, they largely suffered from low profitability, low general level of education, difficulties to recruit new staff and mounting international competition.

Regarding the current development of the secondary woodworking industry I would like to refer to Brege et al. (2005). The turnover of the industry is about SEK 48 billion and could be divided into furniture manufacturing SEK 20 billion and other products mainly related to building SEK 28 billion. The number of
employees is about 35,000 people, of these 16,000 are employed in furniture industry and 19,000 in other woodworking industry (Brege et al., 2005).

**Ergonomics in secondary woodworking industry**

From 1982 to 1987 a national action programme for the development of new technology, work organisation and working conditions (Utvecklingsprogrammet) was carried out and financed by the Swedish Work Environment Fund together with employers’ and unions’ federations. Five out of fifteen case studies on the participative development of new technology, work organisation and working conditions were performed in small or medium secondary woodworking companies. Each company performed their own development with the assistance of an external consultant/researcher. The concluding results from this programme, according to Forslin (1988), included:

- When market preferences change changes were forced on the companies
- Needs for quality development implied organisation wide changes
- The importance of introducing computerised manufacturing resource planning systems due to larger demands of make-to-order products was acknowledged
- New work organisations (group organisations) were implemented to avoid cumulative trauma disorders, reduce monotony, increase autonomy and provide more flexibility in production
- New advanced technology forced the companies to make technological leaps implying increased knowledge demands on personnel
- The need for participative change processes were demonstrated
- Organised project work was introduced in the participating companies with differing success
- Support from workers’ union was considered invaluable to maintain development efforts and prevent that those efforts lapsed into daily routines only
- Informing everyone was important
- External consultancy was needed to overcome the resistance in the unfreezing stage and to reduce “blindness to one’s work”
- Changes included reconsideration by all involved concerning their roles and leadership practice and some involved (small) companies needed a period of increased structure, formalisation and bureaucracy

However, the difficulties to develop better working conditions persisted and many woodworking companies had difficulties to recruit the personnel they needed.
One reason for this was ergonomics, the secondary woodworking industry was known for its poor physical working conditions and to be an industry with low general educational level.

In an investigation of the working conditions in the secondary woodworking industry 1991, Busch (1991) interviewed 2012 employees and 71 CEOs from 116 different companies. The interviewees and companies were chosen to give a representative sample of the entire industry (Busch, 1991). Among the physical problems noise was considered to be the worst with 58 % of the entire workforce feeling discomfort or severe discomfort. Corresponding figures for dust was 39 %, for heavy lifting and repetitive motions 38 % respectively and for solvents 15 % (see Figure 1.1). Moreover, severe work accidents were more common than in most industries with almost 15 severe accidents per 1000 employees resulting in more than 30 days of sick leave. Of these, about six lead to permanent disabilities, often hand injuries (AMF, 1991; Lindell et al., 1991)¹.

![Discomfort from physical working conditions](image)

**Figure 1.1: Percentage of blue collar workers experiencing much discomfort or severe discomfort from different physical working conditions in Swedish secondary woodworking industry 1991 (Busch, 1991).**

The organisation of the companies was also considered to be less efficient by the employees, 24 % of woodworking companies compared to 7 % of average indus-

¹ Today’s statistics are not directly comparable because the categorisation of companies has been changed but the best comparable figure for 2005 is 17, 9 work accidents per 1000 employees resulting in more than 14 days of sick leave and the figure has been slowly decreasing during the last years (TMF, 2007).
trial companies was given this opinion. Furthermore, 52% of the blue-collar workers considered their companies to be underdeveloped concerning production technology compared to 22% in the average industry. This difference did not exist among white-collar workers (Busch, 1991).

Concerning changes that all employees would value, the results pointed out a good pay (woodworking industry was a low-wage industry) as well as better information on business matters giving employees a stronger feeling of being involved. Blue-collar workers also valued safe machinery, safety consciousness and a workplace without accidents where they were involved in planning their own work.

White-collar workers valued safe employment, a job with opportunities to develop their abilities and skill, an employment providing the education they needed and where they have some say concerning important decisions. However, in contrast to this relatively negative picture 79% of the employees considered their work to be satisfactory or very satisfactory as a whole.

In January 1991 the Swedish Woodworking Employers’ Confederation and the Swedish Woodworkers’ Union agreed on and published an action programme for improving and developing working conditions in the Swedish woodworking industry. The main goals with this programme were to create safe and secure workplaces with a high degree of work satisfaction for all employees. Good productivity and profitability were considered main conditions for achieving this goal. Furthermore, it was concluded that there existed a gap between the existing know-how embodied in Trätek, consultants, OSH-representatives and ombuds-men and the applied knowledge within companies, especially SMEs. One of the main questions of the programme was thus how to decrease this gap or how to overcome the difficulties with it (Lindell et al., 1991).

**The Swedish Institute for Wood Technology Research (Trätek)**

In 1991 I was employed by Trätek, the Swedish Institute for Wood Technology Research in Jönköping. The content of my work was supposed to be divided between part time research and project management concerning different technical and organisational development projects, integrating business development, ergonomics and spreading information from research.

Trätek is a research institute working with issues associated with the Swedish mechanical woodworking industry. In the 1990s Trätek had about 85 employees and was located at three different sites; Stockholm with the head office and about 55 employees located close to the Royal Institute of Technology (KTH) to facilitate cooperation with other researchers. In Skellefteå there was another office with about 15 employees, located in the same premises as the Department for Wood Technology belonging to Luleå Technical University. The third office, where I was employed, was located in Jönköping in the middle of the woodworking district in southern Sweden. Since this office at that time did not have any direct contact with a university, the idea was to establish contacts...
and collaboration with Linköping University to create some form of research environment.

As employee in Trätek, my mission as well as that of my colleagues (in total about 15 people), was to support the industry with knowledge, to assist in development and to facilitate change in woodworking industries. About four of us worked explicitly with ergonomics issues. My other colleagues worked with quality management, productivity issues and business development, technical developments etc. The fact that we met in the small companies made it impossible to separate issues why we often integrated different aspects of the businesses in our projects. It is also worth mentioning that ergonomics and especially the development of technical means for reducing problems of noise, dust and accidents had a very strong position in the Jönköping office of Trätek.

Reorganisation of Trätek and the funding of applied research

In 1991 the basic funding of Trätek’s business was based on the volume of contributions by the woodworking industry in Sweden. If the industry collectively invested 1 MSEK, the government would invest the same amount of money through its applied technical research funding body. This ratio was successively decreased by the government during the 1990s. Besides this basic funding there were also other funding sources. The present research was mainly funded by the Swedish Work Environment Fund (closed 1995) and the Swedish Council for Work Life Research (closed 2000). Since then, the area in which this thesis is written is divided between two funding bodies. These are Vinnova, the Swedish Governmental Agency for Innovation Systems being the funding body for applied technical research and FAS, the Swedish Council for Working Life and Social Research promoting the understanding of social conditions and processes within working life.

The other Trätek offices had their main research and consulting services within wood materials science, wood-based product development, sawmill operations, standardisation etc. The office in Jönköping was entirely directed towards operations and especially the secondary woodworking industry. The large problem of physical working conditions in the woodworking industry was one of the main reasons for establishing the office in the mid seventies and the funding from the Swedish Work Environment Fund was essential for the establishment and survival of the office.

Trätek was reorganised in 1999 as a result of a large research concentration in wood technology research at Växjö University. The office in Jönköping was moved to Växjö and I left Trätek for the School of Engineering in Jönköping. As a result the final work with this thesis was funded by the JTH-fund which supports research at the School of Engineering.

A total reorganisation of the publicly funded research institutes in Sweden took place in the beginning of the 21st century. Trätek is now merged with the Swedish National Testing and Research Institute SP, and belongs to the department of building technology and mechanics. According to their English website,
“SP Trätek’s activities span the full range of timber handling and processing from felling and handling in the forest, via production in the sawmill through to finished products and their use. Activities include applied research, development, and studies, various forms of consultant ventures and training, as well as testing and monitoring of materials and products in SP Trätek’s accredited laboratories” (SP Trätek, 2006).
2 Research agenda

Parallel to the formulation of the action programme described above, a development initiative was formulated as a joint project between Trätek in Jönköping and the Division of Industrial Ergonomics at Linköping University. From previous experience it was concluded that there was a need to increase the knowledge on how to effectively stimulate companies to change and to increase their own ability to change. This development initiative formed the starting point for the research reported in this thesis. It was later followed by another project building on the results and experiences from the first. Those two projects form the empirical body of the thesis.

Summarizing the above introduction the research sets out from the following positions:

- It should contribute to the knowledge base of planned change in small or medium-sized secondary woodworking enterprises.
- It should comprise an aim to improve company performance as well as the working conditions in companies.
- It should if possible result in real improvements of performance and working conditions in the companies participating in the research.

Those positions formed both a guideline and served as delimitations of the research performed during the entire period the thesis covers.

Objectives of the research

The research endeavour to be pursued is derived from the research situation described above and the contextual conditions within the secondary woodworking industry. The research process was divided into more concrete questions that can be found in the different papers. These are in short:

- How can key variables for improving the ergonomic situation in a company be designed?
- How does implementation of ISO 9000 quality system, both concerning content of quality system and the implementation process, influence working conditions?
What are the arguments pro et contra standardisation considering the dual purpose of performance and ergonomics?

How can the characteristics of planned change processes in secondary woodworking SMEs be analyzed and understood when including ergonomic considerations?

How can an appropriate method for organising and designing change processes and their initial phases be constructed?

How can the different roles be clarified in change processes with interaction between external researchers/experts and employees in companies?

The reasons for choosing the topic of each paper are examined and commented on directly in the description of the contextual framework for each paper, see Figure 2.1. The research is based on case studies and action research in small companies, mainly with less than 100 employees and in some cases less than 20 employees. In total 21 companies participated in the different projects.

Outline of the thesis

The thesis is divided into three parts as presented in Figure 2.1. The first part is introductory and presents the general context of the research performed together with the objective of the thesis and its outline. In the second part, the papers are presented in the same chronological order as the different projects were performed and the Swedish project reports were written. The papers are arranged in a manner that will give the reader a good view of the development over time of the thoughts and approaches used in the research.

It also means that the first part of the thesis can be viewed in a historical context since the first paper was published 1994. However, due to delays in publishing procedures and the demand to prioritize other tasks in my daily work, the publishing dates of the research papers will not be in the same order as they were initially planned and written in their first versions.

Each paper covers a question of general interest in change processes and a contextual framework section briefly introduces each paper’s summary. The summary is deliberately made extensive to give the reader a clear view of what is said in the paper. Before proceeding to the next paper, some personal reflections in retrospect on the theme are presented as a discussion. These are not supposed to give an extensive updated review on the topic but rather an updated personalised view.

The third part of the thesis is concerned with some general questions of importance for the research. These are for example an updated literature review of influential theories on change, ergonomics and development in SMEs, research methods used and the rationale behind these, conditions for studying change in small enterprises and related problems. This last part of the thesis also discusses my contribution and arguments for its validity. Questions on further research are also raised.
2. Research agenda

Figure 2.1. Structure of the thesis

The titles of the papers included in the thesis and their relation to research projects performed are presented in Table 2.1. The full text papers are appended in the same order as they appear in the second part of the thesis.
Table 2.1. Papers included in the thesis

<table>
<thead>
<tr>
<th>Project</th>
<th>Papers</th>
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<tr>
<td>A. Competitive woodworking industry – work design in the future</td>
<td>1. Use of key variables for improving the ergonomic situation in a company</td>
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<td></td>
<td>6. Ergonomists, experts and participants in change; how do they relate?</td>
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</table>
In Part 2 the appended papers are consecutively presented with an introduction, an extensive summary of each paper and a personal reflection in retrospect. The first four papers are introduced by a comment on the project in which the research was performed and the two last papers are similarly introduced by a project comment.
3 Project A, Competitive woodworking industry – work design in the future (1992-1996)

The main idea behind the project “Competitive woodworking industry – work of the future” was to strive for combining better working conditions in woodworking industries and at the same time improving the participating enterprises’ ability to compete as is indicated in the title. The term “working conditions” included the physical, psychological and social conditions affecting employees’ well-being and performance in the enterprises. Enterprises ability to compete included labour market and factors like flexibility, quality, image, productivity and profitability. The reasons for this twofold approach were that many woodworking industries suffered from decreasing profitability and at the same time a considerable shortage of woodworking labour emanating from the fact that physically bad working conditions (in general) and low status made woodworking jobs less attractive among young people.

The aim to combine improvement of working conditions with increased competitiveness was based on a series of different examples where this had been successful (Andersson, 1988; Andersson et al., 1988; Broms & Lindahl, 1989). The funding body, the Swedish Work Environment Fund, was an organisation established by a joint effort by the Swedish unions and employers’ federations to improve the working conditions at Swedish workplaces. This was reflected in the steering group for the research project where the members were researchers or representatives for the unions and the employers’ federation.

The general belief was that good jobs are more likely to be created and will survive in profitable and competitive companies. The logic behind this idea is that enterprises with low or no profitability will not be able to devote any of their resources to care for the jobs in their premises as they have to concentrate on survival. However, the opposite logic can also be argued. Many of the organisational efforts to bring higher productivity and quality incorporate means that can be considered to bring advantages concerning motivation, variation, work content etc. Work enlargement (additional tasks of the same character), work enrichment (additional tasks of different character), empowerment, quality circles and other similar means are all devoted to improving the performance of the enterprise using features that are supposed to bring more motivation and commitment to the personnel thereby increasing productivity. All these means are also
supposed to increase problem solving, introduce better opportunities to influence one’s own work, reduce repetitive work, reduce risk exposure etc. which are considered to be beneficial for improving work content and working conditions.

The project included a number of activities all aiming to activate enterprises in performance and ergonomics improvement efforts. The main research activities included:

− The development of models for monitoring enterprises’ operations using *key variables* like productivity ratios, quality indicators etc. with the aim to convince enterprises to use them for continuous surveillance of their performance. Furthermore, this activity included the development of key variables for monitoring and evaluating factors relating to the ergonomics in the enterprise which is the research reported in Paper 1.

− *Assessment of ISO 9000 change processes* regarding the resulting differences of how the change processes were driven, both concerning the process itself and the content of the quality system, working conditions in general and effects of standardisation (Paper 2 and 3).

− *Action research development of enterprises* with an ergonomic focus is reported in Paper 4.

The project was closed in 1996 and the four following papers are based on the work and results of the project. Furthermore, the project also resulted in the author’s Licentiate thesis “Characteristics and evaluation of change processes” (Karltun, 1996) (in Swedish).
4 Summary 1. Use of Key Variables for Improving the Ergonomic Situation in a Company


Contextual framework for Paper 1

In 1990 one of the most influential books on manufacturing during the last decades was published. After some years (1984-1990) of global benchmark studies on car manufacturing in the IMVP research program, James P. Womack, Daniel T. Jones and Daniel Roos published their book “The machine that changed the world” (IMVP, 2006; Womack et al., 1990).

It is my impression that both the book and the benchmark studies that preceded it strongly influenced the use of key variables as a means to compare performance between different companies. Furthermore, I have the impression that the book was an important part of almost a paradigm shift towards a much stronger focus on measurements of organisational performances, both in production and in other parts of companies. There were other signs in this direction as well; the Swedish official report on productivity and prosperity was published in 1991 as a series of publications, one of them highlighting the measurement of productivity (Produktivitetsdelegationen, 1991). The introduction of the project T50 in ABB highlighted the measurement of throughput time as a means to achieve productivity gains and the results were widespread in Swedish industry.

Quality issues were as well on the agenda in many Swedish woodworking companies and one of the cornerstones in quality management is the notion that decisions should be based on what you know, not what you believe (Bergman & Klefsjö, 1994). This required that measurements were used, not only for statistical process control and financial control but also for the daily production. Extensive use of such measurements was not common in woodworking industry, some (especially larger) companies used it but many small companies mostly relied on the daily informal control exercised by managers working in or very close to production themselves.

Another source of inspiration was writings on financial effects of bad working conditions, among them the work of Jan-Erik Gröjer and Paula Liukkonen
(1991) who contributed to create a debate on the real costs of raised sick-leave or undesired personnel turnover.

One of the results of this was that in Trätek seminars, held together with the Swedish Woodworking Employers’ Confederation, we argued that companies should define, measure and compare important key variables that were decisive for their competitive advantage. Furthermore, we argued that those variables should be made public for employees in the companies, thereby increasing employees’ interest and giving them feedback and a better consciousness regarding what was important for the profitability of the companies they were employed in. However, the availability of key variables for the ergonomic conditions in a company was limited and it was decided to produce a paper on this issue, thus providing concrete ideas on such variables and testing them in discussions with a number of companies. A Swedish report written for company employees was published as well (Karltun & Eklund, 1995).

Summary of Paper 1

Background

The aim of the paper is to present a key variable model which makes it possible to measure human resource factors in the same way as other performance factors are measured.

One of the basic ideas behind improvement and change is evaluation of current status and changes going on. In short, you need to know where you are and whether you are making any progress. In companies, the yearly taxation demands a financial measure but that is not very useful for continuous management purposes. A better way to continuously monitor and control the operations is by using simple, understandable measures like performance ratios or key variables. There are well known key variables in economics, in quality management, material handling, productivity and continuous improvements.

Some of the benefits associated with a model for measuring working conditions are its capacity to stimulate learning and give accumulation of experience within the area through relevant feedback. Furthermore, the model is expected to redirect the organisations on the importance of working conditions, to stimulate the development of participation in measuring the consequences of the working conditions and to help bring performance related to working conditions to a more equal level as the other management issues mentioned above.

The study was performed in three steps. Initially the concept of key variables for measuring working conditions was discussed with about ten company representatives participating in activities arranged by Trätek. On the basis of the results of these discussions, underlying theory and other developments within the area the key variable model was developed by the author. As a third step the model was evaluated in discussions with three different companies, one small, one medium and one large woodworking company.
Definition of key variables
Mossberg (1977) presents two necessary and sufficient assumptions in his definition of an operative key variable:

1. It is a number.

2. The user shall regard that the number gives concentrated information.

The second assumption raises the question for whom the key variable is designed. A basic intent with a key variable is that it shall be able to make out or raise significant information. Key variables can be a complement to, or a substitute for more detailed information in a report. The receivers’ ability to apprehend the information increases when it is reduced and concentrated to an adapted amount.

Key variables can have different purposes like control, planning, review, alarm, diagnosis and to accumulate experience. To define the relation between the key variable and reality, Mossberg (1977) proposes a key variable hypothesis which describes the users expectations of what the key variable shall convey. The hypothesis consists of three parts:

1. Characteristics of a signal from the key variable.
2. Predominating features of the decision situation to which the signal points.
3. The relationship between signal and predominating feature.

The consequences of using the hypothesis are:

- Every user of a key variable shall determine his expectations of what the key variable describes.
- This determination shall be given a certain form.
- The key variable hypothesis shall be used to accumulate experience systematically.

One main hypothesis behind this work is that the process of defining and using a key variable model will lead to increased knowledge about the work situations in the companies. By giving ergonomic and organisational aspects a concrete form, the company can increase both productivity and well being of the employees.

The design of a key variable model
A general key variable model for good work shall give possibilities for a company to bring working conditions to the same strategic level as other important performance measures. It shall also initiate the development of a locally adapted model. A key variable model will be part of the company’s strategy concerning the working conditions of the employees. Accordingly, the key variable model must be congruent with other chosen strategies. Every single key variable shall be chosen to complement the others concerning objective/cause, by grouping and co-variation. The concentration of information can be increased by using these techniques. In the paper more detailed criteria for key variables are presented and
examples are given from four different categories. There are seventeen strategic variables describing organisational and human priorities, one early warning variable concerns prevention of accidents, two variables for health and safety evaluation and there are six multi-factor variables commonly used as indicators of influence on the companies’ bottom line since they are directly related to legally set financial responsibilities.

**Experience from companies**

The key variable model was developed after discussions with companies. The main conclusion is that the individuality of the company has a very strong impact on managements’ opinion on a key variable model. Culture, tradition and size of the company strongly influence the ability and determination to measure instead of using subjective experience for evaluation of the production system.

The finished model and tables of key variables were introduced to three companies. One small company with 10 employees, one medium sized with 70 employees and one big with 400 employees. The tables were worked through in detail with the management of the companies as well as with the union representatives.

All three companies used some key variables and they all tried to consider some of the human aspects in other forms than key variables. There were small differences between management’s and union representatives’ opinion concerning interesting measures. Variables indicating flexibility, production planning, maintenance, overtime and budget work were clearly classified as important and interesting to use by at least two of the three companies.

A major problem with the measurements, according to the company representatives, was to get reliable data concerning real participation in variables like job rotation, production planning and budget work, i.e. if production personnel do participate or if they just say so. Other measurement problems were not recognised by the companies.

However, the main results from the discussions with the companies were the (expected) need to tailor the variables used for the individual company and that the ability and interest in using more extensive key variable models was strongly dependent on the size of the company. In the small company, the administrative routines necessary were not there which made the cost too high. Moreover, the size rendered some of the statistical measures irrelevant as well.

**Discussion in retrospect**

Key variables describing working conditions were not extensively discussed but were assumed to have a big potential at the time when Paper 1 was written. The main contribution of Paper 1 was that it shows very concretely how key variables for organisational issues can be constructed and what to think about when doing so. The multi-factor variables like short-term sick-leave were and are still frequently used by organisations, especially when they get large. For small enterprises, those factors do not supply a valid picture since the statistical base needed
does not exist when the number of employees is low. In the Swedish legislation it is stated that all organisations must make a written summary of work-related health- and safety problems each year (AFS 2001:1, "Systematiskt arbetsmiljöarbete"). In larger organisations, this is often done with the multi-factor variables described.

Following the publication of Paper 1 at least three different development directions on the subject can be identified. There is one concerning the possibility to evaluate working conditions or ergonomics in a way that makes it possible to clarify the direct impact on financial results. This direction is very viable and something many ergonomists are struggling with in order to place ergonomics considerations higher on the agenda. For example in the 16th World Congress on Ergonomics 2006 there was a parallel session with the title “Measuring productivity in action: the fiscal impact of ergonomics” and the subtitle “Good ergonomics is good economics” (Oxenburgh, 2005).

The Swedish Institute of Production Research developed a more comprehensive tool called the Work Environment Screening Tool (WEST). The tool divides the work environment in six areas: accidents, work-related disorders, psychic and social factors, noise and vibrations, chemical hazards and miscellaneous. The factors are measured one at a time and the cost related to the different aspects of working conditions is calculated (Berglund & Bengtsson, 1997). The tool is reported to have been used in several companies with good results however no objective assessment is available.

A second direction concerns the further development of key variables for the assessment of the working conditions in an organisation. NyckeltalsInstitutet AB (Key Ratio Institute), founded 1996, offers systematic measurements and benchmarks of key variables especially concerning working conditions in a broad sense and their connection to financial results (Nyckeltalsinstitutet, 2006). The institute has developed a specific index, claiming to set a Swedish standard on how to measure key variables related to working conditions. Some of the owners of this company have also published a book on the use of key variables (Catásus et al., 2001). The Swedish Environmental Research Institute Ltd has published a report on key variables for assessment of working conditions in 2002 (Schmidt & Antonsson, 2002). The authors argue that key variables can be used both on a community level and in a company. Furthermore they divide the use into three different areas: input (investments made), state (current working conditions) and output (effects of working conditions).

A third direction is the strategic approach to management of operations that incorporates human values. This can to some extent be found in the Balanced Scorecard described by Kaplan and Norton (1996), introduced some years earlier. The Balanced Scorecard is more of a strategic management system than a measurement system. A business is divided into four different strategic perspectives: The learning and growth perspective, the business process perspective, the customer perspective and the financial perspective. The strategies of the company are broken down and linked to the different perspectives. The learning and
growth perspective includes innovation and renewal aspects but also human aspects to some extent. The large company ABB developed during the same period a management system of their own, to a large extent similar to the Balanced Scorecard. However, ABB divided the growth and learning perspective into an innovation/development perspective and an employee perspective. A large insurance company, Skandia, also introduced a strategic model where the human aspects are more articulated as an asset (Olve et al., 1999). Both these management models included more explicitly aspects described in Paper 1.

A first conclusion when briefly comparing Paper 1 with the development of management systems during the last ten years is that the recognition of humans as parts of the strategic assets of a company is more established today. A second conclusion is that working conditions are mainly considered to be of strategic value in larger organisations, reflecting the beliefs of management. A third conclusion is that when it comes to SMEs, I know few if any signs of companies that use management systems including key variables of human aspects, thereby giving human aspects a more strategic value. A case study on how SMEs use balance scorecards does not indicate that human aspects are given a more central position than previously thought (Höglund & Melin, 2001).

My last conclusion is that regardless of the increased availability of methodological suggestions for key variables measuring working conditions, it is likely that the legal act stating that each company should have a system for systematic assessment and improvement of working conditions is necessary (Systematic Work Environment Management, 2001). The act gives legitimacy and puts some pressure on companies to learn to measure and to do it. The use of key variables as such is to my opinion not sufficient to trigger changes in companies but could rather be seen as a point of departure for a discussion on how to strategically align and include aspects of working conditions with other strategic goals.


Contextual framework for Paper 2

In the 1990s my colleagues at Trätek performed a lot of consultancy work assisting woodworking companies in implementing ISO 9000 quality standards. Those implementations were at the beginning pioneering work since no woodworking industry had done it previously and a lot of questions on how to adapt the standard to woodworking practice and vice versa had to be solved. Examples of specific technical developments triggered by this process and performed by colleagues at Trätek were a report on how to measure surface tolerances on wood and a handbook on how to use measurement tolerances in furniture manufacturing (Klint et al., 1993; Palmqvist, 1992).

During the same period, there were a number of research projects at the Division of Industrial Ergonomics at Linköping University studying the relations between ergonomics and quality (Axelsson, 1995; Eklund, 1995). The area was established also in the international research community and is now a part of the research within the ergonomics field. The writings of Imai (1986), which were directly targeting management, also put a large emphasis on the role of humans in quality improvements.

The implementation of ISO 9000 systems was perhaps the most frequent organisation wide change process among woodworking industries at that time. The goal (certification) for involved companies was the same or similar, the sizes of companies were reasonably similar but the production processes differed and the managerial approaches to the change process differed.

In this context, the idea came up that it would be possible to evaluate some of the implementation work from a change perspective and whether there existed any management awareness of the relation between quality outcome and work design issues that would be apparent in these change processes. In 1994 there was an opportunity to evaluate the implementation of customer certified ISO 9000 systems in six companies, all suppliers to IKEA and with similar production processes. The evaluation resulted in a more detailed report in Swedish
(Karltun et al., 1996) and in Paper 2 (Working conditions and effects of ISO 9000 in six furniture-making companies – implementation and processes).

**Summary of Paper 2**

**Aim and approach**

The aim of the study is to assess influences on working conditions and other effects, following the implementation of the ISO 9000 quality system in six small and medium sized companies. Special emphasis is given not only to the quality systems themselves, but also to the change processes. The topics developed for the study include the following eight points.

1. What reasons and which goals did the companies have for implementing ISO 9002?
2. How did the companies succeed in attaining their objectives concerning:
   a. Certification
   b. (organisational) Quality in system, routines, work flow etc.,
   c. Product quality
   d. Quality deficiencies
   e. Position in market (increase market share, new products, new customers)
   f. Productivity and profitability?
3. Which effects were brought about during and after the project, respectively?
4. What lessons can be learned from the implementation process, the consultant work and the company effort?
5. To what extent has quality and system development progressed?
6. To what degree do ISO 9002 on the one hand and the implementation process on the other hand affect different aspects of the working conditions?
7. What relations are there between improvements achieved in work environment and in quality?
8. How are actual changes and the process experienced by those involved?

The six companies studied were chosen because they all participated in a project with support from Trätek on implementing ISO 9002. This was one of the very first attempts to implement ISO 9002 in woodworking companies and the participating companies can be regarded as being pioneers in this respect. To obtain the empirical data needed and at the same time minimise the strain for the participating companies, a methodology was developed where four researchers vi-
sited each company during one day. This day was very carefully planned and the four researchers made interviews with different categories of people within the company, they collected documents, they did observations and they handed out a questionnaire to all employees. The questionnaires had 32 questions and a total of 218 responses were received. Deep interviews were held with managing directors (N=5), project managers (N=5), one production manager, foremen (N=16). Shorter interviews were held with operators and union representatives (N=60).

Each day of data collection was ended by a short researcher meeting where the impressions of the company were compared and potential misunderstandings or peculiarities were sorted out or listed for further investigation. This was mainly done by telephone interviews and document studies. The official financial statistics for the period before, during and after implementation were analysed and compared to find out if the implementations affected the financial results of the companies.

**Results and discussion**

The answer to the first question was quite simple; to fulfil the demands of IKEA was the main goal. The companies had to do it or they would be out as suppliers to IKEA. The own visions of the companies were in general vague and none of the companies had actually themselves come to the conclusion that to develop their companies, implementing an ISO 9000 system would be a beneficial project to do.

All the companies succeeded in getting their certification but one, which went bankrupt at the end of the period. This fact illustrates the situation for the companies, although important to their local societies, much effort in the companies was directed towards short-term survival. The system as such also forced the companies to improve their routines and standardise those to a certain degree. The effect of this was much better order which to a certain extent was perceived positive. However, additional administrative routines that sometimes seemed meaningless to employees were another result.

Concerning product quality the results of the projects were blurred. In some companies, the product quality improved significantly and less in others. However, the exact figures were not possible to determine, neither from the companies nor from IKEA. The latter did a ranking of the companies before and after the project concerning their product quality and the order between the companies changed as a result of the project.

Concerning quality deficiencies the picture was even more unclear. Only one of the companies had detailed statistics of the deficiencies. The best companies had good or some control over their quality deficiencies but the worst had no control at all. Most of the companies, however, accounted for less quality deficiency-related costs, both internally and externally. Measurement problems were to some extent the cause of the situation. What before the implementation was judged as good enough quality was changed during the implementation which
meant that though the quality increased the costs did not decrease and thus could not be directly related to the quality level of the products.

The position in market remained about the same for the companies. The companies realised that the quality system was not an order winner but an order qualifier in the long run.

There were no possibilities to distinguish signs of increased productivity or profitability as a result of the project. However, there were no signs of extra costs either when comparing the accounts for the last five year period. The variation in financial results among the companies studied was high, the plausible reasons for this being the size of the companies, the high impact of IKEA on the profitability of the companies and also financial planning, moving costs between years to minimize taxes etc.

The answer to the third question is that other effects of the project than the above mentioned were limited. The evaluation was made after the certification process and it was apparent how much of the effects of the quality project already were declining. All implementation projects focused on getting the certification and nothing more which leads us to the fourth question.

There are a number of lessons that could be learned from the implementation processes. First, the visions of management was limited and not clearly communicated. Apart from certification, goals were fragmented, not very well established and not known by employees. Some clichés like “Zero defects” were found but not more than that.

Second, All companies had project managers or dedicated persons that were driving forces. However, in some of the companies there was also strong resistance among leading persons. This resistance was not sorted out beforehand which made some of the implementation processes more difficult. In all companies that succeeded the support from the CEO was outspoken. The question whether the fact that the financial difficulties drew the interest of the CEO to full focus on other issues in the last company will be unanswered. In that company the CEO support for the quality project was very poor.

Third, where the employees were educated the results were found to be better. Extensive educational efforts did pay, especially when the education was performed in easy memorable activities like visiting the customer’s warehouse and inbound quality control. The sustainability of the educational efforts was however short lived; new or promoted personnel did not get any introduction into the system.

Forth, basic project management with a schedule for the implementation was the only change methodology used. In two of the companies there were signs of other change or improvement methodologies like “5 why” or other systematic problem solving but when these traced major quality problems to management they were suppressed.

The role of the consultants was to some extent formed by the fact that these implementations were pioneer work. They played a role of a supervisor, helping the companies to guide and interpret the standard according to the manufacturing
situation in each company. Furthermore, the consultants did a lot of teaching in 
the companies but according to the companies’ own schedule and extent. During 
the process, the consultants and the companies’ representatives sometimes had 
different opinions on their respective roles. A better and more thorough discus-

sion in beforehand had solved some of these problems.

The answer to the fifth question is that after the certification, almost no pro-
gress was made apart from the necessary activities to stay certified. Management 
turned to other projects with other foci than the field of quality. Practically no 

systematic activities were started that could develop the system further; the aim 
to get the certification was enough for the companies’ management.

The answer to question six and seven is that there were so few improve-
ments in working conditions found that relations to improvements in quality 
were difficult to find. From this you can draw the conclusion that it is possible to 

implement the standard as such without any significant influence on the working 
conditions.

The answer to the last question is that the implementation and the system 
were perceived positive by most of the employees. The more people were in-
volved in the implementation, the more positive were their comments. Almost 
everyone preferred the way the system supported the daily work, especially that 
order was maintained. The expectation that people might think the system was 
difficult to change was not confirmed. Most people thought it was easy to change 
and that the system as such was a good base for concrete discussions on quality 
demands and thus played down related conflicts.

The main conclusions in the paper are that implementing ISO 9000 has a 
limited influence on the physical working conditions in the company. Psycho-
social working conditions are more affected due to the regulations in the standard 
as such but also due to changes in the organisation and better understanding of 
the business. The managers do not consider improved working conditions as im-
portant for reaching the ISO 9000 certificate. Furthermore, the process of imple-
mentation has more influence on the results than the standard as such. Facilitat-
ing factors like resource allocation, management commitment, action-oriented 
work and a positive attitude to quality have been identified together with hinder-
ing factors like lack of management consensus, lack of shop-floor level objec-
tives, week finances, low level of participation and lack of knowledge in manag-
ing change. However, it can be concluded that the ISO 9000 project made the 
companies more able to run other organisation-wide change projects like MRP 
implementation or lead time reduction projects.

Discussion in retrospect

When the study in Paper 2 was carried out, the future of ISO 9000 was not evi-
dent. Several developments were possible since it was criticised for lacking a 
development approach and for being expensive in comparison to its benefits. 
Looking back, the ISO 9000 certification matured during the 1990s and the stan-
dard was developed through a number of revisions, the latest dated in the year
2000. The development of the standard was also forced by large manufacturers like those involved in the car industry where company-specific more far-reaching standards were developed. In the perspective of this thesis the most interesting points in the revisions are that the process perspective was emphasised, working conditions were more focused and the demand on a documented continuous improvement process was introduced in the ISO 9000 standard. For a more detailed and recent review of the development of the quality standards and effects of standardisation I suggest the thesis of Bozena Poksińska (2006).

The result that implementing ISO 9000, in spite of its character as a change process encompassing the entire organisation, seldom is used as a development process was later confirmed in a similar study of four companies that implemented ISO 9000 with a third party certification. Those companies were not forced by a big customer but performed the certification as a strategic choice of their own. One of these companies used the certification process as a strategic change process to achieve other effects than only the certification but the other three did not (Karltun et al., 1997). These results show that it is possible to use additional goals and succeed in reaching them as well. This possibility was also confirmed by Poksińska (2006).

Another question of interest concerning ISO 9000 as change process is whether it contributes to the profitability of the company which always is a main objective of any organisational change process (Jensen, 2000). Of the six studied companies in the study described in Paper 2 only one is still active. All the other went bankrupt or have disappeared during the 12 years since the study was performed. In the latter study of four companies (Karltun et al., 1997), three of them are still in business. It is therefore impossible to draw any conclusion on this matter from the studies the author was involved in. Later studies on the profitability of an ISO 9000 implementation process confirm that it is very difficult to say whether ISO 9000 contributes to the financial results of a company. In a longitudinal study of the financial effects of ISO 9000 registration, Häversjö (2000) concludes that the main effect of ISO 9000 registration for all ISO 9000 registered Danish companies is a raise in rate of return. This is best explained by an increase in sales (external efficiency) rather than in an increase in capacity ratio (internal efficiency). However, Häversjö does not conclude that the raise of return is a clear effect of ISO 9000 registration. Another longitudinal study of 800 Basque companies divides them into three samples: certified, not yet certified and non-certified. The study by Heras et al. (2002) tackled the companies over a five-year period. The conclusion of this study is that ISO 9000 registered companies have better performance than non-registered. Whether this is an effect of ISO 9000 registration or whether companies with better performance choose ISO 9000 registration to a larger extent is unclear and questioned by the authors. Furthermore, in a Greek study of 94 early adopters of ISO 9000 (registered 1989 to 1993) it was found that ISO 9000 companies do get financial improvements in their chosen strategic orientation (cost leadership, market differentiation or a focus strategy) but not if the results were pooled together (Dimara et al., 2004). The
last study, however, did not examine the cause-effect relationship with the same rigor as the other two. When compared with my own results that the process of implementation is more important than the content of the standard itself, the difficulties to find general financial benefits of ISO 9000 are understandable.

The implementation of ISO 9000 can to some extent be viewed as an introduction and a first step towards a more comprehensive quality management system. There are, however, many different opinions about this but in the development of the latest version of the ISO 9000 system, some of the most apparent criticised features of previous systems concerning quality management are taken care of. A short comment concerning the profitability of TQM may therefore have some relevance concerning the profitability of quality management.

Total quality management (TQM) is reported to contribute to companies’ long-term profitability and survival by Singhal and Hendricks (1999) who studied the financial development of 600 quality award winning companies and compared them with samples of companies which did not implement TQM practices. Furthermore, Reed et al. (2000) write about theoretical underpinnings of the claim that TQM can generate sustainable competitive advantage. They conclude that the claim is valid based on the theories of competitive advantage, resources of the firm and systems theory. There are two interesting similarities between the study of Singhal and Hendricks (1999), Paper 2 in this thesis and the second study the author was involved in (Karltun et al., 1997). The first similarity is that companies using third-party certification/independent award winners are more successful than customer certified/customer award winners. The second similarity is that the costs of implementations are not visible in the financial results of the companies in spite that both the implementations of ISO 9000 and TQM are supposed to require large resources. The studies on ISO 9000 registration and financial results support this statement as well. Both similarities suggest that independence and strategies based in own visions of company development are preferable. The second similarity suggests that the large amount of small process improvements caused by the processes of implementation may well result in savings comparable in size to the costs of implementing such a system.

The author’s impression of ISO 9000 today from talking to people working in the field as well as from other research is that the standard is more widespread and in most cases viewed as an order qualifier instead of an order winner. This means that companies must be certified to be considered as a supplier but that it is seldom the advantage that makes the company win the order (Poksińska, 2006).

One main issue in the research reported here was finding the triggers that motivated enterprises to start with organisational improvements and changes. One such strong trigger was the implementation of ISO 9000 quality standard system. Although much criticized by many researchers it was adopted by the industry to achieve market advantages, a better control of quality matters, or perhaps a better structure for operations and further development. As is reported in the paper, the implementation of ISO 9000 was at the first outset for these SMEs
to achieve a better structured organisational solution for their business operations. Later studies performed by the author and verbal communication with managers in SMEs have confirmed this. For most companies it is an advantage to have implemented ISO 9000 when starting with other organisational wide developments such as Enterprise Resource Planning systems implementation and lead time reductions but it also facilitates growth and market expansions. However, the author’s impression is that it is not the certificate or that the system is called ISO 9000 that brings the advantage. It is the process of clarifying business ideas and visions, introducing a system of order and relevant routines, clarifying operations processes and responsibilities, setting clearly specified tolerances and standards for products, introducing measures of important performance factors etc. A vital part is also the demand for documentation; SMEs are more often than not poor on documentation.

My reflection now is that the contribution of the ISO 9000 system as such was that it provided a goal system for the companies studied, the certification being the central goal to which interested parties could commit themselves. Furthermore, the system provided a break-down of this goal into operable objectives that had to be met concerning the different activities in the companies. For many of the studied woodworking SMEs, this was an important issue, their culture being developed from entirely other perspectives and priorities. The studied companies’ ability to develop such a goal system that could strengthen their organisational structure on their own was in my opinion limited.

Paper 3 was presented at the conference Ergonomics for Global Quality and Productivity in Hong Kong 1998 and published in the proceedings edited by R. Bishu, W. Karwowski and R. Goonnetilleke

Contextual framework for Paper 3

One result of ISO 9000 registration as well as productivity programs is more standardised work. Standardised work is though something ambiguous, at the same time contributing to efficient means of organising work, to utilizing appropriate skills, to high productivity and high quality but also to create negative aspects of work like boredom, monotony and work injuries due to repetitive work. Standardisation is also a means to create “refreezing” after change and a way to delegate responsibilities since workers more easily can control their own work against performance standards that form a frame of reference in companies. (Imai, 1986; Kondo, 1996)

The ambiguous character of standardisation triggered the discussion at the Centre for studies of Humans, Technology and Organisation (CMTO) at Linköping University. The centre was at the time also visited by professor Kondo who held a lecture on his stance concerning standardisation and its contribution to human creativity. It was decided to write a paper to better understand the double sided features of standardisation using the data of the studies performed on ISO 9000 implementation.

Summary of Paper 3

Background and aim

Standardisation can be viewed to constitute the transition from craft work to industrial production, and has thus heavily influenced industrial work during large parts of the 20th century. Japanese production philosophies and the quality movement including ISO 9000 and TQM emphasised the concept of “Standardised Work”.

However, there is rather limited research of how working conditions are influenced in companies and organisations that have introduced standardisation, for
example standardised work or quality standards, and in what way learning is fa-
cilitated or restricted due to standardisation. The results of existing research are 
also partly contradictory. To say the least, the consequences due to standardisa-
tion are much under debate.

Another question is what standardisation is? The concept of standardisation 
is used in a wide range of meanings, and may refer to many different objects. 
Examples of different usages of the term include the distinctions between:

– international and national standards
– measurement methods
– engineering design, materials specifications and tolerances
– product design
– processes and procedures
– work operation sequences
– task design and task execution
– human movements

The arguments promoting standardisation include that work standards should be 
seen as self-managed by workers, and supported from management structures. 
Workers should also be trained in using methods for evaluating and documenting 
standards. Standardisation is thus a necessary structure for worker participation 
and for the operations, in order to obtain quality, low costs, safe and healthy 
work conditions. The standards should be regarded as an important reference and 
a basis from which creative improvements are to be made. Standardisation is 
therefore seen as a necessary basis for learning and creativity. The opposite view, 
arguing against standardisation, is partly based on the human factors area. Ac-
ccording to criticism from different authors, standardisation may create less varied 
tasks, rule-based work, monotony, repetitive work injuries and may hamper crea-
tivity, motivation and learning, factors that in the long run would be detrimental 
to performance.

An important clue to understand the contradictory findings is given by 
Adler and Borys (1996) by their proposed distinction between a coercive and an 
enabling type of standardisation. While the former way of using standardisation 
means an emphasis on eliminating variation in the work process through “me-
chanical” compliance achieved through different forms of sanctions for devia-
tions from the standard procedure, the latter type of standardisation emphasises standardisation as a way to enable employees to use their skills to deal with the inevitable disturbances that occur in the work process.

The purpose of this paper is to pursue the arguments pro et contra stan-
dardisation a bit further. This is done on the basis of a series of case studies try-
ing to evaluate influences on organisations and their employees in companies that 
have introduced the ISO 9000 standard.
The paper is based on case studies in 10 small and medium-size woodworking companies which aimed at implementing ISO 9000. An evaluation was performed in the companies a few years after the certification. The methods employed included data collection using company statistics, questionnaires, evaluation schemes, observations and interviews. In this paper, results from the interviews with 94 operators and 24 first line managers are reported and analysed based on the frames of reference presented.

**Results and discussion**

Many operators did not experience any changes in work content but some reported additional tasks like doing quality measurements, making and evaluating statistics, writing error reports, problem solving concerning production issues, participating in writing routines for the standard, reading engineering drawings, testing assembly of new products, doing maintenance work and detail planning. The new tasks that were introduced created more variation for the operators who were given the opportunity to take on new tasks. The ISO 9000 standard also gave rise to increased responsibility and authority for the operators in several cases.

The question whether autonomy increased or decreased is difficult to evaluate. To a certain extent, autonomy increased with increasing control over additional tasks and there were changes in the pattern of social interaction. Some operators also perceived that the ISO standard supported them in relation to other workers and the products they received from them. Operators took a more active interest in the production and quality results, and they discussed these matters more often. They also found it easier to discuss mistakes, since the perception of themselves having made a fault was transferred to the perception that the process did not meet the specification. The standard could provide an “objective” view on the problem.

A clear majority of the workers considered that the implementation of the ISO 9000 standard was necessary for the company in order to stay competitive. Also, a majority of them were positive towards the changes, few were negative, but a relatively large group of workers were indifferent. The reasons stated for the positive attitude were better order, more structured work methods, partly more interesting and stimulating work tasks, better communication in the company, and better quality performance. Among the negative aspects were increased bureaucracy, a more physically demanding job, more time pressure and stress.

Concerning the above mentioned issues there were large differences between the different companies and one result that could explain part of this was that the process of how to implement the standard varied. Companies with a higher level of participation, with more management support and with a more methodological approach to the implementation of the standards performed better and gave rise to higher employee involvement. This was also the case in companies with an enabling view on standardisation.
The operators participated to a varying extent in education activities about quality and especially the ISO 9000 standard during the implementation processes. Some first-line supervisors pointed out that it had become easier to delegate tasks to the operators after the implementation of the standards, since the requirements were documented which created less ambiguity, and the operators could easier perform these new tasks.

To conclude, the study indicated that the implementation of the ISO standard could support some improvements of work and learning, but to a varying extent between individuals and companies. Furthermore, it seemed as if the standard could aid improvements of job content from senso-motor tasks to rule-based work and introduction of additional tasks that supported learning and development. Negative effects on work conditions and learning were identified in companies with a use of the standard as a coercive and rigid system, not possible to influence, or due to an expert oriented implementation.

In conclusion the following are some of the important issues to consider in implementing standards:

1. What is standardised? Is the object of standardisation engineering tolerances, work procedures or human movements, and can there be allowance for employee discretion over the tasks performed?

2. Who makes and decides about the contents or applications of the standard? To what extent do those who perform the job participate in formulating the way the standard is applied?

3. How are the standardisation and implementation processes performed? Do the standards support the work? How is the implementation carried out?

There are also some process aspects that should be considered; the organisational context, the reasons for standardising and the implementation procedure. Those may be more important than the standard itself. A broad perspective in the attitude towards the standard and its use, taking into consideration all the different aspects of work conditions is recommended.

Discussion in retrospect

Since Paper 3 was written, I cannot see anything in the development of industry that indicates that the impact of standardisation regarding goods and work will diminish in the future but instead continue to grow. The consequences of this on work are difficult to predict and the questions formulated in the conclusions of Paper 3 seem still to be valid and up-to-date.

Several classifications on standardisation exist. Minzberg (1983) described standardisation as a means to coordinate organisations. He offered three types of standardisation that can replace direct supervision and mutual adjustment: standardisation of procedures, standardisation of output and standardisation of worker (knowledge and skills). Two of these were mentioned by Kondo (1996) as standardisation of work and standardisation of goods. The division of stan-
Standardisation in Paper 3 can also be viewed in that respect, the second to fourth point being standardisation of goods and the fifth to seventh being standardisation of work.

Standardisation of goods is often considered an advantage to all involved. It is nice when the threads of a screw are the same as in the nut. The standardisation of goods is now widespread and covers the entire society, not only goods for manufacturing. Furthermore, there is a tough competition in establishing new standards for example on software protocols or within technology for data storage since this is believed to produce competitive advantage. In the first example, I think almost everyone agrees that standardisation of goods is an advantage, the disadvantages being small in comparison. However, the standardisation of goods and work are sometimes interlinked and dependent. The most obvious for all of us working in computerised settings are probably the large number of standards connected to computers. Sometimes they are very good and everything works fine but sometimes incompatibility between these product standards seems to be the general rule and immediately our work is heavily affected.

Another concrete example of confusion between standardisation of goods and standardisation of work is a study of pallet standardisation and productivity in the assembly line of Volvo Truck Corp. The European standard of pallets is very dominating in Sweden. This means that even smaller containers for goods are adapted to the larger pallet dimensions to ensure cheap transportation with as little transported air as possible. The truck platforms are also adapted to the pallet dimensions for the same reason. However, when comparing the assembly work in Volvo with similar work in Japanese factories it was found that changing the containers and pallets from standard design to workplace optimised design reduced cycle time and increased productivity significantly. The standardisation thus played a vital role in making the work more difficult (Wänström & Medbo, 2005).

As this paper points out, increased standardisation of work procedures emanating from ISO 9000 implementation can be beneficial for many employees. When the standardisation reduces uncertainties and ambiguity concerning roles, responsibilities and technical product specifications, it makes work easier to workers or managers reducing the difficulties in performing jobs and the correction of malfunctions. The latter is confirmed by Poksińska (2006) and it also gives support to the assertion in quality management that “You can’t improve a process that hasn’t been standardised” (Adler & Borys, 1996). This argument is also one of the foundations in lean production and it can be viewed as a change aspect of standardisation. Moreover, standardisation is to me one of the most concrete means of organisational technology2 that corresponds to the “refreezing” in the well-known Lewinian three-stage model of change “unfreeze – move

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2 I have adopted the term “organisational technology” from Adler and Borys (1996) as a name for technical components of organising arrangements. ISO 9000 is in that respect a typical occurrence of “organisational technology”.

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refreeze” (Lewin, 1951). The procedure of standardising, measuring, improving and standardising again at a higher level is also at the heart of the Systematic Work Environment Management (2001) demanded by the Swedish government. Within the concept of lean production, standardisation of work is the sixth of fourteen principles that constitutes the foundation of Toyota Production System (Liker, 2004). The development of lean production, its clear and outspoken heritage from scientific management as well as its far reaching demands on standardised work procedures (Tsutsui, 1998) is probably the most alarming development concerning rewarding work and ergonomics in industrial workplaces. If not combined with concrete and applied means to reduce the shortcomings of standardisation concerning healthy and rewarding work, I consider the risk that lean production reproduces the mistakes experienced from scientific management concerning sustainable working conditions to be large.

Such means can be debated in the light of socio-technical theory. Many of the ten design principles for socio-technical systems (Klein, 1994) are directly applicable to standardisation, the most apparent being the principle of minimal critical specification stating that “no more should be specified than is absolutely essential” (Klein, 1994, p. 201). However, the principles of variance control, boundary location, information flow and power and authority also are very applicable to how standardisation affects work and they might also give some clues to how a given standardisation will affect the work of employees.

Another theory that more clearly models the outcome for workers’ health when the relation between the organising arrangements (standardisation) and the individual is out of fit is activity analysis. Carballeda and Daniellou (1997) argues that when workers face incompatibility between prescribed work (standards) and real problems the workers are forced to “hot adjustments”. If those “hot adjustments” are accepted by management they should preferably be included in the standard. If not accepted, the “hot adjustments” will negatively affect the well-being of workers since their only way of coping with the task given is in conflict with the standard. Workers thus have to choose between not coping with the task or getting in conflict with standard and thereby also with management.

Standardisation will evidently continue to play a vital part in organising work in industry. Its impact on the three vital competitive means in industry, cost, quality and delivery, cannot be questioned. The developments in standardisation suggest that the impact will be even more dominating with new standards continuously developed and improved. The focus on supply chains and closer collaboration between organisations also make the demands for standards stronger.

However, it can be claimed that the balance between the different coordination and standardisation mechanisms is of importance to determine whether standardisation is compatible with humans and sustainable working conditions. How this balance is viewed differs between people having varying opinions on stan-
standardisation. It can thus be argued that examining and affecting this balance may offer opportunities for development.

To conclude it is evident that standardisation of work is a heritage that calls for attention, the negative impact always making itself reminded in alienation as well as in injuries like cumulative trauma disorders.
7 Summary 4. Change processes and ergonomic improvements in SMEs


Contextual framework for Paper 4

Parallel to the studies of the quality certification processes I did action research case studies in two small companies together with colleagues. In these companies, we followed the change process and at the same time tried to introduce change methodologies that did take into account both the knowledge of management and the other employees in line with the project aims specified previously. The problems we encountered were to a large extent related to how to perform case studies in small companies. Their vulnerability, the character of the daily struggle to keep them going, the short term perspective, the difficulties to allocate resources to change projects and similar questions were things we debated during the case studies. These case studies were also preceded by a two series of seminars and evaluations on how small companies could develop their businesses and their working conditions (Karltun, 1992; Karltun & Trygg, 1994).

Paper 4 theorizes and builds further on the results of the case studies that formed a large part of my licentiate published in 1996.

Summary of Paper 4

Background and aim

Many small and medium-sized companies are under strong pressure to improve their performance and ability to compete under changing market conditions. Aspects of this are how to initiate organisational change, how to carry through change processes in the small organisations and how to make the processes effective. From an ergonomics point of view, it could be argued that a desirable approach to organisational change should integrate and combine the perspectives of humans, technology and organisation. The intention in the paper is two-fold; the first is to analyze the change processes in two case studies in using these perspectives, and the second is to develop a more general framework for understanding
change in small- or medium-sized enterprises, including how ergonomics improvements are achieved.

**Method and results**

The change processes in two small woodworking companies (22 and 39 employees respectively) were described and evaluated in order to examine in depth how organisational change can lead to improved ergonomics in SMEs. However, at the same time the identified problems prioritized by the companies were focused upon. In both companies, the author and colleagues acted as external change agents in an action-research approach with a total lifetime of about 2 years. This action-research approach included establishing a small project group in each company including manager, union representative and employees (5 persons). It furthermore included an initial diagnosis encompassing interviews with all employees, a questionnaire, observations and thorough discussions on the objectives with the project. Change agendas with subgoals were developed in the project groups and the subsequent work followed the action-research pattern of stepwise action, assessment, discussion, action planning and action. Large emphasis was put on an open process with information activities like meetings with all personnel, open agendas and emphasising in action that all viewpoints were welcome. The assessment of the projects included a detailed documentation of the entire process over time including minutes, diary notes, documents produced during project, documents produced by each company and separate interviews with all members in the project groups (N=2x5).

The results of the case studies were compared with each other and the differences analysed. As a basis for analysis, the process characteristics of Table 7.1 were used.

The results concerning each characteristic in each case are described elaborately in the paper. A comparison between the two cases resulted in Table 7.2 where the findings of the cases were quantified by making a judgment concerning depth and volume of the change at the aggregate level of characteristics.

It was clear that the chair manufacturer to a large extent reached their goals while the door manufacturer did not. This could be explained by two different main reasons. One was derived from Table 7.2 indicating a clear difference in management commitment and resource allocation between the companies. The other reason was that the people working at the chair manufacturer actually got the things decided on carried out. This action orientation produced results while at the door manufacturer people often expected someone else to do the job or take the initiative or tried to make excuses for not following decisions made and not much happened.

Comparing the results with characteristics of change processes in small and medium enterprises (Ghobadian & Gallear, 1997) it is concluded that change processes in SMEs are different from those in large companies. The proximity of employees to business makes both success and failure visible. The chair manufacturer could take advantage of being small and the visibility of positive results.
### Table 7.1 Process characteristics, used for description and analysis

<table>
<thead>
<tr>
<th>Detailed measures</th>
<th>Aggregated measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Process qualities</strong></td>
<td></td>
</tr>
<tr>
<td>1. Action orientation</td>
<td></td>
</tr>
<tr>
<td>2. Use of goals</td>
<td>Change methodology</td>
</tr>
<tr>
<td>3. Improvement emphasis</td>
<td></td>
</tr>
<tr>
<td>4. Use of methodology</td>
<td></td>
</tr>
<tr>
<td>5. Resource allocation</td>
<td>Organisational resource allocation</td>
</tr>
<tr>
<td>6. Project manager power</td>
<td></td>
</tr>
<tr>
<td>7. General management support</td>
<td></td>
</tr>
<tr>
<td>8. Project manager commitment</td>
<td>Management commitment</td>
</tr>
<tr>
<td>9. CEO commitment</td>
<td></td>
</tr>
<tr>
<td>10. Participation</td>
<td></td>
</tr>
<tr>
<td>11. Existence of communication arena</td>
<td>Participation of employees</td>
</tr>
<tr>
<td>12. Degree of information/communication</td>
<td></td>
</tr>
<tr>
<td>13. Training and education</td>
<td></td>
</tr>
<tr>
<td>14. Expert dominance</td>
<td>Expert orientation</td>
</tr>
<tr>
<td><strong>Aspects of change</strong></td>
<td></td>
</tr>
<tr>
<td>1. Physical work environment</td>
<td></td>
</tr>
<tr>
<td>2. Personal development and learning</td>
<td>Ergonomics</td>
</tr>
<tr>
<td>3. Organisational ergonomics and climate</td>
<td></td>
</tr>
<tr>
<td>4. Applied working behaviour</td>
<td>Applied improvements</td>
</tr>
<tr>
<td>5. Administrative support</td>
<td></td>
</tr>
<tr>
<td>6. Quality</td>
<td></td>
</tr>
<tr>
<td>7. Productivity</td>
<td>Performance</td>
</tr>
<tr>
<td>8. Market position</td>
<td></td>
</tr>
<tr>
<td>9. Financial result</td>
<td></td>
</tr>
<tr>
<td>10. Immediate change</td>
<td>(integrated in the other measures)</td>
</tr>
<tr>
<td>11. Improvements survival</td>
<td>Improvements survival</td>
</tr>
<tr>
<td>12. Continued development</td>
<td>Continued development</td>
</tr>
</tbody>
</table>
Table 7.2  Quantification of measures

<table>
<thead>
<tr>
<th>Process qualities</th>
<th>Case 1 (chair man.)</th>
<th>Case 2 (door man.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change methodology</td>
<td>++</td>
<td>++(+).</td>
</tr>
<tr>
<td>Organisational resource allocation</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Management commitment</td>
<td>++(+)</td>
<td>+</td>
</tr>
<tr>
<td>Participation of employees</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Expert orientation</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aspects of change</th>
<th>Case 1 (chair man.)</th>
<th>Case 2 (door man.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ergonomics</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Applied improvements</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>Performance</td>
<td>++</td>
<td>not available</td>
</tr>
<tr>
<td>Improvements survival</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Continued developments</td>
<td>++</td>
<td>(+)</td>
</tr>
</tbody>
</table>

Note: The quantification was made by assigning one, two or three + to each measure. 

+ means indication of qualities or change, not obvious or coherent 

++ means qualities or change to some, clear, extent 

+++ means qualities or change to a large extent, often obvious and coherent 

Brackets indicate values in between, i.e. that it was difficult to classify on a three-grade scale. 

The sign + was used to indicate that the scale used did not include negative values, i.e. the qualities could not be less than totally absent, and the process did not lead to any identified drawbacks in any measure.

strengthened the change process while the door manufacturer instead was trapped in the disadvantages of being small and unable to carry out necessary change.

In comparing the case studies described above and comparing these with the results of the ISO 9000 implementation processes (Paper 2), an elaborate framework for understanding how the change processes led to improvements in ergonomics is proposed. The empirical results suggest a classification into two different categories, action-driven change and vision-driven change (Table 7.3, Figure 7.1). The classification emphasizes the importance of visible action in SMEs to reach improvements. The term action-driven change is chosen because the successful companies studied were found to be very action oriented. The focus in the change loop is on action; in the small companies studied the ability to act immediately on problems seemed to separate successful companies from others concerning changes of improvement character. The classification also supports the need for developed visions to reach beyond improvements, to find the next redesign of the system, and again the need for action when implementing changes.
**Vision-driven change**

Vision-driven change is change that is enacted by a vision of how the system might work if certain defined purposes or goals are fulfilled. Thus, the focus is on opportunities. The framework in which the vision and desired change are defined is the entire organisational context, i.e. the assumption of the organisation as an open system is at the core of how a vision-driven change is defined. The main principle for renewal is redesign, from details to entire systems. The framing of the problem is not the existing organisation or way of working but the demands of the context. Reflections and ideas on the alignment with identified demands, or contradictions between context and the organisation are the main sources of renewal. The dominating change order or problem-solving mechanism is second order change. The limitation of a vision-driven change is the allocation of resources to reformulate the vision, to redesign and solve the problems connected with the change and to manage the process in which the organisation is transformed.

The process of change can be assumed to follow the Lewin (1951) theory of an unfreezing stage in which the perception of the fit between the demands and the functioning of the present organisation is broken down and a feeling of a need for change is developed. During the move stage the organisation develops and adopts new ways of working, and during the refreezing stage the organisation stabilizes the new way of working. As said above, vision-driven change includes a reformulation of the vision (goals and objectives) of the system, and it is usually more of a top-down process, often initialized by the management for a specific purpose. The change and the implementation process are often organised as a project. Since the change involves strategy-affecting decisions there is a need for proactive management support, not only supporting the process but also being actively involved in the change. The potential for participation in the change process is good, but redesign may require an approach including expert knowledge, politics, strong contextual influences, external requirements, etc., that reduces the influence of participating employees.

**Action-driven change**

Action-driven change is enacted by focusing on emerging and identified problems in the system, and the (often immediate) action carried out to solve these problems. Action-driven change is performed within the assumptions and culture of the local theory of the system, and existing goals and objectives are taken for granted. The closed system forms the context for changes since these are of improvement character, attempting to solve problems within the existing system without significantly affecting its borders. The experiences from the existing system are the sources of renewal, and in line with what is said above, there will be a domination of first order changes. Since the source of renewal is experience, the limiting mechanism is empowerment, i.e. to which extent the perceived problems are allowed to result in changes. The change process is more direct, the lo-
theoretical theory is not questioned and the process is characterized mainly by handling the practical problems connected with the implementation of the solution.

Table 7.3 Distinctions between vision- and action-driven change

<table>
<thead>
<tr>
<th>Change characteristics</th>
<th>Vision-driven change</th>
<th>Action-driven change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Driving force (enactment)</td>
<td>vision</td>
<td>action</td>
</tr>
<tr>
<td>2 Focus</td>
<td>opportunities</td>
<td>problems</td>
</tr>
<tr>
<td>3 Organisational framework</td>
<td>contextual influences</td>
<td>local theory</td>
</tr>
<tr>
<td>4 Main principle</td>
<td>redesign</td>
<td>improvement</td>
</tr>
<tr>
<td>5 Contextual systems view</td>
<td>open</td>
<td>closed</td>
</tr>
<tr>
<td>6 Source of renewal</td>
<td>reflection on purpose</td>
<td>reflection on experience</td>
</tr>
<tr>
<td>7 Dominating change order</td>
<td>second</td>
<td>first</td>
</tr>
<tr>
<td>8 Limitation</td>
<td>resource allocation</td>
<td>empowerment</td>
</tr>
<tr>
<td>9 Process of change</td>
<td>unfreeze-move-refreeze</td>
<td>move-freeze</td>
</tr>
<tr>
<td>10 Time perspective</td>
<td>long-term</td>
<td>short-term</td>
</tr>
<tr>
<td>11 Resistance</td>
<td>usual</td>
<td>less usual</td>
</tr>
<tr>
<td>12 Direction</td>
<td>top-down</td>
<td>bottom-up</td>
</tr>
<tr>
<td>13 Organisation</td>
<td>project</td>
<td>differing</td>
</tr>
<tr>
<td>14 Management support</td>
<td>proactive</td>
<td>active</td>
</tr>
<tr>
<td>15 Participation potential</td>
<td>differing</td>
<td>high</td>
</tr>
<tr>
<td>16 Effects on ergonomics</td>
<td>change of prerequisites</td>
<td>adjustment</td>
</tr>
</tbody>
</table>

The process is not problem sensitive but can be repeated for new problem solutions in a move-freeze pattern. The time perspective is short-term, the problem-solving activities can sometimes take time, but decision and action are generally fast. The resistance to change is less common, since the process is bottom-up, using experiences in the organisation as sources of renewal. Typically, in small organisations or groups, the decision to make the change or improvement is taken during a coffee break or other informal discussion. The action is then immediately carried out by someone responsible, usually not involving more people than necessary. The result of the change is checked informally and the change is accepted or reworked. However, the organisation can differ because there are sometimes action-driven changes of considerable importance and financial mag-
nitude. Management support must be active, encouraging and supporting employees to identify constraints, express their experiences and work with problem solving. Thus, the potential for participation is far-reaching, and it is probably necessary to involve employees in action-driven changes. Achieved changes are of adjustment character; ergonomics are improved concerning identified shortcomings in the existing system.

![Diagram of Framework for Understanding Changes]

**Figure 7.1** Framework for understanding changes. *Action-driven change – dotted arrows, Vision-driven change – unbroken arrows.*

**The framework and ergonomics**

The differentiation between two separate change processes serves the purpose to describe different prerequisites for obtaining improvements in ergonomics. In the case of an action-driven change, improvements of ergonomics are of adjustment character. The need for these adjustments has mainly three sources, experiences of the workforce, legislation and management. There is seldom any opposition from the workforce, since the changes improve their working conditions. Instead the workforce represents a main driving force behind the change. The management, however, might think that the cost is too high compared to the gains of the change, usually in an analysis in which long-term gains are compared to short-term costs. In organisations that emphasize continuous improvement activities, this type of change process is important, and improvements in ergonomics are
supported to increase the motivation for general improvement activities. Action-driven change can result in (immediate) improvements of ergonomics conditions if there is management support, some basic knowledge of ergonomics and enough decision latitude close to the workplace where the ergonomic constraints are identified.

In vision-driven change, such as implementing an ISO 9000 quality system, the mechanism for change is different. As the name indicates, vision-driven change implies a vision of how the change will affect the organisation. Visions are often derived from an insight of opportunities, more abstract and of top-down character. The experiences in the organisation play a less important role, and experiences from the organisation’s context can be influential. In vision-driven change, improvements of ergonomics are more determined by design processes. A general assumption that improved ergonomics is included in the purposes of an organisational change effort is far from reality. Instead, if the vision includes a perspective that good ergonomics are necessary to create beneficial long-term development and profitability, this need to be made universal in the organisation. From such a perspective, vision-driven change will result in improvements of working condition if there is proactive management support, advocating and supporting a vision of good ergonomics as favourable for achieving the general goals of the company.

The need for professional ergonomic advice might exist in both cases, but what should be observed is the difference in hampering mechanisms. The action-driven process can produce improvements in ergonomics when sufficient decision latitude is given to the levels of the organisation concerned and improvement activities are encouraged. The vision-driven process depends additionally on a strategic management belief that good ergonomics is beneficial for the long-term development of the company’s performance. To obtain improved ergonomics in vision-driven change, management needs to proactively emphasize this as a goal and allocate the necessary resources.

**Discussion in retrospect**

Since my model on action- and vision-driven change first was published in 1996 I have from time to time been reflecting about whether it actually adds something to the understanding of change in SMEs and how ergonomics is considered in change. It is a model of change, not of changing, and both action- and vision-driven change are teleological according to the classification by Van de Ven and Poole (1995). The model shows similarities with the theory of punctuated equilibrium, reviewed by Gersick (1991), who compared similar theories from six different fields of research. In the theory, periods of equilibrium are punctuated by transitional revolutions. During the periods of equilibrium adaptations occur frequently but do not accumulate change and the underlying deep structure determining the equilibrium do not change. This can be compared with action-driven change. The transitional revolutions occur periodically, often as a consequence of external forces, and alter the underlying deep structure (vision-driven
change). The deep structure is in my model the conceptions of how the company normally is operated most obviously expressed in the behaviour of management.

Working with small companies you learn that one of the important features of small companies is that in order to do your job you will have to get things done, irrespective of scarcity of resources, knowledge, time etc (Ghobadian & Galleear, 1997). There is seldom someone to ask for help so you have to develop your own ability to deal with all kinds of problems without spending too much time on them. A beautiful illustration of this can be found in the book of Ruth Holliday (1995). She describes how she thought she was going for a short introductory visit to a company but she was immediately drawn into a series of totally unpredictable happenings until ending up home late and totally exhausted. Moreover, in a recent magazine I read about a small manufacturer of coil springs introducing lean production in their company. A representative for the company said that this process resulted in that one person had to leave the company and this person’s name was “somebody else”. It was no longer permitted to blame or leave tasks undone to this unknown “somebody else”. Instead everybody was responsible for taking action and see to it that things get done (Stenwall, 2007).

Another reflection relating other experiences is that I teach at the School of Engineering together with a colleague in a course called “Applied management of change” which is directed to professionals outside the school. In this course, the students are supposed to describe their experiences of an organisational change effort they one way or another participated in, either as an employee or as a manager. From their writings, which often are very good, it is obvious that action and vision often are difficult to deal with. Actions to produce change are often avoided and visions are often too far away from action, the actors distance themselves from action and the desired change is not reached. The conclusion is that action in change is difficult and demanding, it requires courage and commitment and people are not always willing to invest in that.

It may be noted that standardisation, as discussed in Paper 3, is not entirely compatible with action. The latter implies that initiatives are taken regardless of whether the situation is foreseen or not while standardisation presupposes that situations are foreseen and actions can be described as rules to follow. This is acknowledged in activity analysis where this contradiction is used as a lever of change (Carballeda & Daniellou, 1997).

Visions can be a way of overcoming this problem. My experience is that in SMEs these are embodied in the way the company is managed and how the manager behaves, not in how they are outspoken but the way they are lived and made visible. Several times I have recognised that the coupling between formalised visions as written in quality management documentation or similar and the visions applied in action often are very weak. A comment on vision-driven change might therefore be that there is a strong need for coherence between the outspoken vision and its enactment and this need might be stronger in SMEs while the visibility of the enactment is apparent to most employees. The manager may be supervisor, strategist, controller, marketing manager and industrial engineer in
the same person and is thus also the strongest example or pattern of how the vi- 
sion of the company should be interpreted and lived.

Thus, the division of change into action-driven and vision-driven grew out 
of these insights, the results of my studies and my own previous experiences. My 
conclusion now is that the model of action- and vision-driven change needs addi-
tional testing and refinement. It might work well as a basic concept for under-
standing change and how ergonomics are considered in SMEs.
One of the conclusions of Project A was that besides implementing ISO 9000, the most common trigger for larger change efforts was what the companies called planning. This was further examined and a number of investigations all pointed in this direction. In an assessment including 11 small or medium sized woodworking companies in the district close to the city of Nässjö, eight of eleven companies had the opinion that planning was the most urgent area to improve within their operations (Karltun & Trygg, 1994). In a market survey made 1994, 142 Swedish woodworking companies were asked concerning their most important problem areas and what support they would like Trätek to provide. The three major problem areas indicated were production control, human resource management and product development. The three major areas where support from Trätek was demanded were manufacturing process issues, production control and working conditions. Furthermore, the questionnaire used in the Trätek change method called Protek was analysed concerning the first 15 companies where it was used (Svensson & Bjelkvik, 1994). In all, about 500 employees answered the questionnaire and 49% considered the companies’ planning ability to be poor or very poor and 41% considered the information on what happened in the company to be poor or very poor.

When digging deeper into what planning was, it was found that planning was a common denominator for many different coordination problems. Some of these had their origin in increased demands concerning customization, shorter delivery times, lowered tied up capital, shorter series and many product variants, others in less developed organisational routines. Another source to “problems with planning” was difficulties in making reliable process planning and thus calculating manufacturing costs, especially in companies with a large extent of customized work like production of fittings for shops, public offices and other premises.

It was also understood that poor planning had large negative implications for ergonomics at the workplaces. Stressful working situations, overtime and poor information on what to do and when to do it did not only harm in itself and reduced workers’ opportunities to control the own work. These factors also contributed to risky behaviour like not using appropriate safety equipment, casual set-ups, blocked passages, solitary work etcetera.
In close relation to the issue of planning was the information flow. In efficient production a trustworthy information flow on what has been sold, when it should be delivered, how this process should be accomplished and under which conditions is of high importance. To realize this, companies used information systems to different extent but it was clear that this flow often was troublesome in many companies. This also affected the working conditions in the companies.

Coordination in companies includes to a large extent the use of information systems. This part of the research was therefore conducted in cooperation with researchers in informatics. One of the results of this cooperation was the development of the SMECA method, a systematic way of initiating change in companies where coordination and information issues were put in focus (Paper 5). This was done by including business process configuration; participative working procedures and a conscious strive to make the change processes in participating companies resource-efficient.

Paper 6 draws not only on the experiences of Project B but from both projects. However, the basic work for it was done just before Project B was closed down in 1999. I have since worked on it a number of times before it was finished. It is largely based on my experiences and observations during research and consultancy and the different ways change projects are approached by professional people from various backgrounds and with different focus.
9 Summary 5. SMECA – A methodology for organisational change in SMEs

Paper 5 is submitted for publication.

Contextual framework for Paper 5

It was clear that when addressing change efforts with a focus on the area of planning and coordination there was a need for development of an approach that could handle the issues incorporated in this problem. The current method used at Trätek for organisational diagnosis needed to be developed. Experiences, findings and developments from the previous papers in this thesis as well as from other projects were incorporated in the method and large effort was put on valid data collection on the situation of the firm. There was a need, however, to combine that with an improved analysis of data important for coordination. Collaboration was started within the Centre for Studies of Human, Technology and Organisation with researchers from Informatics who worked with methods dealing with aspects of organisations that were relevant when implementing information systems. The resulting methodology and the effects of working with it in three companies are described in Paper 5.

Summary of Paper 5

Background and aim

Important triggers for change efforts in Swedish woodworking SMEs during the late 1990s were problems the firms associated with planning, scheduling and information handling. However, dealing with these coordination problems was not an easy task for many of the firms. The problem area was difficult to define, multifaceted and holistic in its character and often a result of more or less conscious business development and organisational choice. In addition, the knowledge on how to organise and run change efforts was previously found to be less developed among small Swedish woodworking firms (Karltun, 2004). The purposes with the paper summarised here are to describe a change methodology and its theoretical foundation. Furthermore, it is to report the results of addressing such complex, holistic and sometimes ambiguous problem situations as the one described. Three case studies were made in small firms of different size (15-100
employees), working in different business areas within the woodworking industry. The evaluation included two steps. First, the methodology was evaluated whether it actually sorted out the multifaceted problem situations and resulted in a feedback report that was usable concerning common problem descriptions and concrete action plans. Second, the initiating ability and the validity of the proposed actions were tested by comparing the resulting changes with the firms’ initial goals and the action plans for their change efforts.

**Change and SME**

The planned change effort described in this paper can be classified as a teleological change according to Van De Ven and Poole (1995). This is a process of purposeful enactment seen as a cycle of goal formulation, implementation, evaluation and modification of actions or goals based on what has been learned. This cycle is seen as the motor of change for a single unit and the mode is constructive. The change process is furthermore what Weick and Quinn (1999) called an episodic change meaning that it is a distinct movement between phases of relative organisational equilibrium. As an outset concerning the view of the organisation, the framework for organisational change by Porras and Robertsson (1992) is used. In this the behaviour of the individual is governed by four categories of factors namely organising arrangements, social factors, physical setting and technology. Organisational change is considered to be defined by a change in the organisational members’ on-the-job behaviour in appropriate ways (Porras & Robertson, 1992). The framework refers to socio-technical theory as well as to organisational development theory.

Furthermore, as the base for the change effort the difficulties in tasks and activities of people at work are used (Beer et al., 1990; Daniellou & Rabardel, 2005; Norrgren et al., 1996). In the definitions of these, a process perspective of the organisation is taken, thereby aligning the business as such with the activities performed (Davenport, 1995; Lind, 2001; Porter, 1985; Rentzhog, 1996; Scott, 1998).

Issues concerning organising work, change and development work in SMEs are not extensively researched and results are not homogenous (Cardon & Stevens, 2004; Nilsson, 2003). Small firms are sometimes described as conservative and unwilling to change. On the other hand, small firms are described as being highly context dependent and thus having to be flexible and eager to adopt new ideas from their context (Nilsson, 2003). The close dependence on market conditions is supposed to deny SME managers to choose regarding the way they manage employees. Furthermore, the proximity between owners and employees was found to form social relationships that enhance informality and continuous renegotiations around the labour process. The mutual dependence between employees and manager is tacitly recognized giving room for employees to manipulate their own labour process (Marlow, 2005). A conclusion by Nilsson (2003) is that the initiation of organisational changes is context dependent but the results of change efforts depends on the actors in the firm, where actors could be owners/managers.
or other employees like union representatives. However, whether change efforts will take place is dependent on the combination of external forces and internal actors. Furthermore, she argues that an integration of development activities concerning production, work organisation and/or education or training seems to be beneficial to create learning opportunities at work. Similar conclusions are drawn by Ghobadian and Gallear when studying firms implementing TQM. They found that the dependence on individuals and especially managers’ and often owners’ personalities tend to dominate, which may hamper changes and result in rigidity in perspective. A dominant short-term perspective and focus on day-to-day activities may in addition limit the long-term outlook of management as well as the willingness and ability to devote time and resources to planned change activities (Ghobadian & Gallear, 1997). These conclusions concerning management work are largely supported by findings of Florén (2005) from studying managers in Swedish small manufacturing firms.

Ghobadian and Gallear (1997) found that resistance to change is minimal in SMEs but that development work is limited by a lack of knowledge in organisational issues and change management. The establishment of effective communication is an important factor, and the proximity between management and staff is critical to the implementation process, both for the employees to know what is expected and because SMEs are more susceptible to rapid propagation of individual hostile views towards TQM (Ghobadian & Gallear, 1997). Karltun (2004) concluded that the high visibility of success or failure concerning change efforts in SMEs might create good or vicious circles reinforcing previous experiences of change.

It might also be noted that there is a danger in describing SMEs as a homogenous phenomenon, they show high individual differences as organisations even when there are similar external conditions (Holliday, 1995; Karltun et al., 1998). Further, the vulnerability of SMEs, the lack of long-term financial stability and the immediate dependence on owners, managers, employees and dominating customers might be added (Holliday, 1995; Karltun, 2004; Karltun et al., 1998).

Belotti (1998) found that the contribution of customers and suppliers in technical development is dependent on whether firms also have collaborative interaction with other knowledge producers, even such that are research-based. Another result is that a rather large portion relied on institutional and research-based organisations for acquiring support concerning technological changes. Ylinnenpää (2006) found that small firms develop their knowledge differently from large firms. More successful firms use regular personnel meetings with educational elements, mentorship for new employees, recruitment of people with new competences, project work as a means for developing knowledge and participating in networks.
Methodology considerations
A number of methodology considerations are developed. These are:

- The methodology should respect the situation in a small firm, with its scarce resources concerning planned change efforts, its financial vulnerability, its organisational proximity, its context dependence and its high dependence on single individuals.

- The methodology should be able to deal with ambiguous situations where the initial understanding of the problematic situation might change and consequently the final goals with the change effort.

- The methodology should not advocate specific problem definitions or solutions but support firms to describe their problems and find their own solutions defined by their own understanding of the businesses.

- The methodology should be possible to adapt to the specific situation in each firm.

- The methodology should challenge the existing local theories.

- The methodology should use contradictions as levers of change.

- The methodology should deal with the problematic situation in a holistic manner.

- The methodology should strive to combine business aims with improved working conditions.

- The methodology should support participation of employees, be entirely open, include a lot of communication possibilities and enhance learning by providing feedback in multiple ways.

- The methodology should be structured in such a way that the firms in their own developments could adopt parts of it.

- The methodology should use an external agent for process management and change initiation but aim at clarifying the responsibility for changes to the firm’s internal actors.

- The methodology should be internally consistent concerning these demands and the incorporated values.

- The diagnosis should preferably be made in a way that makes diagnosis part of the intervention.

As stated above, the change methodology should not be directed to a certain problem definition or advocate a certain solution but instead open up for a search and learning process. Thus, the objective for the applications of the change methodology referred to in this article is, for example, testing if production planning is the problem it seems to be, not immediately improving production planning. The
methodology should also provide guidance towards what measures could be taken to solve or further analyse the problematic situation.

**Small and Medium-Sized Enterprise Change Analysis (SMECA)**

The main practical purpose of the here-described methodology is to initiate and support change in the firms studied in an action research process where the methodology described is used. As a result of this process the aim is to develop a shared platform for further developments in the firms. This platform should consist of the resulting documentation, a feedback report with action plan agreed on, and the employees’ experiences from working with the change effort in a participatory way.

The intervention process is applied in a way of disciplined inquiry, thereby adhering to the postmodern pragmatic model suggested by Fishman (1999) and Peterson (1991), Figure 9.1. In this model it is the needs of the client that drive the study and the practitioner brings his/her guiding conception and experience as well as research based knowledge to the situation. The guiding conception consists of the theoretical and epistemological foundations as well as the axiological values that underlie the theory.

![Figure 9.1 Professional activity as disciplined inquiry, from (Peterson, 1991).](image)

The structure of the SMECA methodology is presented in Figure 9.2. The first step, determining the prerequisites, is vital for the legitimacy of the process. During this step, the goals of the firm’s management, of the employees and the expectations of the change agent are discussed and agreed on. Furthermore, the structure and the assumptions of the change process are also discussed and the working procedures are agreed on as well as the open information during the entire work. An internal project group is formed in the firm including the project manager and representatives for the firm and the employees. This step is documented in a standardised way.
The second step is the diagnosis of the firm. The main parts of the diagnosis are process reconstruction, data collection and data analysis. Process reconstruction is made during one or two seminars with the project group when the business processes are examined and documented in action diagrams.

The data collection consists of three standardized parts, a questionnaire for individual attitude assessment, a questionnaire for operations characteristics assessment and financial assessment of the last five years of operations.

The procedure for data collection fulfills a triangulation strategy based on combining data (qualitative and quantitative), methods (interviews, seminars, questionnaire, observations, document studies), investigators (external and internal) and theories (from ergonomics, quality, organisation development, informatics etc.) to obtain high validity of the data (Denzin, 1989).

The third part of the diagnosis is data analysis. It is divided into three different parts according to the focus of the analysis. All parts are to be performed together with the project groups in a series of seminars in order to have a joint analysis (Goldkuhl & Röstlinger, 1993).

As the last step of the methodology the external change agents put the results together in a feedback report. The report has a defined content with a text followed by predetermined presentation techniques such as descriptive statistics, hypothetical relation diagrams, action diagrams and categorisations. The report is discussed and revised by the project group until all parties accepted it as a legitimate description of the present state in the enterprise, and it serves later as a platform for further development work.

Figure 9.2  Structure of the SMECA methodology.

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Application of the methodology

The methodology was applied in three different firms in a similar manner. The main characteristics of the enterprises are displayed in Table 9.1. All firms claimed that the problems that made them participate in the study were related to their information and planning activities. A common denominator was also that the enterprises studied were successful and in general appreciated by the employees. In each of them, a project group was formed with representatives from all personnel groups (management, white-collar workers, and blue-collar workers). The projects were arranged as a set of meetings, interviews, analysis work and presentations.

An evaluation with the aims to identify process qualities of the methodology and changes attained in the enterprises was made by interviews, questionnaires, seminar work groups, and revision of process models, one to two years after the feedback reports were presented. The same tools were used for the evaluations that were used during the first diagnosis.

For each of the firms, the feedback report concluded with a plan of actions that ought to be taken to solve the problems discovered and described. These plans were then the outset for change efforts with the actions covering a wide range of efforts, from single hours to weeks of work.

The amount, quality, structure and combination of qualitative and quantitative data made the results, analysed and fed back to each enterprise, strong change drivers. In all the studied enterprises, problems involving aspects of leadership and the way the managers worked were more effectually handled after clear indications of these problems. Crucial points included information flow distribution; role definitions and the way experiences (bottom-up) were suppressed in the enterprises. The managers’ view on the problems identified occasionally differed significantly from the main opinion among the employees. The methodological approach simplified and played down the potential conflict built-in, dealing with these matters, challenging the local theories without neglecting the contradictions.

Table 9.1 Firm description

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Firm A</th>
<th>Firm B</th>
<th>Firm C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main products</td>
<td>Customised shop fittings</td>
<td>Veneered boards</td>
<td>Wood components</td>
</tr>
<tr>
<td>Profitability</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>No of employees</td>
<td>73</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>Annual growth rate (proj. period.)</td>
<td>~10%</td>
<td>&gt;40%</td>
<td>~ 0</td>
</tr>
</tbody>
</table>
Findings and results
The findings of the application of the methodology revealed the basic aspects displayed in Table 9.2 of the different firms and their situation.

Table 9.2 Basic aspects of studied firms, revealed by application of the methodology

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Enterprise A</th>
<th>Enterprise B</th>
<th>Enterprise C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identified main business processes</td>
<td>Two</td>
<td>Four</td>
<td>Four</td>
</tr>
<tr>
<td>Organisation</td>
<td>Project in marketing 3 levels Trad. in production 4 levels</td>
<td>Traditional 3 levels Flat 2 levels</td>
<td></td>
</tr>
<tr>
<td>Level of delegation*</td>
<td>High in marketing</td>
<td>Medium in production</td>
<td>Medium</td>
</tr>
<tr>
<td>Decision latitude*</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Dominating enterprise philosophies (applied)</td>
<td>Strong customer orientation, flexibility Co-ordination between marketing &amp; production, Annual variation, Complexity, Purchase from suppliers, Lack of software support, General information</td>
<td>Lean production, JIT, no inventories Growth problems, Capacity of process planning, Personal planning possibilities, One-way communication, General information</td>
<td>Strong customer orientation, high added value Size of inventories, Work orders, Single person dependence (CEO), One-way communication, General information</td>
</tr>
<tr>
<td>Specified problems in planning and information flow</td>
<td>Co-ordination between marketing &amp; production, Annual variation, Complexity, Purchase from suppliers, Lack of software support, General information</td>
<td>Personal planning possibilities, One-way communication, General information</td>
<td></td>
</tr>
<tr>
<td>Number of defined actions in report</td>
<td>28</td>
<td>24</td>
<td>21</td>
</tr>
</tbody>
</table>

* based on ratings in questionnaire and interview results where questions regarding this were included

The process modelling clarified the participating firms’ processes, the structure of their business processes, their relation and possible ways of expansion. The analyses showed that in spite of similar initial problem descriptions, the needs for completely different approaches in solving the underlying problem causes were obvious and could be handled. Due to the participative approach, the experiences of the employees were considered in the change projects to a much higher degree than they had in previous change efforts in the firms. The projects were also con-
continued with further changes and improvements of ways of working in the three enterprises.

The project managers in the three firms weighed the change process and the use of the methodology to contribute significantly to attaining the goals set up before entering the project. The firms had accomplished a considerable portion of the proposed actions at the evaluation, but due to a lot of unforeseen changes in the contextual conditions, other actions were not and should not be entirely identical with the proposed.

Discussion and conclusions
The evaluation of the methodology shows that the data collected and the ensuing analysis provide detailed problem descriptions and defined many change activities that could be realized.

The model for multiple data collection, rich data on working conditions together with the analysis allow for parallel holistic and detailed views i.e. how the details and processes are aligned. The interplay between the parts and the whole is important in order to enhance organisational learning. The combination of documented data and local theory, interpreted, commented and fed back by the external change agents, render the integrated methodology a powerful change initiator. The contradictions between different existing perspectives, structure and activities, experiences and practice are made explicit and credible by the combination of quantitative data, qualitative data and analysis. The credibility is essential since many of the matters made explicit are known but not considered by management, and thus did not previously play any role as change initiators.

The use of the approach is effective in producing desired insights within the ambiguous problem area of coordination in manufacturing firms. These insights are explicitly based in the opinions of the employees and the reality of the business, which is essential for the methodology as change initiator and driver. Furthermore, the open character of the process enables learning and understanding of details in relation to entire operations.

The aims and theories underpinning the SMECA methodology guide the developed action plans to incorporate considerations that do not have a position as change drivers in many firms. This is the case for many of the causes of problems found in the problem analysis, where among other things ergonomics and individual difficulties in daily work are highlighted.

Discussion in retrospect
Shortly after finishing the project in which the SMECA methodology was developed the research site of Trätek in Jönköping was closed down and the basis for using and developing the SMECA methodology disappeared in reality. However, I still think that there is a room for investigating coordination problems with a methodology that combines highly valid data elicitation with process analysis and holistic perspectives in a context which is characterised by a heritage of hesitation towards formalisation. I mean that this heritage is of great advantage con-
cerning many aspects of efficiency and effectiveness in SMEs but it is also a drag on the development ability of companies. Much of the difficulties within coördination stem from different opinions and conflicting goals which is inevitable in an organisation, the conflict between sales and manufacturing being the classical one (Shapiro, 1977). However, it is a widespread knowledge that to learn and improve the organisational performance there is a need to bring enough order to know where to start and with what (compare the discussion in chapter 6).

Naturally there are other methods and tools to bring knowledge and order to an organisation. The ten principles of socio-technical analysis (Cherns, 1987) can serve as analysis guidelines but do not give concrete advice on appropriate action. There is a more detailed attempt do define what should be done in a socio-technical analysis which is discussed by Klein (1994) but this is specially adapted to the conditions of Shell UK which hardly could be compared with small woodworking firms. Later attempts with socio-technical analysis for improving the development and use of information systems also concern larger organisations (Mumford, 2003).

The macroergonomics methodology described by Hendrick and Kleiner (2001) does share a lot of common elements with the SMECA methodology, not the least concerning underlying values. The cultural differences and the size of the organisations considered as well as the strong focus on manufacturing in the SMECA methodology are important parts that differ. It can however be questioned whether a macroergonomic approach is possible to carry through in a small company as it is described with quite a lot of top-down design work to do before coming into decisions on changes.

Regarding quality management and TQM approaches there are strong links and similarities. Some of the tools included in SMECA are also common tools within quality management. Furthermore, the operations characteristics questionnaire is strongly influenced by the Swedish quality award and the structure for evaluation provided by the Swedish Institute for Quality Development (SIQ, my translation). There are also strong similarities between TQM and ergonomics concerning values for example on participation or on handling variances. The links between quality and ergonomics are strong and have been discussed in depth by Axelsson (2000). The coupling between macroergonomics and TQM as well as with other organisational design and management future developments was discussed by Zink (2002).

I would also like to do a comment in relation to “lean” being perhaps the most discussed and used manufacturing or even business philosophy today. The author of the book “The Toyota Way” Jeffrey Liker wrote

“Lean is about developing principles that are right for your organisation and diligently practicing them to achieve high performance that continues to add value to customers and society” (Liker, 2004, p. 41).

Comparing this with the aims of the SMECA methodology does not signal high discrepancies. What the 14 principles of the Toyota Way do offer is a management goal system, just like ISO 9000 do, where the goals are carefully coupled
with means to achieve them; if companies apply these principles wisely they may end up with a more successful business. SMECA is instead open ended, it offers guidance to a change process of identifying the most urgent needs and developments using the opinions of many in the business but it does not suggest the principles of operations management that will solve the specified problems. The lean concept suggests the fourteen principles based on a general understanding of businesses and argues that they should be applied “right”. However, it cannot be denied that the “lean” concept seems to be very successful but it is difficult to scientifically test if it is (New, 2007), just like ISO 9000 or TQM or any other management philosophy. And this of course goes back to the word “right”, the importance of the change process as such and the complexity of manufacturing businesses.

The values lying behind “lean” and ergonomics and socio-technical design are also under debate but I will not go into that here (c.f. Börnfelt, 2006; Hansen, 2006; Pil & Fujimoto, 2007; Treville & Antonakis, 2006; Tsutsui, 1998). However, I commented shortly upon these aspects in the discussion of the impact of standardisation in chapter 6.

To conclude, I am convinced that for many firms that do want to develop themselves, SMECA would offer a good start for that. Instead of copying the priorities of the neighbour or the consultant, it would bring a more thorough knowledge on the situation to be developed and help sort out the most important issues to prioritise. Using SMECA thus enables a reflective dialogue about the situation of the firm, based on comprehensive data as well as on expressed goals.

I would also like to do a last comment on the process of research that preceded this article. From doing research together with researchers from Informatics I have learnt a lot about different research cultures, how difficult and surprising it can be and that the process of integrating knowledge from different traditions is anything but easy. However, I have also learnt how fun, interesting and enriching it can be.
10 Summary 6. Ergonomists, experts and participants in change; how do they relate?

Paper 6 was published in 2006 in the Swedish refereed journal Socialmedicinsk Tidskrift No 2, pp 156-175. The original title is “Deltagare, experter och förändringsagenter i hälsöfrämjande utvecklingsarbete”. The paper was translated by me for this thesis.

Contextual framework for Paper 6.

All the case studies that constitute the empirical base for this thesis involved different kinds of expert roles. There were technical experts providing knowledge on technical matters like quality technology, industrial engineering or ergonomics. There were process experts providing knowledge in project management or organisational interventions of different kind. Enthusiasts serving as driving forces for developments were also considered as important in change. All these expert roles were expected to contribute to different changes in the studied companies. The role bearers were sometimes employed by the companies and sometimes they were consultants or researchers and I belonged to the last category. Furthermore, there were managers whose support was considered to be important and there were employees of different kinds that participated in the change efforts bringing their unique knowledge into the process. When observing and analysing the influence of these actors I realised that the ideas on the different roles and how they influence the change process can be further clarified.

The idea of trying to bring some order into these roles came up and a first paper was presented at the IEA 2000 congress (Karltun & Eklund, 2000). There are a number of publications on consultants roles in interventions within organisational development (OD), see for example Block (1999), Schein (1988) or Blake and Mouton (1983). Furthermore there are well-known publications on how to become expert and what constitutes expertise (Dreyfus & Dreyfus, 1986; Ericsson & Smith, 1991). There are also a number of comprehensive publications on participation in organisation development and in ergonomics (Haines et al., 2002; Heller et al., 1998; Noro & Imada, 1991). The researcher role in case studies and in action research is well debated. But the researcher as change agent, expert or participant in the change effort is seldom discussed. Paper 6 is my ef-
fort to try to sort this out. What roles can be expected in change efforts and how do they relate?

Summary of Paper 6

Background and aim

Participation is an aspect of organising change that is considered to bring some substantial benefits. Some of these can be transformed more or less directly into financial profit and some can be considered general positive values for organisations or enterprises involved. Parallel to the movement that considers participation important, the development in society towards greater complexity and technological depth implies that the dependence on and need for expertise is growing. Recurrent signs of this are, for example, increasingly longer education, new career paths and discussions on how companies and organisations should be able to retain high levels of knowledge in the strong low-cost trend that is prevalent. At first sight, it appears as if there is a built-in contradiction between experts and other participants. Change is either designed and implemented by an expert, or by a participative process involving the workers concerned. But looking deeper into this issue, the question quickly becomes multifaceted. This gives rise to questions such as: How do the experts and the participants really relate to each other? Who should formulate goals and problems? Who should have access to information and who should make decisions? Who should set up the change agenda? What are the experts’ foci of work and what are their roles? Are a participative change approach and an expert change approach mutually exclusive or may they coexist? Or would a participative program require an expert for its realisation?

These questions are highly relevant for my own experience as researcher. The results from 10 case studies performed, where expert orientation was used as an independent variable for evaluation of its influence on the success of change efforts, showed that the influence was weak or in some cases negative (Karltun et al., 1998; Karltun et al., 1996; Karltun et al., 1997). Furthermore, in five action research case studies in which I was active as researcher and expert there was a continuous confusion concerning the expectations on what type of expert knowledge I should bring into the process (Karltun, 1996, 2004).

The aim of the paper is therefore to contribute to a better understanding of the concepts of participants and experts in change, how they relate, overlap and limit each other. Moreover, the aim is to provide a frame of reference that can serve as guidance for change agents and to furnish a better theoretical basis for the understanding of the issue.

Drawing on an analysis based on a theoretical survey on participation and expert roles in change processes involving ergonomic considerations the following main findings and conclusions can be reported.
Some differences between expert and participant

The relation between experts and participation in ergonomics is special. Who can be better experts on their own work or their health than the workers themselves? Often there is a need for ergonomics expertise to assist and bring theoretical subject knowledge to a situation, to add articulated knowledge to the situation. However, the worker remains the primary source of specific knowledge about the performed work or perceived health. Hence, in the case of ergonomics, the collaborative process between participant and ergonomics expert becomes especially essential. The experts have the professional role of mastering a subject that is important for change, but their own working conditions are rarely the object of change. This turns the expert into a representative of an outside perspective of the object of change.

Table 10.1 Characteristic role differences between different experts and participants in (ergonomic) change efforts.

<table>
<thead>
<tr>
<th>Aspect in change process</th>
<th>Substantive expert</th>
<th>Process expert</th>
<th>Mission expert</th>
<th>Participant (skilled expert)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expertise based on</td>
<td>subject (specialist) knowledge</td>
<td>process knowledge</td>
<td>context and communication knowledge</td>
<td>specific knowledge of own (line) work</td>
</tr>
<tr>
<td>Authority in change process based on</td>
<td>profession</td>
<td>profession</td>
<td>profession or position</td>
<td>delegation or legislation</td>
</tr>
<tr>
<td>Interaction with organisation</td>
<td>technical advisor</td>
<td>process facilitator</td>
<td>priority advocate</td>
<td>performer</td>
</tr>
<tr>
<td>Role in change</td>
<td>solution provider</td>
<td>consequence provider</td>
<td>vision provider</td>
<td>experience provider and implementer</td>
</tr>
<tr>
<td>Time spent on development work</td>
<td>main part</td>
<td>main part</td>
<td>mixed</td>
<td>minor part</td>
</tr>
<tr>
<td>Relation to change</td>
<td>not affected</td>
<td>not affected</td>
<td>not affected*</td>
<td>affected</td>
</tr>
<tr>
<td>Perspective on change</td>
<td>outside technical</td>
<td>outside including all</td>
<td>outside* top-down</td>
<td>inside bottom-up</td>
</tr>
</tbody>
</table>

* In a small organisation the mission experts work close to the participants in their daily life. The relation to and the perspective of the change effort will accordingly be more like the participants’. A small organisation will thus function differently from a large one concerning these aspects.

It can be argued that many advantages with participation are reached just because participation adds an inside perspective to problem-solving and change. This in-
side perspective of participants will also highlight contradictions between existing ways of working and structure as well as between inside and outside perspectives.

An attempt to classify some differences between different experts and a participant is presented in Table 10.1.

In a change effort, the experts base their participation on their professional knowledge, while the participants’ expertise is based on an extensive and specific knowledge of their own work. For the experts, the authority in the change work is based on their profession or position but for the participants on delegation or legislative directives.

While the participants have a subordinate relation to management and are performers, the experts may in many cases have a relation based on mutual dependence. The experts often decide the conditions for participation, while the participants are expected to contribute with experiences and implement changes.

The experts devote a main part of their working time to development work of different character, while the participants devote their main part to ordinary work and by way of exception devote a minor part of their time to participation in change efforts. The participants will see their own work situation affected by the change, while the work situations of the experts are not affected. Hence, the experts’ different views are those of outsiders, while the participants provide an inside view.

Discussion and conclusions
The proposed model, to distinguish between the roles of the substantive expert, the process expert and the mission expert, offers some advantages. It reflects existing beliefs and traditions in organisations and among change agents.

The substantive expert role is a natural element where specialist knowledge that cannot be acquired only through experience is required. The process expert role concurs in the processual view of change and the visions in legislation concerning industrial democracy and employees’ influence on their own working conditions. The mission expert role is commonly described in management literature and it is often the manager, or the manager’s pair-of-hands, that is the change agent and sets the conditions for change. The participants offer profound expertise in their work, with an inside perspective that is affected by the intended change. The experts’ contribution in this respect is much more limited.

The other important difference concerns the role in change. The participants have a unique role as the primary implementers of change and this is of great importance as soon as change includes changes in behaviour which is often the case. Of course, coercive changes can be produced by technical systems or managerial power but offensive changes at employee level can only be brought on by employees’ own motivation and free will. This is also mostly the case in ergonomics, where changes in working behaviour are wanted, almost by definition.
Based on Johannessen’s (1988) expansion of knowledge as concept, it could be argued that while the substantive expert mainly has a knowledge base in articulated knowledge, the participants have more of applied knowledge and familiarity with the situation with the other experts being in between. This implies that to reach the higher levels of expertise, according to Dreyfus and Dreyfus (1986) it is necessary to involve different types of experts in developing work.

Four conclusions are drawn. The first is that ergonomists have a great advantage of being aware of the different change agent stances, the consequences of these and how they are related to ergonomic goals aimed for. This will affect how the change process can be organised concerning the roles of management, the role of the ergonomist as expert and/or change agent, and the roles of participants or targets for change. Secondly, there is a need in every change project to discuss the underlying assumptions concerning the change effort with the management involved. The delimitations of the change effort and the formulation of the goals will affect the change agentry needed; the possible working methods for the ergonomist and the possibilities and prerequisites for participation. Thirdly, the ergonomist might need to learn to work in different ways according to the contextual situation and the results wanted from an intervention. Shifting focus from technical solution to process or goals, working in the operative, tactical or strategic domain or developing problem solutions for the technical, organisational or political/cultural arena may all be necessary to achieve success in a general ergonomics perspective. All roles defined here may coexist to some extent in a real single change process, and as change agent and expert, the ergonomist should be prepared to manage this situation. Finally, in ergonomics participants offer a unique expertise of own work, an inside perspective of change that cannot be entirely substituted; at the same time the participants are a key resource for the implementation of change, which experts seldom are.

**Discussion in retrospect**

Working with Paper 6 solved many of the questions I had about my role as researcher and the roles of different consultants that were involved in projects. For many years I was confused by the fact that many firms had so varying experiences of consultants and the reasons why they failed or succeeded. Our research results concerning implementation of ISO 9000 pointed in the same direction. The literature on researcher roles and on consultants’ roles in organisational development did not provide guidance enough. When I found the article by Marcus & Benjamin (1996) I realised they described additional perspectives on change agents. Now I think this had to do with the mixed characteristics of the knowledge needed in technical organisational advice as well as in ergonomics. Some knowledge is of strict scientific and rational character, for example technical or medical knowledge. However, other types of knowledge like how to organise, how to convince people to adopt new ways of working or how to get political influence are not. The actors in the different knowledge traditions are shaped by the character of their knowledge, thereby bringing confusion concerning the role-
taking in development projects. However, when these issues were discussed at the start of projects, the confusion was less obvious. Clarifying how experts look upon their role and their responsibilities in change efforts can thus be of high importance for reaching the goals aimed for.

Another issue on roles is the possibility of both being consultant and researcher. During my time at Trätek I discussed with my colleagues whether it would be possible to organise projects to get better research and better consulting at the same time. One of the ideas we examined was if it would be possible to divide the researcher role and the consulting change agent role so that one of us could concentrate on supporting and operating the change process and the other on researching the change process. Such a division of roles would not only clarify and simplify the action researcher role, being researcher and developer at the same time, but also to diminish the conflicts inherent in shifting between the roles described in the paper. Before we succeeded in finding a suitable model for this that could handle the difficulties involved in financing, incompatible time-scales, focus and priorities, access etc. the Trätek office was closed down and my working situation changed. The idea of separating expert roles in change processes is however not unique.

In a newly published book on business development of Swedish SMEs performed within a large project called Kraft (Norbäck et al., 2006) a large number of small groups of firms gathered around a theme of high interest for them. To each group one project manager, usually one consultant and one academic teacher were engaged. The project manager was responsible for the development process to proceed and the teacher was responsible for theoretical (academic) input to the development process in the group. None of these were researchers in the sense of doing research on the developments of the group but the idea of separating roles responsible for different aspects of the change process was there. In this case the idea was guided by the concept of adult learning and the learning cycle of Kolb (1984). The academic input was seen as a necessary input for conceptualisation and reflection. A large number of firms participated in the project and the combination of two different expert roles in the project was regarded to be very successful.

When reading the project report (Norbäck et al., 2006), its references to Aristotle and his classification of knowledge into three kinds caught my attention. These could naturally be compared with the three kinds of experts proposed in my paper. The Aristotelian intellectual virtue of episteme refers to scientific knowledge of universal, invariable and context-independent nature based on general analytical rationality. The corresponding expert is the substantive one. The virtue of techne refers to craft and art representing pragmatic, variable, context-dependent knowledge based on practical instrumental rationality, production oriented and governed by a conscious goal. The process expert has the closest correspondence to this. Finally, there is the virtue of phronesis referring to ethics and deliberation about values with reference to praxis. This knowledge is of a pragmatic, variable, context-dependent nature and it is oriented towards action. It
is based on practical value-rationality and the corresponding expert is the mission expert. *Phronesis* is the knowledge that is most dependent on experience and it is about value judgement, not of making things.

I found the definitions of the Aristotelian intellectual virtues in a book by Flyvbjerg (2001) discussing the philosophical basis for social science. To me, the analogy sheds new light on the expert roles and how they might be elaborated and researched in the future. It also sheds additional light on the epistemological confusion within ergonomics which is further discussed in Part 3 of this thesis.

When proceeding to the fourth role, the participant, there is not a natural analogy to any single virtue. But the participant stands for something else. In their daily work participants need to integrate those different kinds of knowledge into their own holistic enactment of the daily work. The participants are in the situation of using scientific findings in a specific context and applying it appropriately in action, thereby both using practical instrumental rationality and values for governing these actions. This is not an easy process without conflict. For example the scientifically verified limitations of human beings are often not considered when practical instrumental rationality or value-rationality is claimed.
Part 3

Part 3 gives an updated theoretical review of the area in which the research was done. It furthermore provides a reflection on methodological and epistemological questions and a discussion on the contribution of the research.
11 SME characteristics

When studying change in SMEs it soon becomes apparent that there are differences concerning the change processes that are linked to the size of the organisation. I will try to outline some of these in this chapter. I have found it relatively difficult to find literature that takes into consideration the qualitative influence of organisational size and does so from another point of view than the entrepreneurial and growth perspective. Secondary woodworking industry is a mature industrial sector where many firms have a long history of reducing the personnel in a slow pace dictated by technical developments. In this context, it is not the characteristics of the “flyers/gazelles” firms that are interesting but the firms that are dominated by “life style owners/managers” or “trundlers”. These firms focus on firm durability and sustainability and limit the reach of the firm by market constraints or by personal choice (Marlow, 2006). It might therefore be supposed that these differ in their managing style from entrepreneurs and that this difference actually fosters another way of looking at working conditions, change and development. Antonsson et al. (2002) confirmed that such a division between firms that wish to grow and firms that do not exists in Sweden as well.

Definition of SME

The common structural definition of a small or medium-sized enterprise (SME) is usually based on the number of employees and varies between different actors and countries. The firms studied that provided the empirical base for this thesis varied in number of employees from about 10 to 300, but most of them had fewer than 50 employees.

However, it is important to note that SMEs are not small big businesses; the quality aspect of the size must also be considered. A functional definition is that small firms:

1. “are businesses, in the sense that they involve all or most of the business functions and decisions concerning production, marketing, financing and management; and

2. do not exceed a size, which, considering the nature of the business, permits personalized management in the hands of one or a few executives, as opposed to institutionalized management characteristics of larger enterprises.” (Hollander, 1967)
This definition presumes that there exists a decision latitude among executives that is large enough for the company to be considered as an independent organisation. It thus excludes firms that are small in structural size but are closely managed, controlled in detail or provided with exceptional external resources by mother companies. This functional definition includes the majority of the firms studied, in total about 20 firms participated in the different studies referred to in this thesis and of these there are only two or three firms that might be questionable concerning this definition.

**Management of SME**

In the following section most research referred to includes empirical studies or reviews. If I know that the findings are related to specific industries or businesses of special interest they are mentioned in the text.

The view of labour management in SME has developed from the “myth of harmony” asserted by the absence of collective dispute during the mid-1970s. More recent work recognizes the employment relationship as a complex interplay between the position of the organisation in the wider economy and the components inside the organisation (Marlow, 2005). An important aspect of SMEs in this matter is a high sensibility to external market forces, either as a subcontractor dominated by your large customer or as a niche actor. SME managers may not be able to choose how to manage employees due to the close dependence on market conditions. Furthermore, the proximity between owners and employees forms social relationships that enhance informality and continuous renegotiations around the labour process. The tacitly recognized mutual dependence between employees and manager gives room for employees to manipulate their own labour process (Marlow, 2005). Other findings from a literature review by Cardon and Stevens (2004) are that labour management is characterized by informal, ad hoc, arbitrary and uncertain management. The emphasis in recruiting is on finding people that “fit in” with existing cultural mores and that there is a lack of formal collective channels for employee voice in these firms.

Holliday (1995) concludes concerning production management in three small British manufacturing firms that existing research literature comes from a logical-positivist tradition which produces major problems for small firms. In the search for order, rationality, validity and generalisability such analyses neglect the strong situational contingencies that are apparent in workaday lives and conditions in small firms. There is thus a need for approaches that recognize these conditions.

**SME and change**

Issues concerning organising work, change and development work in SMEs are not extensively researched and results are not homogenous (Cardon & Stevens, 2004; Nilsson, 2003). Small firms are sometimes described as conservative and unwilling to change. On the other hand, small firms are described as being highly context dependent and thus have to be flexible and eager to adopt new ideas from
their context (Nilsson, 2003). Some entrepreneurs are as well using small firms as a template for organising, thereby using the proximity between employees’ and firm performance as a lever to reach competitiveness (Hogsved, 1996; Sakai et al., 1992).

**Organisational change**
The literature on organisational change in SMEs is divided into different aspects of change. There are studies with a learning perspective, with a technical development perspective and as well studies on change processes.

Lee et al. (2000) report a study on change in SMEs with a learning perspective but make very few comments with regard to the characteristics of SMEs. They mention however the ability to maintain face-to-face communications between management and the workforce, that processes need to be put in place to facilitate the sharing of mental models of the firm’s vision, and the lack of formal structure and procedures for development processes such as encouraging ideas from the workforce. They also conclude that the studied firms’ progress was made involving only limited challenge to the power and authority of management and that there was only limited confidence in the ability of their employees to understand and become committed to all aspects of their firms’ strategies for change.

Concerning managerial learning in small Swedish manufacturing firms, Florén (2005) studied six top managers in small firms in their daily work and analyzed the possibilities for learning. He concluded that there are a number of features that characterizes managerial work and that those features in different ways implicate barriers for managerial learning, Table 11.1. However, the study is only concerned with the managers. Their interaction with their personnel or their board is not considered. In spite of this, Florén (2005) points at some interesting characteristics displayed in Table 11.1 concerning the conditions for managerial work in small firms.

Nilsson (2003) studied development, learning and driving forces in four small Swedish manufacturing firms. She draws the conclusion that changes in manufacturing SMEs where management take a more conservative stance towards changes in work organisation are likely to implement new management ideas like Total Quality Management (TQM) or Just In Time (JIT) in a way that restricts employees decision latitude and autonomy. However, firms that pursue a more innovative stance are more likely not to follow standardised management solutions and that changes might end up in solutions that are more beneficial for employees learning and development in work.

Another conclusion by Nilsson (2003) concerning the change processes in four Swedish manufacturing firms is that the initiation of organisational changes is context dependent but the results of change efforts is dependent on the actors in the firm, where actors could be owners/managers or other employees like union representatives.
Table 11.1.  Features of managerial practice in small firms and their implications for managerial learning according to Florén (2005).

<table>
<thead>
<tr>
<th>Features of the work of top managers in small firms</th>
<th>Implications for managerial learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-handed management function</td>
<td>Difficult to free time for reflection &amp; conceptualization</td>
</tr>
<tr>
<td>Unplanned working day</td>
<td>Makes systematic reflection low priority</td>
</tr>
<tr>
<td>Desire to keep control</td>
<td></td>
</tr>
<tr>
<td>Preference for red-hot, specific, and ad hoc activities</td>
<td></td>
</tr>
<tr>
<td>Tendency to focus on doing things that are perceived as crucial for the survival of the firm</td>
<td></td>
</tr>
<tr>
<td>Multi-role behaviour, including both managerial and operational roles</td>
<td>Fosters a superficial learning orientation</td>
</tr>
<tr>
<td>Responsibility for different functions</td>
<td></td>
</tr>
<tr>
<td>High degree of fragmentation and frequent interruptions</td>
<td></td>
</tr>
<tr>
<td>Tendency to react immediately to received information</td>
<td></td>
</tr>
<tr>
<td>Isolated work practice with few peers</td>
<td></td>
</tr>
</tbody>
</table>

However, whether change efforts will take place is dependent on the combination of external forces and internal actors. Furthermore, she argues that an integration of development activities concerning production, work organisation and/or education or training seems to be beneficial to create learning opportunities at work. An additional result is that unplanned emergent development activities also contribute to change and create new learning opportunities for employees. Such emergent activities are often a result of conflicts in perspectives on work and its organising between different actors.

Ghobadian and Gallear (1997) made a comparative study of two large companies and two SMEs (medium-sized) and their difficulties in implementing
They summarized identified advantages and disadvantages for an SME compared to a larger organisation in change processes.

Advantages for an SME are:

- The top manager of an SME has a high degree of visibility in the organisation and thus does not have to arrange to be visible to emphasize his/her visions or beliefs.
- The greater horizontal and vertical visibility makes the influence of improvements more likely to affect commitment and support; improvements are seen and they influence the culture.
- Employees in SMEs generally have a better understanding of the business and their own responsibility, being closer to market and customers.
- Smaller firms have less hierarchical layers, and it is easier and quicker to mobilize all different groups in a change effort.
- It is easier for small firms to foster personal growth, create understanding of individuals’ own roles and encourage improvement ideas.
- Individuals can more readily see their efforts translated into tangible results in SMEs.
- Decision-making processes are shorter, pass through less hierarchical layers and managers, and communication and co-ordination are easier and less bureaucratic.
- An SME is less complex, usually one-sited and provides less resistance to change than large organisations.
- Functional integration is easier to attain.

Disadvantages for an SME are:

- The owner’s or top manager’s personality tends to dominate the culture, which may result in inflexibility and rigidity of outlook.
- A short-term rather than a long-term perspective, and managing day-to-day activities tend to dominate the responsibilities of the managing team.
- Retraining employees, employing and retaining high-caliber staff, and providing career goals are difficult in SMEs.
- The resistance to formalized procedures and processes is likely to be greater in SMEs.
- There is a general “resource paucity” concerning expertise, specialist knowledge, external information, capital, and management time.
- Time and staffing constraints often preclude the administration of reward and recognition programs.
− Lack of time and systems inhibits the use of performance measurement and review procedures.
− SMEs are usually skeptical of outside help, interact generally less with external sources of information, and valuable knowledge is neglected.

It was found that resistance to change was minimal in the SMEs. The establishment of effective communication was an important factor, and the proximity between management and staff was critical to the implementation process, both for the employees to know what is expected and because SMEs are more susceptible to rapid propagation of individual hostile views towards TQM. Unrealistic targets were a problem for the SMEs studied, but the empowerment of the employees was not. The process also sharpened the external focus of the firms studied.

It might also be noted that there is a danger in describing SMEs as a homogenous phenomenon since they show high individual differences as organisations even when there are similar external conditions (Holliday, 1995; Karltun, et al., 1998). Moreover, there is the vulnerability of SMEs, the lack of long-term financial stability and the immediate dependence on owners, managers, employees and dominating customers (Holliday, 1995; Karltun et al., 1998). These characteristics seem to create good opportunities for an SME to form working conditions that are favourable to those in larger enterprises in many aspects. The dependence on individuals in SMEs also suggests that favourable working conditions will more obviously affect the results of a firm.

Technological change
In his study of how four small Swedish firms adopted new CAD-CAM technology, Norén (1987) compared the implementation processes in these firms with previous studies in large companies (Gerwin, 1988; Pettigrew, 1973). Norén found that the political game and the generation of subgroup specific goals Pettigrew detected did not occur in the studied small firms. Furthermore, the distance between top management and production did not exist. He also found that management had either a long-term or a short-term attitude towards technology and that a long-range attitude did not exclude a short-term. The management’s interest and belief in technology reduced the uncertainty regardless of the complexity of the chosen solutions. In the studied firms management had to convince the personnel that the technical solutions were credible, they also had to select (external) developers and create goals and visions that supplied a meaningful context for the developers. During implementation the uncertainty was low and the judgement of the outcome of implementation was good when the system was implemented in small portions (Norén, 1987).

There are also a number of studies more concerned with how technical renewal in woodworking firms is influenced by external actors or organisations. Belotti (1996) studied this in three Swedish woodworking firms and she found that there are four important external actors contributing to the technical renewal of the firms: customers, technology suppliers, consultants and other small firms within the woodworking industry. Her findings further support that demanding custom-
ers do promote technical renewal. Another finding is that “proximity dimensions” like similarities between external actors’ norms, education, function, status and so on make those actors, being firms or consultants, important for a small firm’s technological renewal.

In a follow-up study of 117 small firms in woodworking and printing industry Belotti (1998) found that the contribution of customers and suppliers is dependent on whether firms also have collaborative interaction with other knowledge producers, even such that are research-based. Another result was that a rather large portion relies on institutional and research-based organisations for acquiring support concerning technological changes. This result reflects a real impact of the increasing and pro-active technology transfer directed to Swedish SMEs. Belotti (1998) identified and described four different strategy patterns for technical renewal. This reflects again that small firms cannot be regarded as a general and homogenous category of firms. The study furthermore showed a weak relationship between technical renewal and performance for wood manufacturing firms but not for printing firms.

Verweij (1997) draw the conclusion that there is a lack of methods that can support small firms concerning the development of their production organisation. These methods, according to Verweij (1997) should fulfil the following requirements:

- The tools should be affordable and external support should be minimized as far as possible whilst providing the knowledge required.
- They should be directly applicable to concrete problems and support direct short term action. This implies integrated solutions and focus on specified problems.
- They should use available knowledge and experience as much as possible.

Ylinenpää (2006) found that small firms develop their knowledge differently from large firms but that the conception that they spend fewer resources on knowledge development may be wrong. Instead they do it in another way which is not captured by often used research methods. More successful small firms differ from less successful in terms of how they develop their knowledge. Important differences are more regular personnel meetings with educational elements, mentorship for new employees, recruitment of people with new competences, project work as a means for developing knowledge and participating in networks (Ylinenpää, 2006).

**SME and ergonomics**

The literature specifically concerned with ergonomics and change with a focus on SMEs is divided mainly into two different categories. The first has an educational and learning approach mainly concerned with low-cost improvement and especially in developing countries. The most well-known representative for this approach is Kazutaka Kogi. In Kogi (1997) it is argued that successful ergonomic interventions should build on local practice, focus practicable solutions
and look at multiple needs together. Furthermore, advances are seen in participative action-oriented procedures and in low-cost solutions. An integrated change strategy should emphasize enabling methods that can lead people to immediate action in multiple aspects of work, it should include steps with active participation of local people and there should be flexible use of support tools as well as techniques and training about how and when to use these tools and group work techniques. The setting for the research performed by Kogi is to a large extent small or micro firms (less than 10 employees) and small farms in developing countries. Kogi further describes that a large number of these firms could be reached by educating and training local actors and providing simple tools like checklists, slides and action guides (Kogi, 2006).

The other approach is concerned with western countries and often labelled “occupational health and safety” (OHS). It addresses the ability of small firms to cope with regulations, especially when the regulations develop in a direction towards the use of management systems for working conditions where firms are expected to self-regulate those issues. In a comprehensive study of the difficulties for small firms related to this shift Walters (2001) brought up a number of problems of which are of particular interest here.

- The problems of health and safety are more related to poor risk management than the absolute seriousness of the hazards represented.
- Additional external pressures are required to raise the consciousness of owner/managers to the need of proactive health and safety management in their enterprises.
- Most successful interventions are associated with face to face contact between small business managers and health and safety agents.

The study, however, included all types of small firms and not only manufacturing firms while the results must be viewed in the light of this fact.

Eakin (1992) provided a striking picture of main components in attitudes concerning health and safety issues. She found that for managers of small enterprises, health and safety issues are far down the agenda, while survival of the enterprise and short-term profits dominate. Furthermore, she discovered that the managers often regarded their employees more like equal colleagues than subordinates, and therefore the employees were expected to be able to take responsibility for ergonomic considerations, safety and health themselves. As a consequence of this the managers bought and made safety equipment available but did not urge their employees to use it. A consequence of the conditions Eakin (1992) described is that change efforts for improving health and safety issues are more likely to succeed if they are combined with goals to improve the enterprises’ performance concerning e. g. quality, efficiency or output capacity.

Antonsson et al. (2002) found that there are a lot of problems related to occupational health and safety that are easy to relate to small enterprises. They found that factors like lack of time and knowledge, negligence of occupational health and safety issues and unstructured management are impairing the deve-
lopment of safe workplaces. Their conclusion is that intermediaries are necessary, external actors which can inform, assist and support small enterprises in development.

Axelsson (2002) studied formalisation of working environment activities according to new regulations in five Swedish small firms, one restaurant, two bakeries and two mechanical workshops. She found that leadership in small firms is based on informal structures and that it was difficult to increase formalisation while informal work patterns were deeply institutionalized in the studied firms. Still there were reasons to believe that increased formalisation would be beneficial for the development of better health and safety in the studied small firms. Informal work with health and safety issues tended to be controlled by unanticipated incidents instead of preventive actions and if this should be changed, managers/owners had to be very proactive in listening to their employees. They also have to balance their belief in the advantages of a small firm; the size in itself does not always produce the supposed advantages. Otherwise, the possibility to make use of the informal culture in small firms might get lost. An example of a typical ambiguity with working in a small firm was the familiar cultures which, according to the managers, lead to a high degree of openness even on matters where there were different opinions. However, the employees did not agree in this description as they lacked the formal arena where these matters could be discussed and examined.
The subject of change in organisations is extremely wide and researched extensively. Scholars have used numerous perspectives and approaches, and the area seems to widen rather than focussing (Poole & Van de Ven, 2004). I will here try to give an overview of the theories that I believe affected my thinking during the research. I start with a description of organisations as systems and continue with the contribution of socio-technical thinking. Change is treated from two perspectives, theories of change and theories of changing. The chapter ends with a section on ergonomics and organisational change where the main contributing theories from ergonomics to the field are summarized.

Organisations as systems

An organisation can be described as a consciously coordinated social entity, with a relatively identifiable boundary, that functions on a relatively continuous basis to achieve a common goal or set of goals (Robbins, 1990). A similar definition is given by Scott (1998). He also draws some conclusions of what central efforts must be made to manage an organisation. Its goals must be defined (and redefined); its participants must be induced to contribute services; these contributions must be controlled and coordinated; resources must be garnered from the environment and products or services dispensed; participants must be selected, trained, and replaced; and some sort of working accommodation with the neighbours must be achieved. All these activities take resources from the organisation, thus everything cannot be devoted to fulfil the defined goals (Scott, 1998). Small manufacturing organisations, like those discussed here all fulfil this definition very clearly.

Another aspect of organisation is that it can be looked upon from a view on its functioning, dividing the organisation into processes and structure. The processes describe the activity time series, which transform the input to the output, i.e. what is done in the organisation. The structure describes the distribution of power and authority as well as responsibilities. It is in that sense normative, reducing the possible decision latitude of the different layers and creating control (Westlander, 1999b).

Scott (1998) identified three different definitions of an organisation viewed as rational, natural or open systems. The focus is moving from formalization to-
wards shifting coalitions of participants, from defined, relatively specific goals towards dependence of, exchange with and embeddedness in the environment and from normative coordination towards systems of interdependent activities. Weick (1995) made the comment that this also means a shift from hierarchy towards process and from closed towards open systems. The shift is also chronological, from viewing and analyzing organisations as closed rational systems in the beginning of the 20th century, towards a domination of open systems as analytical framework at the end of the same century.

Organisations seen as open refer to the theory of open systems, originally developed by the biologist Ludwig von Bertalanffy in the 1950’s, and adopted by the theory of socio-technical systems stemming from the work at the Tavistock Institute of Human Relations. A system can be defined as a set of interrelated and interdependent parts arranged in a manner that produces a unified whole. A unique characteristic of a system is the interrelationship between the parts within the system. Two diverse forces characterize every system: differentiation and integration. The differentiation is to identify its subparts with specialized functions, and the integration is to ensure that the system doesn’t break apart but fulfills its purpose. The borders of the system separate it from the environment. The theory of open system recognizes the dynamic interactions of the system with its environment. The open system is believed to depend on the environment for its survival and like all systems it takes inputs, transforms them and produces some output. The systems can be divided into subsystems and added to suprasystems depending on from which perspective the organisational system is viewed. Robbins developed a picture of an open system suitable for industrial research which is shown in Figure 12.1.

Figure 12.1. An industrial organisation as an open system. From Robbins (1990).
An interesting critique or complementing view concerning the openness of systems and the validity of the distinctions between the system and its environment comes again from an analogy to research on how to interpret biological phenomena. Based on the work of the researchers Humberto Maturana and Francisco Varela, the organisational sociologist Morgan (1997) discusses the concept of autopoiesis, the logic of self-producing systems. The argument is based on that living systems are characterised by three principal features: autonomy, circularity and self-reference. The circularity is related to the patterns of interaction. The point then is that these patterns are always self-referential because a system cannot enter into interactions that are not specified in the pattern of relations that define its organisation. This makes the system’s interaction with its “environment” a reflection and part of its own organisation. An understanding of the autopoietic nature of systems requires that we understand how each element combines the maintenance of itself with the maintenance of others. Thus, the concept of autopoiesis does not contradict that systems are open but claims that the openness is defined from inside the system. This is an important point for understanding why organisations, though they are open systems, sometimes have such big problems in delineating their operations with their environment and its changing demands.

Morgan (1997) draw three “creative” conclusions out of this. The first is that organisations act in and enact the environment as an extension of their own identity. Secondly, the problems many organisations encounter when interacting with the environment have a close connection to the identity they try to shape and maintain. Thirdly, explanations concerning development and organisational change must emphasize the factors that create the patterns which include both the organisation and its wide environment.

**Socio-technical systems**

After studying productivity problems in various industries, the socio-technical theory started to develop at the Tavistock Institute in the beginning of the 1950s. It was based on the need to humanise work through the redesign of jobs and later also democracy at work (Mumford, 2003). The theory of socio-technical system is based on four major concepts (Klein, 1994):

1. The technical and the social systems are interdependent. They influence each other, in both directions.
2. There is a choice in the way one organises round any given technology.
3. The work system is an open system.
4. There is a choice in the way in which technology itself is designed.

To optimize a work system there is a need to create a fit between the (optimal) technical system and the (optimal) social system. One of the main points and contributions of socio-technical systems design is that it specified how to adapt the social system (human system) to the technical. Thorsrud and Emery (1970)
summarized the research at that time in six basic psychological demands on high quality work. Those are in short:

1. A demanding content in work that is more than pure endurance and a minimum level of variety
2. Learning opportunities
3. Scope for making decisions
4. Esteem, human understanding and respect
5. A job recognized as important by the outside world
6. The potential for making progress in the future

The field studies in Norway (Thorsrud & Emery, 1970) were the first that explicitly used the combination of action research and socio-technical design as a combined methodology to develop workplaces in industry. However, the problem with the psychological criteria is that they say nothing about working conditions like noise, lighting, heavy lifting or repetitive motions. Nor do they take into account specific local conditions or cultures. This is reflected when talking with workers who always bring up working conditions that make their work more difficult (Klein, 1994).

Albert Cherns provided ten principles of socio-technical design in Cherns (1976) and revised them in Cherns (1987). His formulation of the principles is strongly influenced by open systems theory and they are here only shortly introduced. For a fuller understanding of the principles the reader is referred to the original publications as well as Klein (1994) and Mumford (2003).

Principle 1. *Compatibility*. The process of design must be compatible with its objectives.

Principle 2. *Minimal critical specification*. No more should be specified than is absolutely essential. But this must be specified.

Principle 3. *Variance control*. Variances (any results of a transformation process that is undesired) should be controlled as close to their origin as possible.

Principle 4. *Boundary location*. Organisational boundaries should be drawn to facilitate the sharing of relevant information, knowledge and learning. This implies that main transformation processes should be organised within the same boundary.

Principle 5. *Information flow*. Information must first be directed to the place where it is needed for action.

Principle 6. *Power and authority*. Those who need resources (equipment, materials etc.) should have access and the authority to use them and in return accept responsibility for their prudent use.

12. Change in organisations

Principle 8. **Support congruence.** Systems of social support must be designed to reinforce and align with the desired social behaviour.

Principle 9. **Transitional organisation.** The treatment given to people during changes, regardless of their future in the organisation, must be compatible with the espoused philosophy in the transition.

Principle 10. **Incompletion.** As soon as a design is implemented, its consequences indicate a need for redesign.

Klein (1994) criticised some of the developments under the sign of socio-technical systems (STS). Autonomous work groups have sometimes been used as a panacea but may well not fit the situation. Furthermore, autonomy is important but might not be the prioritised criteria for work design in all cases. With increasing technological development there is also a need to move STS design from the shop floor to the wider organisation. Klein (1994) also pointed out that the methodological approaches sometimes have been used without reflection on the circumstances. Most important, though, is her critics against training sessions where socio-technical analysis are taught as separate technical and social system analyses. This means that the very fundamental idea with socio-technical systems view gets lost.

The principle that the technical and social systems are closely interlinked and that changes in one system always will affect the other is widely accepted today and it is included in most modern theories on organisation, leadership and group processes (Morgan, 1997). However, development approaches are seldom run under the “socio-technical flag”. Instead, concepts like Business Process Re-engineering (BPR), Total Quality Management (TQM) or “Lean Production” have been dominating the scene from 1990 and until now. Of these, BPR is the concept that differs mostly from the socio-technical thinking. BPR has been criticised by many authors and its disregard of human aspects is seen as a key issue for the large number of failures that are associated with the concept (Butera & Schäl, 1997; Davenport, 1995; Mumford, 1994; Munkvold, 2000). The later developments of socio-technical systems theory are particularly associated with information systems development and the shortcomings when introducing new information systems. These developments are also labelled second generation socio-technical systems (STSII) to separate them from previous thinking. One important difference is that focus is shifted from workers at the lowest level to a more heterogenic collection of people ranging from professionals to customers. A second difference is that socio-technical systems are seen as a tool for general process-orientation instead of rethinking inside hierarchical systems (Westlander, 1999a).
On of the best known graphical interpretations of socio-technical systems is the Leavitt “diamond” (Leavitt, 1958) depicting the four interdependent domains he considered to exist in socio-technical systems, Figure 12.2.

This model was further developed and redrawn by Sutton (2000). Sutton claimed that the role of people is insufficiently emphasised. Organisations consist of people that actively perform the tasks and people use the technology for this. It is through people that all the interactions are actualised and all the organisational activities are conducted, Figure 12.3.

Wilson (1999) stated that since the study of ergonomics focuses on the interactions between humans and their environment it is clear that the contribution of ergonomics might be of great value in socio-technical systems development and vice versa.
Organisational change theory

The first typology on change I would like to address is that of first order and second order change. Early authors to distinguish between these concepts were Watzlawick et al. (1974). They described first order change as solving problems by applying a solution that is “more of the same”. They thereby focus on the formation of the problem as important for the possible solutions (as indicated by their title). Second order change is a change that produces a solution that breaks or describes a way out of the entire system, a metachange that violates the fundamental assumptions of the system producing the problem. Watzlawick et al. (1974) furthermore refer to two mathematical theories. The theory of groups was established by the French mathematician Galois. It says in short that in a group of similar objects, the order in which these are combined does not affect the result of the combination and this is supposed to correspond to first-order change. Second-order change is supposed to correspond to the theory of logical types established by Whitehead and Russell, and the theory says that if an object includes all objects of a type it cannot by itself be in that inclusion. So if you change the type, the object will be in another inclusion. This distinction between first and second order change was identified by many researchers and Levy and Merry (1986 p. 6-9), made a list of 18 publications with different definitions that still can be characterised as variants of the theme of first and second order change.

A change theory includes both theories of change and theories of changing (Poole & Van de Ven, 2004). Theories of change focus how organisations change and factors that produce the change. Theories of changing focus instead on how change can be brought about and managed. This distinction is partly also a distinction between planned and unplanned change. Theories of planned change describe how managers or other parties can create change and innovation by means of their actions, whereas unplanned changes are “always there”, driven by evolutionary forces inside and outside organisations. Based on a literature review, Van de Ven and Poole (1995) distinguished four different basic types of change processes and their related theories, Figure 12.4.

The different types of change processes described in Figure 12.4 are not irrelevant for understanding planned change. It is however important to note that when dealing with planned change and single firms it is the teleological change process view that is in the practitioner’s main focus. This views

“development as a cycle of goal formulation, implementation, evaluation, and modification of action or goals based on what was learned or intended by the entity. This sequence emerges through the purposeful enactment or social construction of an envisioned end state among individuals within the entity.” (Poole & Van de Ven, 2004) p. 7.
Figure 12.4 Typology of theories of change and innovation. Arrows on lines represent likely sequences among events, not causation between events. (Van De Ven & Poole, 1995)

Poole & Van de Ven (2004) call the generative mechanisms behind the different process views the motors of change. They also analyzed a number of change theories and concluded that there are single-motor theories but that there also are dual-motor, tri-motor and quad-motor theories. Often these motors operate at different organisational levels and evolutionary and life-cycle motors are to some extent always present. The distinctions between the different motors are helpful in analyses of change processes however not as trivial as the model might give appearance of.

Another categorization of change processes was identified by Weick and Quinn (1999). They argue that the time aspects of change must be considered in a more expressive way suggesting that the “characteristic rate, rhythm, or pattern of work or activity” or what they call the tempo of change. Drawing on a thorough literature study of change theories they draw a distinction between episodic and continuous change. Some details of their comparison are depicted in Table 12.1.

When comparing the typology of Van De Ven and Poole (1995) with the one by Weick and Quinn (1999) large similarities exist with regard to the main features such as the separation into continuous development and episodic processes in search for equilibrium. However, it is apparent that they to some extent do not correspond concerning for example the views of linear or cyclical patterns, perspectives and emphasis.
12. Change in organisations

Table 12.1  Comparison of episodic and continuous change, modified from Weick and Quinn (1999).

<table>
<thead>
<tr>
<th>Metaphor of organisation</th>
<th>Episodic change</th>
<th>Continuous change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organisations are inertial and change is infrequent, discontinuous and intentional.</td>
<td>Organisations are emergent and self-organising, and change is constant, evolving, and cumulative.</td>
</tr>
<tr>
<td>Analytic framework</td>
<td>Change is an occasional interruption or divergence from equilibrium. It tends to be dramatic and it is driven externally. It is seen as a failure of the organisation to adapt its deep structure to a changing environment.</td>
<td>Change is a pattern of endless modifications in work processes and social practice. It is driven by organisational instability and alert reactions to daily contingencies. Numerous small accommodations cumulate and amplify.</td>
</tr>
<tr>
<td>Intervention theory</td>
<td>The necessary change is created by intention. Change is Lewinian: inertial, linear, progressive, goal seeking, motivated by disequilibrium, and requires outsider intervention.</td>
<td>The change is a redirection of what is already under way. Change is Confucian: cyclical, processional, without and end state, equilibrium seeking, eternal.</td>
</tr>
</tbody>
</table>

Theories of changing

At the heart of theories of changing is the concept of action. Without action there will be no change. A theory of action perspective, initially developed by Argyris and Schön (1974), has been further developed in a number of publications and it is summarized in Argyris (2000). Its basic thoughts are that humans and organisations develop through effective actions produced by individuals using their mind/brains. This is achieved by using causal designs for actions that are stored in and are retrievable from the human mind/brain. The designs specify the intentions to be achieved, the actual behaviour needed to achieve them and the values that govern these actions. These designs are also testable or else we can never assess our effectiveness. However, there is a difference between the designs or theories of action that we claim we use, the espoused theories, and the ones we actually follow, the theories-in-use. The difference between these is seen everyday; people do not act as they say. To achieve change is to get at the discrepancy between what we say and what we do by observing and analyzing action, to unfold the theory-in-use which often is disguised by values and norms which need to be articulated. This can be done as single-loop learning or as double-loop
learning. Single-loop learning is instrumental learning that changes strategies of action or assumptions underlying strategies in ways that leave the governing values of a theory-in-use unchanged. Double-loop learning is learning that results in a change in the governing values of theory-in-use, as well as in its strategies and assumptions. The term double-loop refers to the feedback loop required for change of strategies and assumptions (Argyris et al., 1985; Argyris & Schön, 1996).

A definition that uses a more organisational or systems perspective on what actually constitutes change, when can we say that something has changed, was formulated by Porras and Robertson (1992). This is often apparent with regard to the technical system. When the new machine or new technology is there and is used, then there is a change. Concerning the social system the question is not equally simple. However, Porras and Robertson made a distinct definition and assumption stating that:

"Change in the individual organisational member’s behaviour is at the core of organisational change and, therefore, any successful change will persist over the long term only if, in response to changes in organisational characteristics, members alter their on-the-job behaviour in appropriate ways." (Porras & Robertson, 1992) p. 724.

When stating this, Porras and Robertson also conclude that this assumption is rooted in the belief that behaviour is significantly influenced by the setting in which it occurs, and thus, the behaviour is best changed by changing aspects of the work setting. The assumption that behaviour cannot be adequately understood without examining the context in which it occurs is also a base for behaviour setting theory (Wicker, 1991). In behaviour setting theory, originally launched by Barker (1968), the behaviour of people is seen as a fit between the actions of people and the features and arrangement of physical objects in the setting. This fit is called the behaviour-environment synomorphy. Furthermore, the behaviour is guided by a program which is the time-ordered sequence of person-environment interactions that leads to the enactment of essential setting functions. A third characteristic is that behaviour settings have a lack of dependence on particular individuals. In a specific work setting, people with equal qualifications are believed to perform similarly. The theory also acknowledges that these settings are capable of handling threats to their programs by for example repairing technical devices or replacing individuals who no longer participate in the setting (Wicker, 1991). Behaviour setting theory thus provides a link between the technological design of a work setting and the behaviour of the people working in this setting.

Porras and Robertson (1992) identified the key factors in a work setting that shape and guide the behaviour on the job. They defined four categories which are a) organising arrangements, b) social factors, c) technology and d) physical setting. Those categories are then broken down into more concrete and easily identifiable key factors, Figure 12.5. The facts that each of these categories are believed to influence all the others and that two of the four categories each can be
12. Change in organisations

referred to as social and technical system respectively makes the similarity with socio-technical theory even more apparent. The model actually merges Organisation Development (OD) theory with socio-technical systems theory.

This work setting model is also included in a larger systems model describing a whole change effort. According to the model the characteristics of the work setting will influence organisational members’ cognitions (they learn what is expected, feasible, required and rewarded) which in turn influence on-the-job behaviour. Porras and Robertson (1992) argue that the outcome of an organisational change effort is twofold. One purpose is to increase the performance of the organisation and the other is to develop the organisation’s members’ psychological well-being, level of self-actualisation and their capabilities. These two purposes are intertwined; they cannot be reached regardless of each other. Such a view is also argued by other authors (Senge, 1994; Weisbord, 2004). The full framework is depicted in Figure 12.6. The model provides a tangible guidance concerning what to do and what different measures that can be taken to produce essential change.

Figure 12.5. Factors constituting the organisational work setting (Porras & Robertson, 1992)

Moving from the framework to a process view of teleological or episodic change, the basic and still dominating theory (Hendry, 1996; Weick & Quinn, 1999) is the three-stage process suggested by Kurt Lewin (Lewin, 1951). The current state and level of performance of the organisation is supposed to be in equilibrium, held in place by opposing forces. To move to a higher level of performance, the equilibrium and the force field must be altered. Such a change includes three
stages, unfreezing the present level, moving to a new (higher level) and refreezing at the new level. Lewin also noted that if the change is not only to be a “shot in the arm”, the permanency at the new level must be included in the objective. Hendry (1996) remarked that most accounts of organisational change follow the three-stage pattern and employ a mix of cognitive and political strategies. He further concluded that change as a learning process is more conspicuous in the unfreezing stage. Lewin (1951, p. 229) acknowledges that the unfreezing stage is not always easy and he noted that “to break open the shell of complacency and selfrighteousness it is sometimes necessary to bring about deliberately an emotional stir-up”.

Figure 12.6. A change-based organisational framework (Porras & Robertson, 1992)

An example on how Lewin’s three stage change model is reflected in a management change theorist’s model is the “eight steps to transforming your organisation” by Kotter (1995). The steps are:

1. Establishing a sense of urgency
2. Forming a powerful guiding coalition
3. Creating a vision
4. Communicating the vision
5. Empowering others to act on the vision
6. Planning for and creating short-term wins
7. Consolidating improvements and producing still more change
8. Institutionalizing new approaches.

It is not difficult to identify steps 1-5 as unfreezing, 6-7 as moving and 7-8 as refreezing, the content of each step might also be strongly influenced by the size of the companies involved. Kotter also put high emphasis on the vision which is highly consistent with other authors like Porras and Robertson (1992) or Senge (1994).

A different approach to change is proposed by Beer et al. (1990). Their argument is based on the distinction between what they call programmatic change which includes standardised programs with standardised means rolled out in broad campaigns, and task alignment where the energy for change is focused on the work itself.

Table 12.2. Contrasting assumptions about change. (Beer et al., 1990)

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>Programmatic change</th>
<th>Task alignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change logic</td>
<td>Problems in behaviour are a function of individual knowledge, attitudes, and beliefs.</td>
<td>Individual knowledge, attitudes, and beliefs are shaped by recurring patterns of behavioural interactions.</td>
</tr>
<tr>
<td></td>
<td>consequently</td>
<td></td>
</tr>
<tr>
<td>Primary change</td>
<td>The primary target of renewal should be the content of attitudes and ideas; actual behaviour should be secondary.</td>
<td>The primary target for renewal should be the behaviour; attitudes and ideas should be secondary.</td>
</tr>
<tr>
<td>target</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change accomplishment</td>
<td>Behaviour can be isolated and changed individually.</td>
<td>Problems in behaviour come from a circular pattern, but the effects of the organisational system on the individual are greater than those of the individual on the system.</td>
</tr>
<tr>
<td></td>
<td>consequently</td>
<td></td>
</tr>
<tr>
<td>Level of change</td>
<td>The target for renewal should be at the individual level.</td>
<td>The target for renewal should be at the level of roles, responsibilities, and relationships.</td>
</tr>
<tr>
<td>target</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Beer et al. claimed that successful change is best reached in a process of task alignment. A basic reason for this is their argument that peoples attitudes and beliefs are shaped by the way they behave, not the opposite. The focus in a change process thus has to be renewing roles, responsibilities and relationships within a unit in a way that will enhance the coordination required to accomplish the tasks critical to the success of the business and this will in turn change the behaviour of people.

Task alignment occurs in units small enough for a group of individuals to have responsibility for a common goal, Table 12.2. Beer et al. (1990) then propose a six step procedure similar to Kotter above, with the big exception that it should be based on a joint diagnosis of business problems as the first step.

This change strategy could be compared with a Swedish study of 69 Swedish organisations and the effectiveness of their change strategies, with a learning strategy tested against a programmatic strategy (Norrgren et al., 1996). It was found that the learning strategy correlated significantly with the two effectiveness measures used (0.57 and 0.59, p<.001) while the programmatic strategy did not. The authors characterised learning and programmatic change strategies according to Table 12.3.

Table 12.3. Learning and programmatic change strategies according to Norrgren et al. (1996)

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Learning strategy</th>
<th>Programmatic strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logic</td>
<td>Vision driven</td>
<td>Imitation driven</td>
</tr>
<tr>
<td></td>
<td>Strategic business dialogue</td>
<td>Imported methodology</td>
</tr>
<tr>
<td></td>
<td>Broad problem definition</td>
<td>Strive for equilibrium</td>
</tr>
<tr>
<td>Implementation</td>
<td>Top-down – bottom-up</td>
<td>Top-down + formal participation</td>
</tr>
<tr>
<td></td>
<td>Empowerment</td>
<td>Expert project</td>
</tr>
<tr>
<td></td>
<td>Many engaged</td>
<td>Heavy planned</td>
</tr>
<tr>
<td></td>
<td>Successive broadening</td>
<td>Delimited</td>
</tr>
<tr>
<td>Content</td>
<td>Focus many content aspects in parallel</td>
<td>Concentrate on few or single content aspects at a time</td>
</tr>
<tr>
<td></td>
<td>Use many change tools simultaneously</td>
<td>Use few change tools simultaneously</td>
</tr>
</tbody>
</table>

The study confirmed the importance of management support and emphasizes change process control. The latter can be done systematically at the operative level through:

- Congruence between goals and methods;
- Skilled use of methods;
− Consequence, consistency and sustainability;
− Working feedback routines; and
− Interaction between “change masters” and “system upholders“.

Furthermore, a good insight in terms of change process control requires:
− Awareness of change as resource demanding;
− Understanding that the effects of change cannot be reached immediately; and
− An ambition to gain concordance between different power bases.

Management support requires middle management to actively engage for change and that they reasonably well agree on the content and form of the change process.

The results of these studies (Beer et al., 1990; Norrgren et al., 1996) are further supported by a study of 341 Swedish workplaces (Håkansson, 1995). She found that the workplaces in which the employees were engaged in many fora and had pluralistic problem foci reached a higher extent of affecting effect variables than other workplaces. Håkansson (1995) further found that results concerning different aspects of the change effort were explained by different factors and thus that the change strategy might need to be adapted to the content of the goals strived for. It can also be noted that the explaining variables behind improvement of workplaces and physical ergonomics were found to be partly others than those explaining improvements of organisation performance. Similarly, Norrgren et al. (1996) asserted that improvement of physical working condition achieved the lowest score (47%) of 10 variables, the highest being improved overall understanding (84%). The question of improved physical working conditions will be further examined in the next section.

Before concluding this section, a note on a different perspective on change and changing that emerge from engineering management and the work of Imai (1986; Imai, 1997) is worthwhile. Imai differentiated between kaizen (continuous improvement) and innovation and the features of each concept are listed in Table 12.4.

The resulting effects of these two different ways of changing are also described graphically in Figure 12.7.
Figure 12.7. Innovation plus kaizen, adopted from Imai (1986).

It may be noted that the vertical performance axis is not depicted but when Imai wrote about performance it boils down to quality, cost and scheduling.

Table 12.4. Features of kaizen and innovation (Imai, 1986)

<table>
<thead>
<tr>
<th></th>
<th>Kaizen</th>
<th>Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect</td>
<td>Long-term and long-lasting but undramatic</td>
<td>Short-term but dramatic</td>
</tr>
<tr>
<td>Pace</td>
<td>Small steps</td>
<td>Big steps</td>
</tr>
<tr>
<td>Timeframe</td>
<td>Continuous and incremental</td>
<td>Intermittent and non-incremental</td>
</tr>
<tr>
<td>Change</td>
<td>Gradual and constant</td>
<td>Abrupt and volatile</td>
</tr>
<tr>
<td>Involvement</td>
<td>Everybody</td>
<td>Select few “champions”</td>
</tr>
<tr>
<td>Approach</td>
<td>Collectivism, group efforts, systems approach</td>
<td>Rugged individualism, individual ideas and efforts</td>
</tr>
<tr>
<td>Mode</td>
<td>Maintenance and improvement</td>
<td>Scrap and rebuild</td>
</tr>
<tr>
<td>Spark</td>
<td>Conventional know-how and state of the art</td>
<td>Technological break-throughs, new inventions, new theories</td>
</tr>
<tr>
<td>Practical require-</td>
<td>Requires little investment but great effort to maintain it</td>
<td>Requires large investment but little effort to maintain it</td>
</tr>
<tr>
<td>Effort orientation</td>
<td>People</td>
<td>Technology</td>
</tr>
<tr>
<td>Evaluation criteria</td>
<td>Process and efforts for better results</td>
<td>Results for profits</td>
</tr>
<tr>
<td>Advantage</td>
<td>Works well in slow-growth economy</td>
<td>Better suited to fast-growth economy</td>
</tr>
</tbody>
</table>
Ergonomics and organisational change

An ergonomics perspective on organisational change is included in the title of the thesis and the following section is supposed to clarify to a large extent what is meant by that. From the theories on change and changing there are possibilities to distinguish that human capabilities and human behaviour is at the heart of both organisational performance and organisational change. The socio-technical theory above explicitly argues that holistic aspects of humans at work need to be considered in change efforts. This can also be found in the model of Porras and Robertson, Figure 12.5 and Figure 12.6.

Moreover, Beer et al. (1990) argued that task alignment is a fruitful concept for creating necessary change. This is close to what can be considered as an ergonomics perspective, putting the strategically important tasks in focus and how they should be accomplished by humans organising their work. The learning strategy recommended by Norrgren et al. (1996) can also be considered to put the human in focus. It is learning on the conditions for the job and the subsequent actions of this that lead to desired improvements. However, none of these theories do apply a holistic view of the human considering all aspects of human abilities and human well-being is not at heart like in ergonomics.

The need for cross-disciplinary knowledge on human performance at work was the reason for creating the Ergonomics Research Society and the naming of the area as ergonomics in the United Kingdom in 1949. This was achieved on the initiative of the English psychologist Murrell. In the US ergonomics was developed under the name of “human factors” and typical main interests were phenomena like human errors and attention (Ruth & Odenrick, 1994). The origin for ergonomics was thus in psychological problems related to work. In the Nordic countries a lot of focus was put on physical work ability which possibly founded the strong connection between the word “ergonomics” and work physiology that currently exists in Sweden and the Nordic countries. This is however not an internationally used limitation and it is neither widely accepted among Swedish researchers nor in official definitions. From the start of the discipline until today, the discipline has expanded its focus from man-machine interaction and environmental issues to a more emphasised systems perspective. The connection to human health was soon incorporated since the relation between poorly designed work and human health was obvious and known for centuries. With this and socio-technical theory came also the democratic influence into ergonomics, although this is more apparent in the European tradition.

The old definition of ergonomics by the International Ergonomics Association (IEA) and reprinted in Ruth and Odenrick (1994) is:

“Ergonomics integrates knowledge derived from the human sciences to match jobs, systems, products and environments to the physical and mental abilities and limitations of people.”

In august 2000 a new official definition of ergonomics was offered by the IEA (IEA, 2000).
“Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.

Ergonomists contribute to the design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people.”

Chapanis stated that the main purpose with ergonomics is design (Chapanis, 1995). The object of design may however vary. And the definition above is followed by separate definitions for different subdisciplines of ergonomics. For organisational ergonomics the IEA definition is:

“Organisational ergonomics is concerned with the optimization of sociotechnical systems, including their organisational structures, policies, and processes.”

It may be noted that there has been a move towards emphasizing the interactions and this is of high interest concerning the scientific understanding while design is an additional contribution by ergonomists.

Wilson (2000) echoed the same point when stating that the role of ergonomists is to

“fundamentally understand purposive interactions between people and artefacts and especially to consider the capabilities, needs, desires and limitations of people in such interactions.”

The contribution to design then is to maximize the capabilities, minimize limitations and try to satisfy the needs and desires of the human race. Within ergonomics a number of different theoretical developments that affected my work can be distinguished.

**Macroergonomics**

Macroergonomics is a systems approach that considers the entire work system. According to the main founder of the concept of macroergonomics it differs from the narrower field of ergonomics by extending the design of systems to include industrial and organisational psychology approaches in combination with ergonomics approaches (Hendrick, 2002b). Macroergonomics is supposed to be concerned with analysis, design, and evaluation of work systems in its broader sense. It builds directly on the socio-technical view of work systems.

Macroergonomics is further described as a top-down socio-technical design approach. The carry-through of the overall work system design is performed by including the design of the human-job, human-machine, and human-software interfaces (Hendrick, 2002b). Although participation is supposed to be integrated in the process, the macroergonomics design process is described mainly as a technical design process with a very large portion of macroergonomics expert
analyses. My impression is that in the macroergonomics approach there is stronger emphasis on how to analyze the technical aspects of a work system, both in terms of the ergonomics aspects of single workplaces and concerning the more general characteristics of a technical system. Moreover, it deals with the problem how to achieve the joint optimization, something a social-technical analysis previously has been criticized for not doing (Hackman & Oldham, 1980; Hendrick, 2002a, 2002b; Nagamachi, 2002; Robertson et al., 2002).

**Participatory ergonomics**

Within ergonomics, the concept of participation has received a strong position. However, basic ideas on participation and participatory ergonomics come from different parts of the world. When studying work and changing behaviour participation is an indispensable idea in action research while the reality studied needs both specialized action and integrative concern (French & Bell Jr, 1999). Wilson (1995) defined participation from an ergonomics perspective as:

> the involvement of people in planning and controlling a significant amount of their own work activities, with sufficient knowledge and power to influence both processes and outcomes to achieve desirable goals.

Eklund (2000) proposed that participation might be regarded in the dimensions of control, communication, activeness and human consideration, each of them seen as a scale describing the level or degree of that dimension. Eklund (2000) further concluded that leader control and employee participation should not be seen as two alternatives but rather as two coexisting organising strategies, which might be mutually dependent on each other.

Another way to classify participation is to look at its operative dimensions. Haines and Wilson (1998) provided an identification of dimensions across which ergonomics initiatives might vary as shown in Figure 12.8.

Here are some clarifications concerning the dimensions given. Extent/level refer to where a participative initiative is applied. Purpose describes whether participation is used for implementation, design or if it is the method of work organisation. Continuous participation is used in everyday work while discrete is tied to single efforts, e.g. change projects. Full direct involvement means that everyone is participating while partial direct involvement means that those affected are represented by a sub-group (because of practical reasons). Representative means that interests or user knowledge is provided by single representatives for employees or users. Formal participation is provided in meetings, teams and committees while informal refers to including it in everyday work. Compulsory participation is found in workplaces where it is part of the management strategy. In decision-making, managers can make the decisions after consulting the workers; decisions can be made in consensus or workers decide themselves. Coupling refers to that the participants affect their situation either directly or remotely with
the latter meaning that the views of participants are filtered through questionnaires, statistics etc.

<table>
<thead>
<tr>
<th>Extent / level</th>
<th>Organization</th>
<th>Worksystem</th>
<th>Workplace</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>Work organization</td>
<td>Design</td>
<td>Implementation</td>
<td></td>
</tr>
<tr>
<td>Continuity</td>
<td>Continuous</td>
<td></td>
<td>Discrete</td>
<td></td>
</tr>
<tr>
<td>Involvement</td>
<td>Direct (full/partial)</td>
<td></td>
<td>Representative</td>
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<tr>
<td>Formality</td>
<td>Formal</td>
<td></td>
<td>Informal</td>
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<tr>
<td>Requirement</td>
<td>Voluntary</td>
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<td>Compulsory</td>
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<tr>
<td>Decision-making</td>
<td>Workers decide</td>
<td>Consensus</td>
<td>Consultation</td>
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<td>Coupling</td>
<td>Direct</td>
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<td>Remote</td>
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Figure 12.8. Dimensions of participatory ergonomics (Haines and Wilson, 1998).

Noro and Imada (1991) argued that participatory ergonomics is specially suited for solving problems in small steps, thus combining these small steps into changes of larger scale. They also maintain that a main task for the ergonomics expert is to develop methods that are suitable for participation, i.e. that these ergonomic methods must be applicable by people not having a thorough knowledge of ergonomics.

“*The ergonomist should recognize that the ergonomic methods do not produce any profits if they are unused because they are too difficult*”

(Noro & Imada 1991: 12).

The opinion that participation in change efforts is more suitable for continuous improvement efforts and incremental change than for change leaps and design of systems was backed by Heller et al. (1998). There are however other examples of such efforts. Daniellou and Garrigou (1992) developed an ergonomics method to run a production design process by relying on the knowledge of participants working close to the existing manufacturing process to achieve realistic knowledge of future production operations.

Kuorinka (1997) asserted that the essence of participatory ergonomics is learning, both at a professional (dealing with technical subject matters) and an interpersonal level. This puts some dictating demands on the participatory ergonomics methods, which should be able to deal with practical matters, to proceed from practical to abstract and conceptual issues and at the same time be able to handle differences in initial expertise of problem-solving and project work.

Haines and Wilson (1998) also discussed the question of methods or tools for participatory ergonomics. They hold the view that the structure of the participatory initiative would decide the role of the experts. Experts may support or guide the participatory process; they may be involved as members of multifu-
tional groups or they may undertake much of the analysis themselves using participation to validate and implement ideas. Training in ergonomics techniques and simple tools and methods, thereby enabling participants to analyze their own work from a reasonable “professional” perspective is used by many authors. For example Haines and Wilson (1998) listed 26 different ergonomic tools. They highlight the participants’ ability to call for experts when needed as well as the experts’ ability to leave when participative groups do not need them. Haims and Carayon (1998) prefer a participant-guided methodology addressing both content and process, evolving from being expert designed for internal control to being self-guided through learning, feedback, control and action over time.

**Activity analysis**

Activity analysis put the human work activity in focus instead of the human. In this it adheres to the view that it is the interaction that is of high interest. Some fundamental aspects of activity-oriented approaches were summarized by Daniel-lou and Rabardel (2005). These aspects are here presented in a short version to give an overview of the perspective.

1. Activity is finalized in that it is object-oriented towards one or more goals.
2. The relation between the subject and the object is mediated by technical devices, psychological schemes and organisation. The mediators are socially and culturally constructed as well as historically situated.
3. Activity is always unique.
4. Activity bears traces of its past.
5. Activity is not only a relationship between a subject and an object but also with other subjects as well as with the subject itself.
6. The analyst’s approach to activity is intrinsic: he/she tries to understand from “within”. Analysis of activity can thus not be based purely on the observation of the behaviour but is most often a joint production with the subject.
7. Activity is integrational in that it construed at the crossroads of the subject’s goals and other determinants, which may be directly connected to the work-place but not necessarily.

Understanding activity generates knowledge about:

− the physiological and psychological mechanisms at work;
− how the operators are solicited and the cost that may ensue;
− the more or less tacit competences activated;
− forms of interaction in collectives;
how the activities performed correspond the descriptions provided by management, designers and organisers.

In the French tradition of ergonomics the activity of the single operator is more emphasized, it is the specific level of work that is in focus, describing and comprehending what the operator is doing in a given situation (Daniellou, 2005; de Keyser, 1991). Emphasis is put on analyzing the work performed by the operators in real work situations in order to learn about their knowledge and competence, how information is collected and treated as well as how decisions are made. The task is the prescribed work or objective which always differ from the actual activity performed (Daniellou, 1998).

Two main principles guide activity analysis. The first is the principle of diversity which concerns the human being in the activity and it states that all people are different. The second principle is that of variability which concerns the task performance and it states that there are always deviations from the anticipated outcome.

In activity analysis, there is a focus on the operators’ performance and strategies in relation to the human cost for this performance and use of strategies. Activity in a work situation may in this approach be defined as the way the worker will, consciously and unconsciously, use his or her body, mental capacity, and personality to carry out a work task, Figure 12.9 (Daniellou, 1998).

![Figure 12.9. General model of work activity, modified from (Daniellou, 1998; Daniellou & Rabardel, 2005)](image)

The concept of activity has been developed and the word conduct emerged and is used alternatively since 1977 to further emphasize the intentionality and subjec-
ivity manifested in the way a worker, being blue-collar or white-collar, carries out a work task (Daniellou, 2005).

In the model the worker, characterised by diversity and variability, is engaged to perform the prescribed task. This prescribed task is defined by the workplace and characterised by variability. When the individual worker shall perform the prescribed task it will transfer to an actual task which is determined by the difficulties for the individual worker to cope with the prescribed task under the conditions set by the situated variability. The resulting work activity yields production with specific quality and health consequences. The experiences of the results will then modify the worker and the workplace.

De Keyser (1991) argues against standardised methods for capturing the work environment. This will lead to two important weaknesses or dangers.

1. They will contribute to the detachment of the environment from the analysis of the behaviours and their effects which will drastically reduce the richness of the diagnostic.
2. The consistency between different standardised methods and subjective factors of the work environment is not good enough, for the same work station the methodological differences can be great.

Another aspect that is stressed within this approach is the different logics that exist in an organisation. Since different actors naturally focus on different matters, they will have different representations on activities, problems etc.

The contribution ergonomics can make is that it will change work by altering the representations of work, which is how people think about work, their point of view and their image of work. An important contribution to the ergonomics field by activity analysis is that it very clearly relates both production yield and health yield to the difficulties of the work activity, which in turn is determined by the specific worker in the specific situation. Daniellou (1998) builds his theory on the assumption that there is always a person trying to “manage the situation” between the work activity and the expected results, regardless of whether this leads to negative health consequences. This will create problems, especially when the risk is unknown.

As can be understood from the above, both these theories have a strong development character and they are also described and considered being methods or strategies for change.
13 Research approach and epistemological considerations

There are some conditions under which the research was done that are of special interest to discuss. The first condition is the implications for the research approach included in the projects and thus the research grants. The second is the access to the firms in which the case studies were performed and different aspects of this access. The third is the epistemological difficulties I encountered during the research.

The research approach

When Project A (Competitive woodworking industry – work design in the future) was launched it included a mission to work actively with firms in order to improve the situation in these firms and provide examples for the industrial sector as a whole. This was also a general fundamental part of the work at Trätek, working close to the industry with the industrial problems at hand trying to find approaches that helped the industry to improve and develop. In this situation the choice of case studies and action research as a part of the research approach became quite obvious. The research questions as such, encompassing change processes in small firms, also put forward to use action research as methodology for achieving appropriate knowledge concerning change processes (Gummesson, 2000). The thought ascribed to Kurt Lewin also support this approach:

“You cannot understand a system until you try to change it.”
(Schein, 1996, p. 34)

However, action research was not the only approach used. The case studies performed studying ISO 9000 implementation processes used a more detached approach where these processes were studied in an embedded case study design evaluated through a retrospective data collection and analysis. Nevertheless, the choice of case studies were never questioned, the knowledge aimed for was not considered to be available with other approaches (Fishman, 1999; Gummesson, 2000; Huber & Van de Ven, 1995; Yin, 2003).

The choice of firms for the case studies performed was made according to two main criteria. For the action research cases the firms were chosen according to their own willingness to let me and my colleagues in and their ability to pre-
sent a situation in the company that demanded change in the direction that aligned with the aims in the research grants. Their commitment to stay in the project was granted by the quality of the work and a written agreement between Trätek and the participating firms. The agreement stated that the consultancy provided by Trätek was free as long as the firms stayed in the project. If they chose to terminate the agreement the firm was due to pay the consultancy already provided at Trätek’s regular fees. For the firms involved this was a considerable cost. The ISO 9000 firms were chosen among the firms that had received consultancy from Trätek in their implementation projects. Their motivation to participate was based on the feedback they received in the report comparing them with similar firms in the same industry, which became a benchmark of their ISO 9000 systems. I can see at least three implications of these agreements. It deterred the firms from using the research project as a short-term problem solving activity. Moreover, it gave us legitimacy and better access to the entire organisations and it gave us possibilities to come back and perform evaluation.

**Access and preunderstanding of the small firms**

Gummesson (2000) reviewed the possibility for researchers to get access to the decisions and development processes in firms where change is studied as the number one problem in case studies. With access is meant to be able to get as non-distorted real-world data and information concerning the studied change processes as possible. The ethnographer Holliday (1995) described her experiences of getting access to small firms by declaring that it was not difficult but the cost was to work in the firms for free. Her research was however not intended to promote development and change but to better understand how small manufacturing firms work.

In the action research cases I was involved in, the researchers also worked for free but under the conditions described above. Another means of getting access was that not only decision makers were included in our contacts with the firms but all personnel or their representatives, which meant that there was high probability that any decision affecting parts of the firm would come to our knowledge. My impression is that the access was better in the smaller firms and my explanation is that the managing director and the leading employees always were involved in the projects in these firms.

Our preunderstanding of the businesses involved was an important advantage. We came from Trätek and although some firms did not regard Trätek as essential for their further development (Belotti, 1996), there was a respect for the business and knowledge provided among the case study firms. Moreover, it meant that I and my colleagues had an institutional knowledge of the secondary woodworking industry. We knew many people in various positions in the industry; we had prior experience from working in the industry in different positions; we had thus technical, practical and business-related knowledge and experiences we could bring to each firm and we were able to understand the specific institutional difficulties apparent in the secondary woodworking industry. Naturally, it
also meant that we had ideas on how things should be organised, what measures should be taken under certain conditions that were based on our experience and discussions with people in the firms but also from academic knowledge or other circumstances where people from the firms did not participate. Furthermore it meant that we had certain ideas on the general problems of the industry like low educational level and low value added which were based on investigations made by employers federation or trade unions. The difference in educational level between researchers and employees in firms, the difference in ideals concerning manufacturing practice per se and in relation to ergonomics are examples that influenced views on such things as the necessity of rigor in administration or in use of methods for problem solving, wood as “living” material, the view of production as industrial manufacturing or handicraft and acceptable levels of noise and dust.

One issue that I know to some extent limited the access was that three of the five firms where we did our action research were family businesses. We did not have access to the discussions in the families and their different opinions of what was going on in their firms. In her thesis on the understanding of the strategic development of family businesses, Hall (2003) concluded that the development of the firm cannot be separated from the interactions in the owner family. However, in our cases the goals for each firm were formulated by the firm’s managing director or his deputy and this meant that these hardly could be questioned to any significant extent. The values we brought with an emphasis on a participatory development process stressing the importance of good working conditions, machine safety and transparent information on the development of the firm were not equally obvious for all involved and could be questioned. My impression is though that this did not affect my results to any significant extent.

**Action research and action science in small firms**

Holliday (1995) wrote on her fear for entering a world she did not know when she begun her studies of small firms. I did not feel anxious on those grounds, however, I felt a deep respect for those small firms which were successful in their markets and they were competitive although with problems or development ambitions they wanted to explore through my assistance and that of my colleagues. In entering these firms I could see their strengths in knowing and exploring their specific contextual conditions in the way they handled their daily work. On the other side I could also see their vulnerability in being small, highly dependent on few single individuals and their ability to develop all aspects of a manufacturing firm, in some cases also isolated by their hard work. In this situation the need for being careful on how much to demand from the firms in the research was apparent. Among the researchers involved we discussed questions like: How do we make approaches that do not threaten the existence of the firms? What changes are feasible without decreasing instead of increasing the strengths of the firm? It could be argued that this was to exaggerate the value of our intervention but there were examples that clearly pointed in this direction. It is also easy to be mislead
by the firm size. Having a meeting in a project group of five meant that up to 30% of the entire personnel were engaged in the change project. It must thus be understood that one manager always had meetings in his office where he was sitting at his desk performing other work at the same time as he was participating in the meeting. Frequent interruptions, difficulties in producing minutes from meetings, difficulties to have meetings with more than one person, often the managing director, and all kinds of shortcomings concerning project work were always subordinated to daily producing. This hampered of course the change projects but ensured the survival of the firms.

These conditions also serve as a background for the knowledge development in small firms. Action research in small firms is very much the theoretical meets the practical. Gummesson (2000) wrote on the problem with access that managers might make up a situation that fitted reasonably well with theory and tell researchers about this instead of telling how it really was. The reason for doing so was to maintain their own credibility versus researchers. I did not find that in the small firms I studied. What I found was a world of practice in which everything was judged according to its feasibility to increase the likelihood of solving today’s problems with the resources available, without neglecting and sometimes with consciously improving strategies for further development. The research demand is then of course how to develop knowledge that both helps the companies in their situation and advances the more general knowledge on how to create change and healthy and rewarding workplaces.

Lewin’s idea of an action research process as a means to assist or help the practitioner in solving problems of daily life put role demands on the researcher. He or she is supposed to provide advice concerning alternative courses of actions, evaluate, design (experimental) investigations and conduct independent research in a long-range knowledge perspective (Westlander, 2006). Furthermore, Lewin proposed a stepwise rational “social management” procedure of planning, action and fact-finding. It may be noted that Lewin did not repudiate the so-called basic research in social sciences but saw the results of this as important inputs concerning underlying laws of social life.

The ideas of the role of action research spread in different directions (Westlander, 2006). A more pragmatic, less theory-generating direction was that of organisation development (OD). Another was the direction in Scandinavia where the practitioner was not “the organisation” as in Anglo-Saxon action research literature but often became employers and employees with a strong influence of unions as was the case in my research where representatives for both employers and unions were supervising the projects.

A further development of action research as Lewin used it was proposed by Argyris et al (1985). They put up three key features that define action science. It encompasses:

1. Empirically disconfirmable propositions that are organised into a theory;

2. Knowledge that human beings can implement in an action context; and
3. Alternatives to the status quo that both illuminate what exists and in- 
form fundamental change in light of values freely chosen by social ac-
tors.

These three points seem to be a mixture of traditional mainstream of science and 
what sometimes is called postmodern views (Fishman, 1999). The first point ad-
heres to the mainstream view of science, however at the same time it counter-
views directions that argue that meanings cannot be reduced to regularities. The 
second point means knowledge as “intended for use” and includes a reflection on 
the nature of practical knowledge. The third point is normative and thus also re-
lated to practice since practice always has a normative dimension. In this stance it 
distinguishes itself from science that postulates that the values of the practitioner 
must be distinguished from those of science.

Gummesson (2000) also propose the use of action science as a means to 
develop knowledge that is intended for use in management. His standpoint is that 
this is the best way to get access to the real processes of decision and action in 
firms and thus vital for the understanding of change processes. Perhaps the main 
influential source behind action science; the process of action research as formu-
lated by Kurt Lewin has a societal dimension. However, Gummesson argues that 
his standpoint is managements’ and the successful operations of a business. Ac-
tion research and action science as presented here are concepts with a large em-
phasis on learning, they are reeducative and change is viewed as a learning proc-
ress (Argyris et al., 1985).

A related theory on pragmatic psychology is presented by Fishman (1999). 
He formulates a centrist position for pragmatism where he acknowledges the 
findings of traditional positivistic research as well as the necessity for under-
standing phenomena in their holistic context. Fishman (1999) referring to (Peter-
son, 1991) proposed a model in which the professional and the client together 
form the activity for disciplined inquiry. This inquiry is supposed to solve the 
specific problems of the specific client and the disciplined rigor of the process is 
supposed to generate knowledge that is context dependent and at the same time 
useable for generalisations over many cases.

The roots to these views emanates from the work within social psychology 
and action research of Kurt Lewin but also from numerous researchers within 
social sciences and philosophers during the 20th century with an interest in the 
problems of the distance between science and practice in social contexts. For 
more detailed arguments, see Argyris et al. (1985); Fishman (1999) and Gumm-
nesson (2000).

Another book that needs to be mentioned concerning my own development 
is “The reflective practitioner” (Schön, 1983). It made me conscious about the 
importance to think more freely on my role as professional practitioner. More-
over, the need for combining my substantive knowledge in engineering and er-
gonomics with the process of inquiry to increase my own and others understand-
ing of different situations became clearer.
During the research process I have come to appreciate the writings mentioned here more and more finding them to be most relevant to my research and my stance in the case studies performed. Not fully conscious at the beginning of the process but more and more as the research proceeded. These writings also propose the use of several methods for data collection and analysis, combining quantitative and qualitative approaches. This is something I have found important in change processes; often figures are needed to explain the importance or power of a situation or problem and the descriptions are needed to give meaning to the figures and point out directions on where to look for solutions. The significance of a holistic approach becomes obvious in small firms where the proximity between the activities of a single worker, regardless of what he/she does, and the business strategies are apparent to most people. Even if not clearly articulated, a large portion of the workers in the studied firms knew by heart the competitive advantages of their firms and it is my impression that this also affected the way they performed their work.

A comment on the methods used

In all case studies performed four main methods were used for data collection and inquiry. These methods were interviews, questionnaires, document studies and observation and each of these are commented on below.

I regard interviews as the main method used for data collection. The main reason for this is the knowledge aimed at. Another reason is related to some extent to the context in which the research was performed. As can be understood from the description of the character of small firms the context limits the methods available (Kvale, 1994).

All small firms are unique and many of the firms are highly dependent on their context and the surrounding society. Furthermore, the influence of the personalities of the individuals employed is large on the studied phenomena. The number of employees is low and thus diminishes the possibilities of using statistical methods for evaluating working conditions, especially things such as accidents and narrow escapes which happen very seldom in a small firm but still too often per employee.

Interviews

All interviews performed were semi-structured following a predefined interview guide with subjects chosen for the purpose of the research. As performed they can be characterised as ideographic interviews (Westlander, 2000) containing both a guiding procedure following a pattern with introductory reasonably open questions, a core of more focused questions and ending up with totally open questions and the possibility for the interviewee to pose questions to the interviewer. In general these interviews were performed by one researcher interviewing one employee at a place chosen by the interviewee, usually his or her workplace or in the canteen. White-collar workers were interviewed at their offices. Anonymity was always guaranteed except for top managers at each site. During
interviews with managers there were sometimes more than one researcher since it was regarded important that as many researchers as possible should have a direct impression of how the manager expressed aspects like mission, goals and values. The documentation of the interviews was made by notes taken freely during and after the interviews. No interviews were recorded and transcribed for several reasons. There were expectations that recording the interviews would reduce the openmess and willingness to answer the questions frankly since the time available for each interview was limited and thus the time for creating an open and relaxed atmosphere was short. The asymmetry between the researcher and the interviewee could sometimes be characterised as large concerning the familiarity of talking about the experience of work with an academic. Furthermore, we had no intention to explore the deeper meanings of work for the interviewee but instead explored the more direct opinions on experience of work, on the development of the workplace and on the working conditions. Moreover, the amount of interviews made it expensive and time consuming both concerning transcription and interpretation to do recorded interviews (Kvale, 1966).

The analysis of the interviews was made in a stepwise reduction process where data were stepwise clustered to the questions asked and the phenomena inquired. Following-up questions were asked during the interviews on subjects not understood or for clarification. A difference between the analysis for the research papers and the reports to the companies was that in the company reports all opinions were always shown. These reports adhered largely to the concept of grounded theory in trying to generate a substantive local theory with discussable propositions as free from delimiting interpretations as possible (Glaser & Strauss, 1967). In the research reports single opinions that were considered irrelevant and data that were not in line with the focus of the research paper were omitted. In these decisions the researchers’ preunderstanding obtained from theory and previous experience played an important role.

Questionnaire
Early in the research process a questionnaire was developed by me and colleagues at Trätek and at Linköping University. It consisted of 29 questions with a five point bipolar scale and three open questions. The topics in the questionnaire covered briefly the psychological demands on work formulated by Thorsrud and Emery (1970), different aspects of the relations between management and workforce, opinions and experiences of organisational changes and the general knowledge of the business. The open questions covered the most important things to improve, what I am most satisfied with, as well as miscellaneous. All questionnaires were handed over by Trätek or by the foremen together with prepaid return envelopes and total anonymity was guaranteed. No personal follow-up concerning answered and sent in questionnaires was performed. The analyses were made at Trätek and only summarized results were reported to the companies. To reduce the possibility of misunderstanding the questions the questionnaire was interview validated in May 1994 by a psychologist at Linköpings University. The
validation was made at the door manufacturer (Paper 4) and after this validation five questions were reformulated to better correspond to the language of the respondents.

The results of the questionnaires were analysed with descriptive statistics when fed back to the companies. Concerning the research papers, these include a description of how the questionnaire was used in each case. A version of the questionnaire was published in my licentiate thesis (Karltun, 1996).

**Observation**

Observation as a method for understanding what happened was always present in the research, not the least because of my own curiosity to constantly try to know more about the companies and people I have been studying. In most cases there were no structured observations done although the particular processes of study and any signs telling more about it were of course noted. However, at certain times when there were reasons to see whether decided actions were done or if signs of a specific behaviour could be observed these observations were planned to be done and the results noted. The observations also served as an extra input to the analysis of the interview and questionnaire results providing a contextual frame for the interpretation.

**Document studies**

As the reader may have noted formalisation and documented administrative procedures are less developed within SMEs. Formal meetings were seldom documented and I did not have access to the personal notes taken by different people in the firms studied. Most of the documents studied were public material from the companies and official and legally claimed financial documents and statistics. Also documents on notice-boards and documents used for organising, planning and informing employees were collected. During the quality system studies (mainly Paper 2 and 3) the quality manuals were audited and judged by the researcher in the group with the sufficient knowledge. The content in the quality manuals was also compared with results of the other data collection methods.

**The epistemological confusion in ergonomics**

A substantial problem during the research process reported here was to find out the difference between what could be considered to be an ergonomics change process or not. The reason for this is naturally that neither ergonomics nor change is especially clear or straightforward concepts. In addition they are not independent of each other.

**Ergonomics and science**

To start with ergonomics, its etymological Greek roots are ergo meaning work and nomos meaning laws, thus ergonomics could be seen as meaning the laws of work (Helander, 2006). Furthermore ergonomics includes aspects of health and personal development related to work.
The laws or recommendations are derived from different fields of research dealing with different aspects of humans. An effort to classify the models of humans implicit in ergonomics was made by the French ergonomist Daniellou (2001). He refers to four description levels of the human being:

- The biological level where the human is considered an energy processing system (anatomy, physiology, biomechanics, biochemistry, toxicology etc);
- The cognitive level where the human is considered an information processing system (studies of perception, mental models, thought processes, categorising and knowledge representation, memory, judgement and decision making etc);
- The psychic level where the human is the subject with a unique history, a specific personality leading to subjective processing in each experienced situation;
- The social level with membership in social groups and cultures which partly will determine values and habits.

(Daniellou, 2001, p. 44)

The most frequent ergonomics research addresses the biological and cognitive levels, leaving out or considering the other two only in a much reduced manner. The psychic and social levels are in turn researched in the psychological and sociological fields but this research is seldom labelled ergonomics. Furthermore, these four levels have different knowledge character, ontological (world view) roots and research traditions. These range from a strictly objective normative view of the world and how research (science) should be performed to reach general laws on phenomena to a subjective, contextual view where the knowledge of how to perform action in unique practice is strived for.

Healthy and rewarding work or “Det goda arbetet”

The Swedish concept of “det goda arbetet” was an essential background during the research projects reported. However, it is not easily translated into English but an expression that is useful and will be used here is “healthy and rewarding work” although this does not entirely encompass the meaning. “Det goda arbetet” was used by the unions as a catchword and a vision mainly during the eighties and nineties and here is the union definition of it, which includes nine conditions:

1. Employment safety – a precondition for change
2. A fair portion of the production outcome
3. Participation (democracy) in decisions
4. A work organisation promoting cooperation
5. A need for personal skill at work
6. Education (learning) – part of work
7. Acceptable working hours concerning social demands
8. Job equality
9. A work environment without risks for unhealth or accidents

(Svenska metallindustriarbetareförbundet, 1985, my translation)

These conditions have strong political considerations but it is my impression that the values they embody also were recognized by Swedish employers’ federations. However, the degree to which these goals were reached in certain cases was of course a matter of strong disputes. The practical consequences of the vision for the research reported here were mainly three. Employment safety was always a concern in the action research cases in the sense that satisfactory performance of operations was always considered as necessary for other improvements in working conditions. Secondly, union or employee representatives were always participating in the projects as project group members in each company. Thirdly, the information gathered and fed back to companies was always open; any employee could receive a full report on the findings.

The concrete question of what satisfactory operations performance was is not further dealt with in this thesis as the definitions the different firms participating in the research used explicitly or implicitly was not questioned by me or my colleagues and we thus accepted the definitions provided by the firms. However, we always added that the operations performance aimed for should be combined with the aim of developing good and rewarding work. Moreover, in some cases we urged the firms to measure and evaluate performance more explicitly. The reason for this was to provide better feedback to employees on the overall performance of the firms as well as on the performance the employees could influence by the results of their work. In this matter it can also be regarded as a part of rewarding work.

To further sort out the preconditions for the research the concept of health and of “healthy and rewarding work” from the legislators point of view is discussed below.

Health

The concept of health has long been a subject of discussion. Hippocrates and Plato (~400 BC) viewed health as a holistic entity. However, Christianity introduced the belief that the body was divine and a temple of the Holy Spirit. Health and health interventions thus became a matter of the relation to God. This was the dominating dogma in Europe until the idea of a dualistic relation between body and soul was introduced by Descartes (Medin, 2005; Medin & Alexandersson, 2000).

The evolving positivist tradition within medicine developed successively a statistical view of health formulated by Boorse (1977), quoted in Medin (2005):

“Health is normal functioning, where the normality is statistical and the functions biological.”
This is a state definition, although with the recognition that there is a statistical distribution. However, normal functioning is not an appropriate condition for health at work. People may have diseases or disabilities but given the specific conditions of their work this abnormal functioning may not affect their ability or health at work. In this context the delimitation to biology is a problem since psychological or social disorders may reduce the ability to work.

Already 50 years earlier the definition that was suggested at the constitution of the World Health Organisation (WHO) and entered into force on 7 April 1948 was considerably broader with a bipolar (well-being – disease) structure but it is still a health state definition (Awofeso, 2005).

“Health is a complete state of physical, mental and social well-being, and not merely the absence of disease or infirmity.”

A more holistic and normative view of health was reformulated by WHO 1986 (Medin, 2005).

“Health is ...seen as a resource for everyday life, not the objective of living. Health is a positive concept emphasizing social and personal resources, as well as physical capacities”

This definition stresses the positive side of the bipolar definition and is more close to what can be applied in a working context and the human is seen more from a dual perspective of object and subject. A further development of this view is the discussion and writing by Nordenfelt (2004) where he argues that

“a person is completely healthy if the person has the ability, given accepted circumstances, to fulfil his or her long-term minimal happiness.”

Minimal happiness is the feeling you get when the circumstances and the possibilities for action are what you want them to be. Ill-health is thus dependent on how individuals perceive their eventual illness. A similar definition is put forward by Dejours (1995) and quoted in Daniellou (2001):

“health is the possibility for every single individual to open up his/her own original way”

The perspective has moved from describing a state to a process in which the individual as an acting person plays a major role. In the process description, health is not the absence of acknowledged pathologies but instead created by situations where there is a possibility for an individual to forward the ongoing tentative construction called the own health (Daniellou, 2001; Medin, 2005).

However, the health definition in relation to work is complicated. For example psychological illnesses or social disabilities might not be perceived by the individual but by colleagues at work who recognizes them as clearly hindering to perform. Such circumstances make the process definitions less valid. And how should long-term effects of chemical hazards, noise, shift work, stress and strain or repetitive motions be judged? The process to “open up his/her original way” might work or even be desired for a while but leads in the long term to ill-health.
Furthermore, process definitions put a high responsibility on the individual and less on the employer or those responsible for the design of the work setting which could lead to undesired consequences.

**Vision of the legislator on healthy and rewarding work**

What is then healthy and rewarding work in the legislators’ view? According to the Swedish work environment act SFS 1977:1160, it has the purpose to prevent ill-health and accidents at work and generally to achieve a good work environment. The work environment should thus be satisfactory with regard to the nature of the work and social and technical progress in the community. Furthermore, working conditions shall be adapted to people’s differing physical and mental aptitudes. The employee shall be given the opportunity of participating in the design of his/her own working situation and it shall be designed so that the worker is not subjected to physical or mental strains which can lead to ill-health or accidents. It is also explicitly stated that closely controlled or restricted work shall be avoided or limited. Efforts shall be made that work provides opportunities of variety, social contact, co-operation and coherence between tasks and that it provides opportunities for personal and vocational development. In the official comments on the act it is declared that there is an aim for work to be found a meaningful, rewarding aspect of life (“The Work Environment Act”, 2005).

I have included the reference to the work environment act, not to use it as evidence of the demands employers and employees shall follow but to illustrate the content of healthy and rewarding work. The act is a “frame enactment” meaning that it stipulates generally worded requirements for working conditions, leaving the detailed stipulations to separate Provisions. It thus actually works as a vision of healthy and rewarding work.

It is also clear when comparing with the definitions of health above that it adheres to the process definition of health; the employee shall be given opportunity to participate in the design of the work process.

The question that comes into mind when working with this in practice is what is good enough and what is not acceptable. How much should be invested in time and money for improving workplaces? When is investment in workplaces financially motivated and when not? What investments do improve the performance of the firm and what do not?

This is however something that cannot be found in the Provisions. They often state minimum requirements, hygienic thresholds or technical functions but do not include holistic perspectives or the dynamics in “opening up your own original way”. The penalty system included in the Act works the same way. Penalties are connected to the requirements in the Provisions and not to more general aspects of working conditions.

So what are the acceptable or desirable working conditions? The answer to these questions can in favourable circumstances be answered or calculated, especially when putting a lot of effort into a strict examination of work but most often it is a matter of judgement. In the small firms I have studied it is definitely a mat-
The character of the knowledge produced here

I have already commented on this in different parts of this thesis. To sum up, my ambition has been to produce knowledge that could be used for action in change processes. Furthermore, the ambition is also to contribute to more general theories or concepts that could serve as frameworks, mental models and parts of pre-understanding when entering new research. With my background as a mechanical engineer, my initial view of change when entering working life many years ago was that of applying science to solve technical problems. Still I find this appropriate in many situations and it has given me a basic understanding of much what goes on in production systems. However, working life has taught me, both as engineer and researcher, that there are other dimensions of working life that cannot be understood or changed purely by developing and applying science. Wilson (2000) says that ergonomists in research have the double task of contributing to the scientific knowledge on humans at work and providing support and guidance for application of this knowledge to change and develop workplaces but that many would choose only to engage in one of these tasks.

So how do you produce knowledge in ergonomics? Going back to Daniel-lou (2000) he lists the stance of ergonomics that poses large epistemological difficulties:

- **Ergonomics deals with technical devices and human beings in systems where the “laws” are of different nature;**
- **It is oriented towards action in real situations;**
- **It takes on both health and efficiency issues;**
- **It deals with social situations which raise all the questions of liberty and power struggle;**
- **It deals with complex systems characterized by non-linear answers, uncertainty about the initial state, variations in the context and the number of influencing factors;**
- **As a design discipline, it has to do with “things that do not yet exist”, the existence of which is both a matter of technical feasibility and political will;**
- **It is continuously facing ethical dilemmas (what is an acceptable workload?);**
- One of the ways it uses to produce knowledge about the phenomena is by changing them (knowledge through action).

(Daniellou, 2001, p. 46)

In my research I think I have encountered all these issues. I have found it a very fascinating but sometimes a difficult and demanding journey. The answer to the question what differentiates an ergonomics change process from another change process might be found or derived from the list above, especially the first statement. I would however also like to express it as an active interest in work as a basic process for surviving and achieving welfare combined with the ethics that work should not be designed at the sacrifice of single or few blue or white collar workers for the benefit of many (customers, citizens, share holders etc). This trade-off is frequent both in firms and in society and these criteria will not coincide with those who call themselves ergonomists and those who do not but with a humanistic stance on work and work demands.
14 My contribution and future research

When analyzing the contribution of the six papers and this thesis more explicitly with the question “What does it stand for?” I would like to point out some reflections on the relevance for the industry and in the theoretical developments. Finally I will provide a very short summary of what I think should characterise change efforts in small firms.

Practical relevance for small firms in the secondary woodworking industry

Since the empirical work for the thesis was made, the secondary woodworking industry has undergone a lot of changes as most other industries. In a recent comprehensive study of the secondary woodworking industry by Vinnova, the Swedish Agency for Innovation Systems (Brege et al., 2005) the following conclusions are drawn concerning the way to stay competitive:

− Product and system innovation with clear traits of “lean production” thinking; technology and commercial developments should be welded into an entity.

− Innovation of commercial models for market orientation with profitable value-adding using modularisation and standardisation to combine efficiency with customer feelings of choice and creativity. Mega-retailers in building materials play a vital role here.

− Organisational innovations which form more lasting integration within networks and between customers and suppliers.

− Production innovations combining flexibility with low cost automation using high-tech solutions.

− Wood material innovations.

Comparing my results with those recent characteristics of the industry and developments needed for the future, I think that many of them actually could be interesting for use in firms and by researchers.

Concerning the first paper, the model of key variables for measuring working environment characteristics I find that it can definitely be a part in the first four conclusions. The argument is that these innovations will require new ways
of working which in turn will necessitate new forms of evaluating performance. How firms manage their employees, how knowledge is created and how the scarce human resources of small firms are utilized are for me levers of new developments in integration of technology and commercial developments, new commercial models, networking and flexibility. Paper 1 can in this development be used as a source of inspiration and a source of knowledge on what can be achieved or not by using key variables for evaluating performance in the different aspects of new ways of working.

Concerning the second paper, it provided a reasonable amount of advice concerning on how to run change processes. Although it is ISO 9000 implementation that is researched, a conclusion of more general interest is that the change process as such does influence the quality of the developments achieved and the effort needed. Furthermore, there is a need to practice project management in order to learn how to be successful, not the least when the projects incorporate organisation wide change.

Regarding the third paper, especially the aims of “lean thinking” and flexibility combined with efficiency raise the question on the limits of standardisation. The paper provides no answers but raises arguments that could be used as basis for dialogue and discussion on the subject. It may be noted that the only form of more concrete organisational solutions that is mentioned in the work environment act is that closely controlled or restricted work shall be avoided. Standardisation and fragmentation are to me two large threats against combining “lean thinking” with “healthy and rewarding work”.

As for the fourth paper, it provides more detailed aspects of change processes in small firms that need to be addressed in order to get results. Perhaps the most important aspect is that action is at the heart of change, there is no scope for thinking that questions belong to someone else. You have to do it or see to it that someone else does it but do not leave the topic in the air. Together with the results of Paper 2, you may also note that action and formalisation must be balanced. This balance is vital and clearly dependent on size and demands. Considering the four first aspects of innovation above, success means that appropriate ways of handling the balance between action and formalization is a question that must be solved.

Concerning the fifth paper it addresses the question of proximity between business processes and organisational structure and functioning apparent in small firms. It provides a methodology to analyze and compare commercial and organisational innovations with organisational state. This is done in multiple perspectives and terms of finance, processes, problems, strengths, goals and differing views of technical and organisational functioning. The aim with the methodology is to be able to suggest well-founded appropriate and meaningful action towards visions and goals. The paper and the described methodology thus may assist firms in finding their own way to suggested innovations.

The last paper addresses the role of actors in change processes. All innovations described above require experts. Those may range from the highly skilled
wood material specialists required for wood material innovations to contextual interpreters of what businesses may be successful, from participants in all type of positions with their expertise in their parts of the local processes to facilitators and advocates of chosen change processes and visions. This paper, in my opinion, may be helpful for companies to sort out the various contributions that can be made by different actors in the development process.

To sum up, I argue that each of the papers concerns issues of high relevance to small firms in the woodworking industry and similar industries with intent to improve their performance and working conditions. Together, the papers and the thesis emphasize the importance of action and work activities as a base for change. It is in the conflicting work activities or work conduct of differing perspectives or realities where many of the drivers of change can be found. I also argue that this is a main reason for good working conditions being of high importance for the performance in organisations. Good working conditions in general terms form the base for individual performance and thus for highly competitive organisations when they are characterized as innovative, integrative and flexible.

**Theoretical relevance**

Dunphy (1996) describes the elements that define the scope of what he calls “a fully fledged theory of organisational change”. These are specified as:

1. **A basic metaphor**, often unconsciously held, of the nature of the organisation.
2. **An analytical framework or diagnostic model** for understanding the organisational change process (This framework specifies key variables critical to the change process and ideally specifies the processes which link the variables.)
3. **An ideal model of an effectively functioning organisation** which suggests direction for change and the values to be used in evaluating the success of the change intervention (survival, growth, workforce, satisfaction etc.).
4. **An intervention theory** which specifies when, where, and how to intervene so as to move the organisation closer to the ideal.
5. **A definition of the role of the change agent**.

I will here discuss my results in the light of the points above to see whether the initial questions of the research are satisfactorily addressed.

**Metaphor**: Basic metaphor is the organisation as an organic open system in active interchange with its environment. This is especially apparent concerning small firms which have less power to influence their environment and often are more dependent on external actors than larger firms. However, this picture is a little too simple. Manufacturing companies can also be described as machine bureaucracies by the nature of their technological systems which to a large extent are mechanistic, not the least in woodworking. The technology is comparably
stable in this mature industry. It is difficult and expensive to change rendering it less organic and less open. Furthermore, as described in Paper 4, change could be considered to be effected both in open systems, vision-driven change, and in closed systems, action-driven change.

**Analytical framework:** The analytical framework here is the SMECA method for change in SME, combining analyses of working conditions and production systems functioning with business process and finance analysis. It thereby provides the holistic picture necessary to support change in firms with the high proximity between context and operations found in SMEs.

**Ideal model:** A profitable woodworking firm providing good working conditions for the employees. Those good working conditions are composed of reasonable stability in employment, a minimum of health hazards, favourable psychological and social conditions at work and a possibility for development of the individual as well as of the firm. The use of measurement of both company performance and individual development to maintain continuous progress as suggested in Paper 1 on key variables.

**Intervention theory:** Participative processes inspired by socio-technical design and broad intervention strategies were found to be favourable concerning implementation of ISO 9000 in Paper 2. The conscious use of action-driven change for rapid developments within the local theory and vision-driven change to expand the theory according to recognized opportunities (Paper 4). The theory also includes recognition of ergonomics and improved working conditions as a vital element in change, both concerning adjustments of already operating system (action-driven change) and concerning design of new systems (vision-driven change).

**Role of change agent:** The roles of possible change agents as well as of participants are described in Paper 6. The role of the substantive (ergonomics) expert needs to be combined with the role of the facilitator, working to develop the organisation’s own ability to change and the role of the advocate, interpreting the environment and the fit with the operations of the firm. Furthermore, the role of participants is discussed in relation to the different forms of change agency.

To conclude I find that the six papers together form a theoretical basis for developing small firms with attractive workplaces in parts of the manufacturing industry. The theoretical basis is not new but the way it has been accomplished and combined forms a reasonably holistic picture on how to develop small firms which I have not found elsewhere.

To sum up I would like to describe the favourable conditions necessary for creating planned organisational change in small firms in the following manner.

At the heart of change is action, implying changed behaviour of the few and influential actors in small firms. The high visibility of the actors, always performing “on stage” among the employees and with the actors’ decisions never mediated by staff or subordinates make change efforts something that is highly dependent on the own behaviour. It is of importance to avoid getting into a vicious circle of rhetoric and no results but instead being in a good circle of reinforcing
behaviours and visible results. Visions that are intended to create a renewed local theory must be concrete and lived, meaning that they should affect the behaviour of the vision provider. Visions need also to encompass holistic considerations excluding single goals but favouring ideas including multiple goals and an open development process.

External providers of impressions, new developments and knowledge should be used systematically by participating in networks and cooperating with organisations that can provide knowledge resources and assessment of external actors can be of high value. The scarce resources of a small firm presuppose that there is a strong need to make the best use of what is available.

The use of organised project work for developmental purposes will help keep focus on development in a culture that is overwhelmed with short-term performance and deliveries. In this process it can be helpful to reflect on the different expert roles needed and how they should be accomplished. An open attitude that respects individuals’ difficulties in performing their tasks will be favourable thereby creating good reasons for employees to engage in their workplace development. The systematic use of methods for development and evaluating performance should include many aspects of the business to provide a holistic picture. A communicated results hypothesis can be advantageous, including performance indices to use and how these are supposed to contribute to the development of the firm. Analytical tools like process mapping and cause-and-effect diagrams are important to strengthen and deepen the dialogue, which is the most important tool, as well as to create a common opinion on problematic situations.

Concerning ergonomics it is to some extent included in the above. Respecting difficulties in work includes ergonomics considerations. There are always trade-offs on the concrete action level and the vision of management will decide how these trade-offs are decided upon. A strong emphasis on the need to follow security rules and to use protective equipment is a must. A systematic inquiry into how changes and investments will affect different aspects of human work will create possibilities to proactively affect ergonomics conditions while the omission of such inquiry will create the need for adjustments afterwards. Which of these alternatives are most effective will depend strongly on the content of the change. Adjustments afterwards can be extremely costly under certain conditions while inquiries of jobs that do not exist are very difficult to execute in detail.

The studies were performed in the secondary woodworking industry but I see no main objections against generalising the findings to an industry with similar main characteristics as the secondary woodworking industry. The ergonomics problems related to the specific industry, noise and dust for woodworking, will change but not the principles for how change and improvements are brought about. The limitation to small firms is more appropriate, neither organisational structure nor resources available are the same in larger companies. This has a number of implications on aspects like available theoretical knowledge, vulnerability, formalisation, institutionalised organisational inertia etc. that will alter the demands on the change process.
Considering the discussion above on practical and theoretical relevance, I claim that the research endeavour and the research questions in the different papers are well elucidated and answered in the thesis.

**Future research**

I can see the need of future research in each of the topics dealt with in the papers and as the research performed to a large extent is exploratory there is a need to verify and develop the findings in other case studies. During my time at Trätek I had the opportunity to meet with researchers or consultants working with small firms in different countries. I learned by then that all countries in Western Europe provide financial support for consultants or researchers to work with small manufacturing firms in one way or another. Small firms’ development processes are thus something that is regarded as very valuable for authorities and small firms are looked upon as an important part of the welfare society. Furthermore, it is my impression that managers/owners are important for the development and stability of small firms more than in large firms. It is the ambition of the managers or their families that to a large extent determines whether small firms stay small or grow. This fact also contributes to what is increasingly acknowledged, namely small firms are individuals and develops as such.

The conclusion is that future research should focus on how to combine different aspects and topics of work in small firms into more holistic development views. Therefore I suggest that approaches including multiple interactions between humans, technology and organisational solutions where the business as such and the chosen business strategy are valid inputs may be viable. Problems like the difficulty in finding an appropriate technological level, the balance between the technical and the social system, coordination problems in firms with “lean” information systems solutions and large conflicting customer demands, the balance between formalization and practice are always typical questions in small firms. The solutions for these problems will directly affect the work performed at each individual workplace and thus the overall ergonomics situation in the firm.
15. References


15. References


