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International Symposium on Corporate Strategy, Production System Design, and Musculoskeletal Health

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International Symposium - Corporate Strategy, Production System Design, and Musculoskeletal Health

Human Factors Engineering Lab, Ryerson University

www.ryerson.ca/hfe

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For a more in-depth look on this subject, please see:

Dul, J. And Neumann, W.P. (2009). Ergonomics contributions to company strategies. Applied Ergonomics, v40(4): 745-752.

Neumann, W.P. And Dul, J. (In Press) Human Factors: Spanning the gap between OM & HRM. International Journal of Operations and Production Management.

Report to Land och Sjöfonden

INTERNATIONAL SYMPOSIUM on

CORPORATE STRATEGY, PRODUCTION SYSTEM DESIGN, AND MUSCULOSKELETAL HEALTH.

Conducted At:
XVth triennial Congress of the International Ergonomics Association
August 24-29
Seoul, Korea

Chairs:
WP Neumann, J Winkel, R Kadefors

Symposium Participants (left to right): Dr. P.L. Jensen, P. Neumann, Dr. P. Vink, S. Tooley, C. Walker, Dr. R. Kadefors, (not in image is Dr. J. Winkel).

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Objective

The objective of this work is to develop better understandings of the current trends in corporate strategy and production system design and the consequences these trends can have for the musculoskeletal health of production system operators.

Executive Summary

In order to improve our understanding of how corporate strategies can affect worker health we organised a special symposium at the 2003 international ergonomics association (IEA) conference in Seoul Korea.

While global productivity has been increasing so have employees work-related disorders and related costs. We invited 4 groups from around the world to share their recent experiences examining how strategic decisions by manufacturers can affect ergonomics in the resulting work systems. The bulk of this report is their written work and visual aids used in the symposium presentations.

Each presenter dealt with a different aspect of Strategy. Key Findings Include:

- Work-related disorders have their roots as unintended side-effects of early strategic decisions made in the production system design process.
- Ergonomists are political agents who should seek coalitions of support to promote ergonomic priorities and objectives in the organisation
- Companies can improve productivity and ergonomics simultaneously in improvement projects. (Though, despite apparent success the work might not be continued!)
- Corporate strategies can have both positive and negative effects on ergonomics – participatory ergonomic strategies show good results, ‘lean’ approaches and ‘downsizing’ can lead to increases in risk.
- While sociotechnically innovative production systems are being abandoned, elements of these systems appear to have both productivity and ergonomics benefits over traditional line-based assembly.

This international symposium has served both to raise awareness of, and share information on, the importance of corporate strategy as an early determinate of work-related disorders of operators in modern production systems.

INTRODUCTION

Symposium Objective:
The objective of this work is to develop better understandings how corporate strategy and production system design can affect ergonomics in production systems

We furthered this objective by organising a special symposium at the International Ergonomics Association's (IEA) world's congress in South Korea in August 2003. The International Ergonomics Association's (IEA) triennial conference is the world's premier conference for both scientists and practitioners in the area of ergonomics.

Symposium Title:
CORPORATE STRATEGY, PRODUCTION SYSTEM DESIGN, AND MUSCULOSKELETAL HEALTH.

Symposium Organisers:
WP Neumann, J Winkel, R. Kadefors

Symposium Rationale:
Work related musculoskeletal disorders (WMSDs) are unintended consequences of many modern manufacturing systems. While many WMSD risk factors have been identified, the sources of these risk factors lie in a series of events beginning with strategic business decisions through production system design and emerging finally in the implementation and operation of the production system itself. Thus we can see a chain of events and critical decisions which are displaced from the 'shop floor' in both time and space but

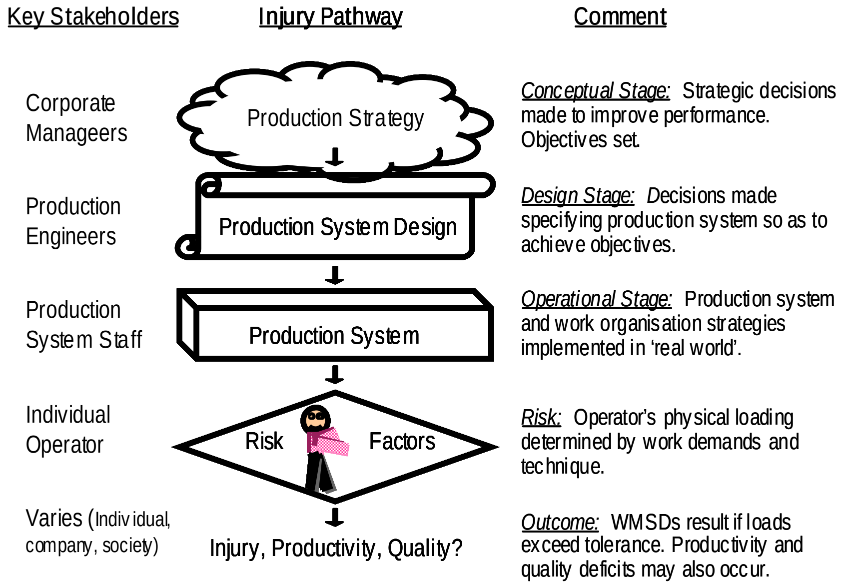

Figure 1: Simplified system model illustrating how production strategies can influence work-related musculoskeletal disorders (WMSD)

can have dramatic impacts on operators' exposure to WMSD risk factors. Intervening to jointly optimise both worker health and productivity aspects requires a combined understanding of ergonomics, production engineering, and corporate strategy. There is a critical need in today's hyper-competitive business environment to learn how to design productive systems that are also ergonomically sustainable – without the need for expensive 'ergonomic' retrofitting. Thus, we proposed a special symposium to explore the international state of corporate strategy and production system design with respect to the musculoskeletal health of production system operators. A panel discussion will follow with key presentations to focus on the implications of each presentation for both researchers and practitioners in the area of production ergonomics.

Symposium Strategy:

We recruited researchers, practitioners, and labour representatives from the international community to contribute both written conference articles and presentations to this symposium.

Authors are asked to address the following core questions in their talk:

1) What are the current trends in *corporate strategy* in manufacturing? (e.g. what is coming into practice now or soon?)
2) How might these strategies affect ergonomic conditions for production workers?
3) What possible routes of action might be taken to improve ergonomics in the face of these new manufacturing trends

This report includes the written and visual aid materials produced by the participants for this Symposium in the Appendix.

Key Results:

Neumann, introducing the symposium, presented a system model explaining how strategic decisions can eventually affect workers health. He also outlined some of the historical trends of strategy pointing out that these issues have deep roots with social, organizational, and individual elements which affect how and when disorders might emerge from a production system design process.

Jensen & Broberg pointed that ergonomics practitioners, who must operate in complex work systems with many groups and interests, might usefully recognize the political nature of their role. As political agents ergonomics can lobby and form coalitions to further ergonomics objectives inside the organization.

Vink & de Jong provided an example of a corporate strategy to improve working conditions and ergonomics simultaneously. This allowed both better performance, but would also allow the company to take on more challenging work since employees could stay on the job longer there-by gaining more experience and capabilities. This demonstrated win-win potentials for ergonomics improvements.

Stuart, Tooley, and Holtman pointed out that corporate strategies can have both positive and negative effects on worker health. Specifically that participatory improvement strategies seemed to yield good results and that corporate downsizing could artificially 'age' the workforce and result in older workers returning to heavier tasks. They also discussed the challenges of integrating ergonomics in a 'lean' environment.

Neumann et al. Presented a case study in which adoption of a serial line production strategy demonstrated both advantages and clear disadvantages for both productivity and ergonomics . Neumann also points out that each element in the production system must be considered for it's ergonomics and productivity consequences if improved systems are to be developed.

Finally Walker, the Canadian union representative, initiated the discussion phase with a number of challenges to Ergonomists and researchers to find ways to engage both workers and management to improve working conditions over the long term.

A general discussion followed the presentations.

Conclusions:

- Work-related disorders have their roots as unintended side-effects of early strategic decisions made in the production system design process.

- Ergonomists are political agents who should seek coalitions of support to promote ergonomic priorities and objectives in the organisation

- Companies can improve productivity and ergonomics simultaneously in improvement projects. (Though, despite apparent success the work might not be continued!)

- Corporate strategies can have both positive and negative effects on ergonomics – participatory ergonomic strategies show good results, 'lean' approaches and 'downsizing' can lead to increases in risk.

- While sociotechnically innovative production systems are being abandoned, elements of these systems appear to have both productivity and ergonomics benefits over traditional line-based assembly.

While many good examples of how corporate strategy affect ergonomics were presented, much more work is necessary both to understand the relationships between strategy and operator risk, and to identify better production strategies and approaches for tomorrows production systems.

2003 IEA Symposium Program

Corporate Strategy, Production System Design, and musculoskeletal health – P. Neumann, R. Kadefors, J. Winkel

August 27, 2003

Introduction: Patrick Neumann (National Institute for Working Life – Sweden)
Neumann, Kadefors, Winkel: *Corporate Strategy, Production System Design, and musculoskeletal health.*

Speaker 1: Per Langaa Jensen (Danish Technical University)
Per Langaa Jensen & Ole Broberg: *Conceptual frames for changing production system design.*

Speaker 2: Peter Vink (TNO – Netherlands)
Peter Vink & A.M. de Jong: *The link between corperate strategy and cost/benefits of physical load: a case in a company of 7,000 installation workers 'Case Study'.*

Speaker 3: Sherril Tooley (Boeing Corp., USA)
Mark Stuart, Sherrill Tooley, & K. Holtman: *The Effects of Ergonomics, Lean Manufacturing, and Corporate Downsizing on Musculoskeletal Health.*

Speaker 4: Patrick Neumann (National Institute for Working Life – Sweden)
Patrick Neumann et. al.: *Ergonomics and Productivity Consequences in Adopting Line-Based Production Systems.*

Response Speaker: Cathy Walker (Canadian Auto Workers Union):
CAW Reactions and commentary on presentations

Open discussion with audience and speakers finished the session.

APPENDIX

Papers & Presentation Materials from the:

INTERNATIONAL SYMPOSIUM on

CORPORATE STRATEGY, PRODUCTION SYSTEM DESIGN,
AND MUSCULOSKELETAL HEALTH.

Conducted At:
XVth triennial Congress of the International Ergonomics Association
August 24-29
Seoul, Korea

SYMPOSIUM INTRODUCTION: CORPORATE STRATEGY, PRODUCTION SYSTEM DESIGN, AND MUSCULOSKELETAL HEALTH

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Musculoskeletal disorders (MSDs) are unintended consequences of many modern manufacturing systems. While many MSD risk factors have been identified, the sources of these risk factors lie in a series of events beginning with strategic business decisions through production system design and emerging finally in the implementation and operation of the production system itself. Thus we can see a chain of events and critical decisions which are displaced from the 'shop floor' in both time and space but can have dramatic impacts on operators' exposure to WMSD risk factors. Intervening to jointly optimise both worker health and productivity aspects requires a combined understanding of ergonomics, production engineering, and corporate strategy. There is a critical need in today's hyper-competitive business environment to learn how to design productive systems that are also ergonomically sustainable – without the need for expensive 'ergonomic' retrofitting. This symposium aims to explore how corporate strategies can influence employee musculoskeletal health in order to set the stage for developing innovative strategies that are both profitable and sustainable.

SYMPOSIUM INTRODUCTION

Setting the Stage

This paper introduces a special seminar examining the current trends in manufacturing practice and the consequences these trends can have for musculoskeletal health. We see the ongoing problem of musculoskeletal disorders (MSDs) in the manufacturing sector as an unintended side effect of production systems. In Sweden we have seen a disturbing and rapid increase in long-term sick-leave and associated costs. Europe wide surveys have noted long term trends in increasing work intensity and its coupling to MSDs (Paoli & Merrilé 2000). The term "globalisation" appears both in popular and scientific literature daily and implies increasingly intense competition between companies. Increases in electronic commerce (stock trading) have also intensified pressure in the time domain for companies to maximise short-term profits. Rassmussen (1997) has explained how the forces of competition *systematically* drives complex systems towards unsafe operating conditions as stakeholders attempt to optimise their operational domains independently and thus, unknowingly, drive the whole system towards unsafe states. Operating in a competitive context, senior managers may choose production strategies that, while profitable in the short term, are not sustainable from the human perspective and thus are not profitable over the long term. Better models and methods are needed to assist decision makers in choosing manufacturing approaches that are both profitable and ergonomically sustainable.

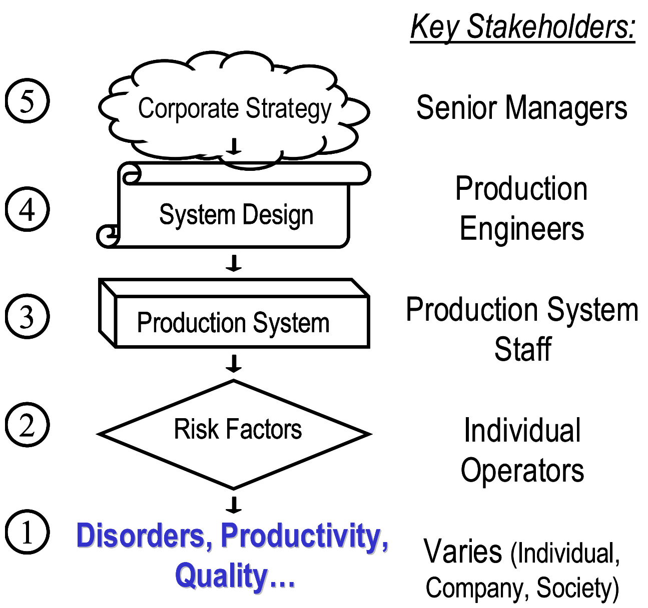

Figure 1: Simplified model of MSD causal chain

A Model of MSD Sources

While many psychosocial and physical risk factors for MSDs have been identified (e.g. Bernard 1997), and mechanistic model have been proposed (NRC 2001) the sources of these risk factor lie deeper in the system development process. Figure 1 illustrates a deliberately simplified system model to assist in understanding MSDs emergence in production systems (adapted from Neumann et al. 2002). In this model MSDs, as well as production outputs and quality levels, result from the interaction of operators with the Production system (level 1). These disorders are related to a variety of both physical and psychosocial risk factors (Level 2). These risk factors are determined by the physical and operational features of the production system itself (Level 3). This production system, however, is the result of a design process in which decisions are made regarding layout, technology, cycle times and all other system features (Level 4). This design process in turn is directed by senior managers who make strategic decisions on production models and design process to be used by the design team (Level 5). It is this highest level in which initial decisions with ergonomic impact are being made. It is at this point that we believe the greatest latitude exists to integrate ergonomics into production systems. Intervention at higher levels in the model may also address multiple outcomes simultaneously – creating potential for the joint optimisation of human and technical factors in the system. Can we integrate ergonomics considerations to decision making at these higher levels in work system design?

Production Strategy as Ergonomic Determinant

Adam Smith was promoting the economic benefits of division of labour already in the 18th century (Smith 1776). Three quarters of a century earlier Bernadarno Ramazzini (1700 as cited by Kadefors & Läubli 2002) was already describing occupational diseases related to intense and unvarying workload. By the 20th century entrepreneurs like Henry Ford (Ford 1926) had begun to implement Taylor's "scientific" principles of management, which virtually destroyed craft style production and set the stage for today's 'Lean manufacturing' and 'Continuous Improvement' rubrics. This trend, we argue has been taken further in recent years as a huge array of "new" strategies are proposed for increasing competitiveness in the increasingly globalised market environment. This historical view echoes the work intensification trends observed today (eg Docherty et al 2002) across Europe. Biomechanically, this could occur as individuals' work has been reduced to increasingly narrow scope with less physical variability, increased repetitiveness, and ever increasing demands for productivity. Clearly this change has influenced both the psychosocial and physical conditions for individuals operating these systems.

The negative health consequences of overwork have been much discussed since Razzamini & Smith starting in the 18th century. In the modern manufacturing context, Björkman (1996) has presented a helpful discussion of the relations between manufacturing strategy and ergonomics. Vahtera et al. (1997) have found 'corporate downsizing' to increase MSD risk by 5.7 times. Landbergis et al. (1999) in their review of available literature noted increased negative health outcomes with the adoption of Lean manufacturing approaches. Karltun et al. (1998) found signs of increased physical loading with the implementation of ISO 9000 standards. Looking at more specific system design elements Coury et al. (2000) have demonstrated increased physical risk with partial automation strategies which couple workers more tightly to the production system. An increasing number of studies are finding risk increases with the adoption line-based production approaches (Neumann et al. 2002, Fredriksson et al. 2001, Ólofsdóttir & Rafnsson 1986). On the positive side, Kadefors et al. (1996) found that ergonomics improved in the application of parallelized assembly flows without sacrificing productivity. This small but growing body of research demonstrates how higher level strategic decisions can result in increased, or decreased, MSD risk for employees.

Intensification of Work

Ergonomic efforts focussed on reducing load amplitude can often be implemented successfully. Efforts to reduce the time duration of exposure, such as number of repetitions, can be more problematic as these tend to reduce productivity - the primary concern of industrial engineering teams who wish to maximise productive working. These two forces operating simultaneously can lead to a workplace with very low exposure amplitudes but, because of high system efficiencies, very high exposure durations and thus high time-density of working. The resulting high risk situation has been described as the 'ergonomic pitfall' since an 'ergonomically designed' workplace retains high MSD risk, albeit with different risk factors (Winkel & Westgaard 1996). How can we control exposure durations in the face of continually intensifying work systems?

Ergonomics and productivity elements are intimately entwined. Overcoming the ergonomic pitfall therefore will require engaging the hearts and minds of industrial engineers and others to integrate ergonomics into the design process (Jensen 2002). Thus there is a growing call for 'joint optimisation' of productivity and ergonomics in the design of new workplaces (Neumann 2001, Burns & Vicente 2000). Can the negative consequences of increasing intensity be avoided by working smarter instead of just harder?

Stakeholders, Decisions, and Processes

Figure 2 presents a simple model of the context in which decisions are made by individuals in the system modelled in Figure 1. More detailed models of this type are presented by Rasmussen (1997) and Moray (2000). This model does not just apply to the affected workers, but to all stakeholders in the system. Individual decisions and action are embedded in the social and cultural forces acting at the company (or other sub-group). Power relationships, for example, can be expected to play a role in decision making within these systems. Corporate culture, established routines, structures and patterns will influence individual behaviours. Neumann et al. (1999) have discussed specific stakeholders and groups in relation to achieving ergonomics objectives in the organisation. Similarly societal forces such as legislation, professional fads and fashions, and economic forces will all influence individuals who make decisions with eventual ergonomic consequences in the production system (Figure 1). Unfortunately decision makers are often distanced from these ergonomics consequences both in time and organisationally, as most system designers are not forced to deal with MSD problems arising from their decision-making processes. We believe that successful solutions will engage arrays of stakeholders who see their personal and professional goals as being best met through the joint optimisation process. Are organisational or societal changes necessary to have ergonomic objectives integrated into decisions on production system design? Do individuals have the information, competencies, and mandate needed to achieve good ergonomics in modern work systems?

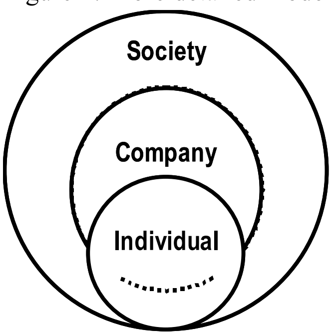

Figure 2: Simple model of stakeholder context applying to ALL system stakeholders.

Symposium Objectives

The problem area we describe is very large. In this symposium we aim to explore current trends in corporate strategy and production system design and the consequences these trends can have for the musculoskeletal health of the production workers. We attempt to foster discussion in this area with invited papers by both researchers and practitioners working in this area internationally by asking the following questions:

1) What are the current trends in corporate strategy in manufacturing?
2) How might these strategies affect ergonomic conditions for production workers?
3) What possible routes of action might be taken to improve ergonomics in the face of these new manufacturing trends?

These questions are addressed in four papers and are to be discussed in a plenary discussion. Each paper deals with a different aspect of corporate strategies in modern production environments.

Symposium Papers

The first paper in this symposium by Jensen & Broberg (2003) from the Danish Technical University presents conceptual frames for changing production system design. Here the authors explore the importance stakeholder roles and social dynamics in production system development processes. Strategy here includes recognition of the existing organisational structures and behaviour patterns while working as a political agent to integrate ergonomics into the ongoing design processes.

The second paper from Vink & de Jong present a case study from a large company considering the strategic advantages of keeping employees healthy to build experience and competence to tackle larger, more complicated jobs. The project demonstrated repeatedly that both productivity and ergonomic objectives could be furthered with careful planning. Distribution of these new methods to achieve workforce-wide impact however remains a challenge.

Stuart, Tooley, and Holtman from the Boeing Corporation describe their approach as ergonomics practitioners operating inside a large organisation using the strategies of participatory ergonomics, downsizing, and 'lean manufacturing'; all common practices in today's industries.

Finally Neumann et al. present a case in which a parallel long-cycle time assembly system is redesigned to a more conventional serial flow system. This appears to be part of a trend in Sweden in which sociotechnically innovative production approaches, developed in the past decades, are abandoned in favour of modern variants of traditional line assembly (e.g. Ford 1926). This case presents a systems analysis of the change that reveals both advantages and disadvantages of the new system from both human and technical factors aspects.

These papers all examine different types of corporate strategies and demonstrate their effects on employee risks. As Stuart, Tooley, & Holtman point out in their paper – these strategies can have both positive and negative effects on ergonomics. Our question remains as a challenge: Can today's complex manufacturing systems be induced to embrace the long and short-term benefits of the appropriate integration of ergonomics at strategic levels?

ACKNOWLODGEMENTS

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IEA 2003, SYMPOSIUM INTRODUCTION:

Corporate Strategy, Production System Design, and Musculoskeletal Health

W.P. Neumann
R. Kadefors
J. Winkel

Arbetslivsinstitutet
WEST
National Institute for Working Life

Chapter 1: of the Division of Labour

”The greatest improvement in the productive powers of labour… seem to have been the effects of the division of labour”

-ADAM SMITH (1776)
’The Wealth of Nations’

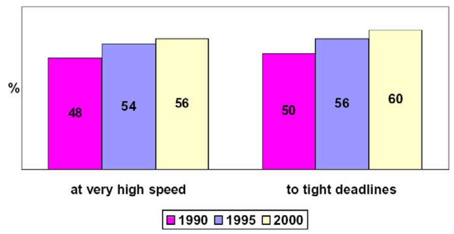
✓ The Pin Factory Example

And the race was on…

- Talyor (1911) – *Scientific management*
- FORD (1920’s)
- Demming (1950s +) – *Continuous Improvement*
- TOYOTA (1970 +)
- Womack (1994) – *The machine that changed the world*

Modern signs of work intensification

Figure 4: *Working at very high speed or to tight deadlines*

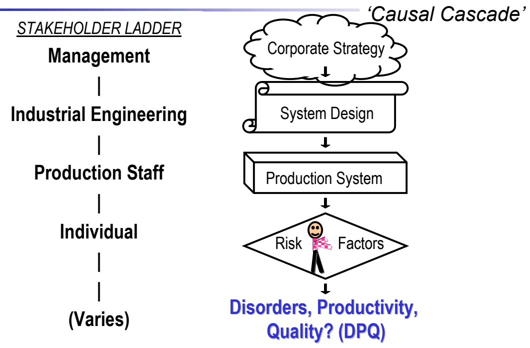


3rd Survey on Working Conditions in EU
Merllié & Paoli 2000. **n=21 500** EU workers

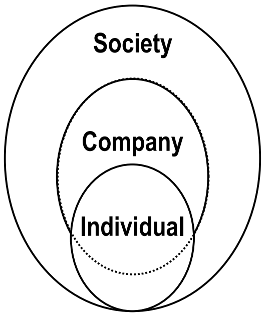
WMSDs - Scope of Problem

- **~5% GDP to WMSDs in industrialised countries (WHO 1995)**
- **~40% Musculoskeletal Disorders**

System Model

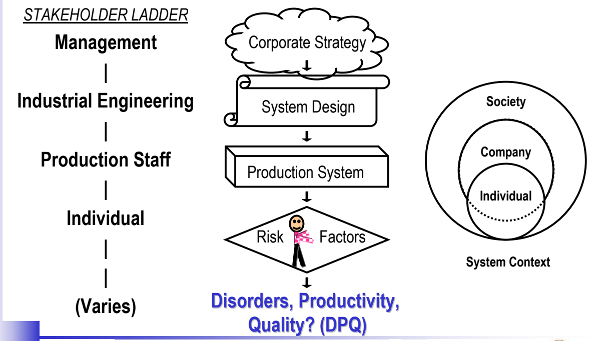


System Contexts



- **Globalization** (Netherlands 16th c.)
- **'Hyper-Competition'** (D'aveni 1994)
- **Complex Sociotechnical Systems** (Rasmussen 2000)

System Overview



Productivity - Ergonomics Relationships

Ergonomics (columns) / **Productivity** (rows)

	Better	No Change	Worse
Better	*Go!*	OK	Phantom Profit ?
No change	OK		X
Worse	Hidden Gains?	X	X

Symposium Questions

1. Current trends in corporate strategy?
2. Consequences for ergonomics?
3. Opportunities for Intervention?

Symposium Papers

1. **Jensen & Broberg** (DTU) *Conceptual frames for changing production system design*
2. **Vink & de Jong** (Delft U, TNO) *Corporate strategy & workload reduction in installation work*
3. **Stuart, Tooley & Holtman** (Boeing) *Ergonomics, Lean Manufacturing, and reductions in Workforce*
4. **Neumann et al.** (ALI, LU, CTH) *Ergonomics and productivity in line-based production*
5. **Walker** (CAW) - *Response & Union Perspective*

CONCEPTUAL FRAMES FOR CHANGING PRODUCTION SYSTEM DESIGN

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In order to integrate ergonomic aspects into the design of products and production systems many tools and procedures are available. For the ergonomists, however, it is a question of recognizing the organizational context and the role to play for making integration possible. Based on an understanding of design processes as social processes we suggest a supplementary role for ergonomists: political agents. This might open up for a new understanding and thereby influence the priorities of ergonomics in enterprises.

INTRODUCTION

It has often been argued that the ideal for ergonomic intervention is to be integrated into the design of products and into planning of production systems contrary to participation in modification and repair of existing systems. Practice has always had difficulties in living up to this ideal. Whereas consideration for the consumers is a topic of growing concern in the design of products, consideration for the workers are presently seldom included neither in the design of products nor in - the design and planning of production processes (Broberg 1997; Jensen 2001).

Most often working conditions are introduced in the phases of implementation and operation. This implies that the ergonomic issues are primarily introduced by problems with or maybe even complaints about the actual working conditions, whereas designer-initiated, preventive initiatives based on modelling or on other sorts of test methods are absent. So, compared with the earlier phases of the planning process the 'latitude of decisions' is limited thereby reducing the options of preventive measures typically to a simple - i.e. not too costly - repair of present facilities and to efforts to modify the workers behaviour. This paper addresses the question of what to do to change this situation.

An examination of literature reveals that many applicable tools and procedures are available. Jensen (2001) identifies six different types of tools, see table 1. All have been tested in different settings and have shown applicable. Therefore, attention should be paid to the preconditions for applying these tools. This requests the ergonomists to accept a new understanding of their roles in an organization.

THE ORGANIZATIONAL CONTEXT

Perrow (1983) emphasizes that within the perspective of organizational theory the main problem is neither designers and planners lack of knowledge and motivation to integrate human factor knowledge in their activities nor the ability of the human factors specialists to present adequate and useful knowledge. The cause of the problems is to be found in the organizational context, which limits the human factor specialists' influence and restricts their perspective. To understand why human factors are neglected Perrow in a more comprehensive model points to specific aspects of the social structure such as top management not emphasizing ergonomics in goals and perspective, a reward structure of the organization excluding performance in ergonomics, designers not being presented with the consequences of their decisions, and a contrasting logic for design and operation on what characterizes good design. As a consequence, human factors specialists get a marginal position in the organization. They are a small group characterized by insufficient formal influence, no control of strategic resources and a weak network in- and outside the organization and therefore not having early information of opportunities and threats. Besides, their professional approach is unfamiliar to the designers.

Perrow, in his discussion refers to large organizations and most often to ergonomic issues in relation to major accidents, but his analysis can easily be transferred to the relation between enterprises and their affiliated occupational health service staffed with specialists in ergonomics (Jensen 2001). To change this situation ergonomists might await top-management initiatives, but ergonomists have an active role in changing the situation. To identify potentials ergonomists

Table1. Approaches for integrating ergonomics in technical planning (Jensen 2001)

Approaches		The traditional approach	The socio-technical approach	Union-based development of resources.	Dialogue-seminars	Human Centered design	Participatory ergonomics
Understanding of the social frame of planning and change processes		Harmonious	Harmonious, maybe negotiations	Conflicts, negotiations and compromises	Agreement or compromise	Harmonious	Harmonious
Role of the different social actors	Managers	Formulates goals and criteria's	Formulates goals and criteria's	Willing to negotiate		Participates	Formulates goals and general criteria's
	Planers	Plan and implement	Joint optimization	Plans in line with	Interested in a dialogue and willing to follow agreements reached	Establish technical-economic and human criteria's	Facilitates participation
	Employees	Follow plans	Participates	Formulates demands and negotiates		Participates	Participates
Working environment aspect in focus		Physical	Psychological	Primarily psychological	Primarily psychological	Primarily psychological	Primarily physical

has to understand organizations and design processes as socially constructed.

Social processes in design

Broberg (1999), in a theoretical study of models for integrating working environment issues into design, identifies two main strategies on how to accomplish integration. The first strategy is a knowledge strategy focusing on the individual designer and the demands on her or him for ergonomic knowledge and hers or his efforts to gain this knowledge. The rational version of this strategy is integrated with the traditional approach in the table. The second strategy is a process strategy focusing on the organizational context of the design process. In the latter design is perceived as based on teamwork. Broberg points out that problems do not just exist; they are established through a process of 'naming' (i.e. identifying what has to be dealt with) and 'framing' (i.e. placing the problem into a context). This should be understood as a social process involving team members as well as other stakeholders able to get access to and influence on the processes.

What does the character of the design process mean to strategies for integration of ergonomic aspects? In a study of the design process of a continuous wok for the food industry, Broberg (2000) claimed the design process to be a social process involving networks building, coordination, and negotiation between different professional knowledge domains and between actors with different perspectives and interests in relation to the continuous process wok. During the design process, the artefact was changed dynamically according to the balance in the actor network. Hence, the potential ergonomic aspect for the future operators was being designed and re-designed. Therefore, it does not seem appropriate to rely on strategies in which ergonomics criteria are stated in the requirements specification. First, such specifications only existed as very rough sketches and descriptions. Second, it turned out that specifications were not just translated into design objects. They were transformed, subject to interpretation, as the design object changed from sketches, technical drawings, plastic models, and prototype. These conditions point to the necessity of making an ergonomic perspective an integral part of the network instead as an add-on measure.

Broberg found that the coming users were not involved in the design process. Instead they were 'inscribed' in the technology, meaning that the designers envisaged certain roles for the operators and their working environment (Akrich 1995). Often these notions about the users first become explicit when the designers were asked who the operators were and how their work would be. The designers were very focused on *the machine*. They did not form an overall picture of the working environment in the continuous process wok *system*. They were not able to explicate the man-machine interactions and which tasks would be necessary to feed the system with raw materials. Nor did they think about cleaning and maintenance operations, job requirements, and training of the operators.

THE ROLE OF THE ERGONOMIST

Summing up, tools, methods and procedures are not sufficient to promote ergonomics. From an organizational point of view it is important to establish or increase the organizational platform for ergonomics. This can be done in many ways. Changing or modifying the configuration of the organizational structure and strategy may affect the ability to increase ergonomic capabilities by intensifying the receptiveness to ergonomic advice. This implies affecting top-management's goals and priorities, the reward structures and participation in planning teams. According to Broberg this implies the preparedness of the ergonomist to enter into a social process, in which their naming and framing are not accepted in advance but form part of a general dispute between several conceptual worlds. Entering this dispute open the question on what role to play.

Traditional roles: Expert or facilitator

As the ergonomic experts have a major role to play in the promotion of this change, their understanding of their own roles is crucial. For many years the discourse in the Danish OHS community has placed OHS consultants on a line between a professional expert and a process consultant. This discourse may be related to Schein's expert or doctor-patient model versus process consultation (Schein 1987). When the OHS consultant is an expert or has the doctor role, the client enterprise has determined that additional knowledge is needed on some matter or that some activity needs to be carried out. The OHS consultant both do the diagnosis and recommend what kind of information and expertise will solve the problem. An example may be identifying sources of noise and make technical suggestions to solve the problem.

Process consultation puts the emphasis on helping others to help themselves, not on solving their problems for them or giving them expert advice. The client thus learns how to solve problems on future occasions without the help of the consultant. An example may be learning an enterprise to accomplish a workplace assessment required by authorities in Denmark. Since it has been seen as the way to 'empower' the organization to deal with ergonomic issues the debate among the Danish ergonomists has emphasized the importance of adopting elements from process consultancy.

A new role: political agent

But the previous discussion of theories and concepts opens up for a third conceptualization of roles as one among many players in a political process. The actors or players should conceive the social fields as a number of actors with different interests and power bases (i.e. position - formal as well as informal- in the organizational structure, knowledge and skills, access to information) and with different naming and framing of the problems caused by the differences in the underlying perspective. They negotiate and compromise openly or covertly in many different both formal and informal political arenas. During this process the ergonomist should maintain their interest in creating safe and sound jobs through effective protective measures and even a move towards 'developmental work' (Hvid & Møller, 2001). Likewise, it is important for them to identify their power base, and to be capable of anticipating possibilities for alliances and compromises and possibilities to gain access to new political arenas in the organization. Alliances and compromises are not necessarily made on explicitly formulated interests and political positions. Both naming and framing form part of the process to make alliances and compromises, but in the reflections on activities and results the basic interest in safe and sound working conditions and developmental work is central. Broberg & Hermund (2002) emphasise that the effective change agent must be capable of orchestrating events; socializing within the network of stakeholders; and managing the communication process. Being a change agent as OHS consultant implies then playing an active part in developing and changing something in the organization from the perspective of work environment.

In a study of technological changes Broberg & Hermund found that the ergonomic expert at a first glance also acted as a change agent but this is not the adequate term because she was not in the organizational role of change management. Called in as an ergonomics expert they suggest another term describing the role of the OHS consultant, namely ‘political reflective navigator’.

The OHS consultant was political in the sense that she was pursuing a work environment agenda in the technological change process. She tried to build and stabilize an ergonomics actor-network thereby trying to influence the shaping of the technology. She was reflective in the sense that she was able to change between different roles in different contexts and situations. In that she mobilised different types of knowledge (ergonomics, regulatory, practice of users). Finally, she was able to navigate in the very complex organization surrounding the change project, both internally in the organization and externally, for example in relation to the work environment authorities. The OHS consultant also possessed very important competencies in acting as a facilitator or ‘translator’ between different languages or practices in the technological change process. She was able to mediate between the users, safety representatives, supervisors, managers, engineers and architects. And she was investigative and insistent.

CONCLUSION

New production concepts do not just exist ‘out there’. They have to be appropriated by the enterprise. This appropriation is a social process with many actors. A major aim in industrial ergonomics is to integrate the issue of ergonomics into planning processes. We have argued that this aim has to be pursued not by developing tools and procedures but by focusing on the basic understanding of organizational life among ergonomists. They need to be skilled in political and reflective processes and the dynamics of technological design processes. Senior ergonomists may to some extent have developed such skills. The skills are, however, often ‘tacit’ knowledge, which impedes reflection and a transformation into training courses for and education of ergonomists. Pointing to the political reflective navigator competence may be a breakaway from a discourse in the Danish OHS community, which traditionally places OHS consultants on a line between a professional expert and a process consultant. This might open up for a new understanding and thereby influence the priorities of ergonomics in enterprises. This may include the understanding of successes and failures of the different methods presented in the first part of the paper.

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Conceptual frames for changing production system design

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The basic model of MSD causal chain

	Stakeholders:
Corporate Strategy	Senior Management
↓	
System Design	Production Engineers
↓	
Production System	Staff
↓	
Risk Factors	Individual Operators
↓	
Disorder, Productivity	Varies

Traditional approaches within human factors and ergonomics

- ‘Good ergonomics is good economy’
- ‘Integrate ergonomic criteria’ (with others criteria used in decision making)

Basic assumptions behind these approaches

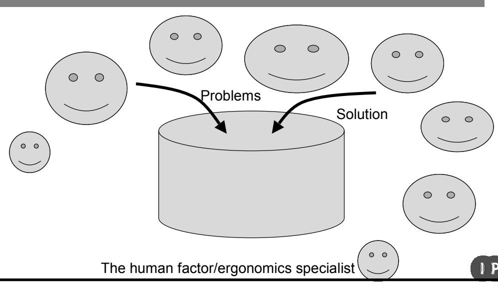
Designing production systems is:

- A top-down process
- Initiated by top management
- Dominated by rational decisions
- Related to a pre-determined set of criteria
- Following a pre-established, well-defined procedure

An alternative understanding of organizations

1. Organizations are open systems
2. Often organizations can best be explained as composed of loosely sub-systems
3. In some cases: embedded routines determines outcome
4. In others: decisions are the outcome of a coupling between problems and solutions depended on access and resources

The ‘Garbage-Can Model’ of organizational decision making



Traditional conceptualizations of the role as ergonomic/human factor specialist

1. The expert
   Presenting information of high quality within their field on problems and solutions
2. The facilitator
   Establishing a decision making process involving major stakeholders leading to a consensus on what to do

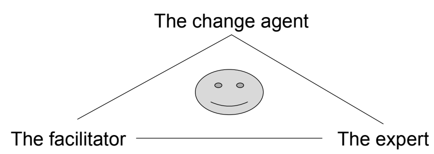
Conceptualizing a new role: the change agent

- One of more actors with different interest and differences in power base
- Carries a specific interest (safe, healthy)
- Constantly in search for alliances
- By framing and naming their interest into the conceptual models of the others
- Willing to compromise
- To gain access to central decision making arenas in the organization

Production system design

- Is not a rational top down process
- It is a social process between many actors inside and outside the enterprise
- It is important that the ergonomist/human factor specialist reflects upon his/her role
- And tries to develop the corresponding qualifications

Roles for the ergonomist/human factor specialist



CORPERATE STRATEGY AND COST/BENEFITS OF REDUCING PHYSICAL LOAD: A CASE IN A COMPANY OF 7,000 INSTALLATION WORKERS.

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The relationship between strategy and an ergonomics project is clarified in this project. A part of the strategy of the company was to take care of the workers and work as efficient as possible. The project was successful according to the company because it resulted in an reduction of musculoskeletal workload and an increase of productivity. From a scientific point of view the evaluation was not good enough to support this conclusion.

INTRODUCTION

Ergonomics linked to corporate strategy

According to Hägg (2003) dissemination knowledge concerning ergonomics to enterprises the last link, the work performed within a company, is all too often overlooked. An important link to the company is the link to top management and strategy. Also, a lot of work in companies is never documented (Hägg, 2003). In this paper the link between a project and the strategy of one case in an installation company is presented and a contribution is made to documentation.

Corporate strategy of this case

Installation work is found in construction and maintenance. It could be installing central heating, installing electricity systems, plumbing and making regulation systems for the process industry. The work is partly done in the work stations of the company, but mainly at the construction sites. These sites are very varying. Often the work is done under time pressure, because clients want to use the systems as soon as possible. The company is one of the largest companies in the Benelux with a staff of 7,000 employees. The company intends to be the best regarding quality and safety and is well equipped to do the more complex installation work. The strategy of the company is to acquire the more complex projects as well as the 'average' projects. A part of the strategy is to pay much attention to the workers, because they are important in the production process.

Production system design

The consequence of this strategy is that experienced and high educated installation workers and a group of employees equipped to do the 'average' projects are needed. Attention is paid to training of the employees with regard to new working methods, but also to health and safety issues. The company has several locations spread over several EU countries to serve the clients in the different regions and have employees close to the clients. Each location has a manager that is responsible for planning, quality and health and safety. The manager can use specialists in the field of health and safety, because almost each location has a health and safety manager. The different locations often have work stations, where work is prepared. If new systems are introduced these work stations are redesigned. At the construction sites the influence on the working conditions is very low. The only influence of the management is to pay attention to the optimal tools to improve the work.

Production system

The work station in the local offices and the work preparation stations are ergonomically well designed to speedup the work and increase quality. At the construction sites the working conditions are difficult to influence. Transport of materials and tools from and to the van is often done manually. Employees have to work kneeled, in limited space or above the head in a static posture.

Risk factors

The major risks are found on the construction sites. Safety and musculoskeletal loading are major issues. Regarding safety slippery and falls is a risk, but also accidents due to electricity. Regarding the musculoskeletal loading heavy manual lifting and carrying, static postures and repetitive handling is often seen.

Consequences of the strategy

In one of the meetings the president of the company presented the importance of improvement to the management and the health and safety managers. In the session the change of priority was discussed. After paying two years attention to improving the safety, the coming two years will be focused on improving the physical loading. The president said in his speech: "for our company there are two main issues: making money and care for our employees that make the money. Therefore, in improving the physical load we will have to look for those improvements that reduce the loading on our employees and increase efficiency in work". The idea was that especially for the work on the construction sites improvements were needed. After this session the staff was asked to develop a stepwise approach to implement improvements applicable at various construction sites. This was one of the consequences of the strategy to do complex and 'average' installation work and pay attention to the employees.

In this paper the implementation of the strategy in an ergonomical improvement process will be described and the effects will be evaluated.

METHOD

The ergonomical improvement process consisted of six steps based on previous experience (Vink and Koningsveld, 1990; Jong and Vink, 2000; Looze et al., 2001) .

1. *Preparation*. In this step the goal of the project was defined. Also, a steering groups was formed, that was responsible for the process. All employees were informed by the companies' journal and every employee received a postcard specifying the project.

2. *Analysis*. In this stage the main musculoskeletal risks and hazardous tasks were defined, based on sick leave documents already available at the health and safety institutes, interviews with management, HSE managers and employees and previous studies.

3. *Idea generation*. Group sessions were planned to develop new ideas for improvements for the most hazardous tasks. Three group sessions were planned, one on heavy lifting and carrying, one on kneeled work and one on static work. The groups consisted of appr. 20 subjects mainly employees, middle management and foreman, some staff and an external ergonomists. In the group sessions first the main problems were explained with videos and pictures, then all attendees wrote a solution on a paper. This was collected and presented (nobody knew whose solutions was whose). After this a new solution round was introduced and additional ideas were collected. For each of the solution an estimation was made of its effect on productivity, health and feasibility.

4. *Testing*. The most promising ideas were build by employees, staff or external experts. These were tested by a group of employees that were used working together. Tasks were observed in the old and improved way of working. The musculoskeletal loading and productivity were estimated by observations.

5. *Implementing*. The solutions with positive effects were spread through the whole company. This was done by making a solution book containing all the solutions. The book was presented in meetings with the employees. Especially, the solutions applicable for their work were giving attention. If a solution had a negative effect on at least one of the issues 'musculoskeletal loading' or 'productivity' it was not spread. Also, additional improvements were asked for and also added to the book. This was promoted by giving prices to the best solutions.

6. Evaluation. Based on interviews with health and safety executives in all parts of the company the number of bought solutions were calculated. Also, additional solutions were estimated and the use of the improvements was estimated. Also, cost/benefit was estimated by the company.

Fig. 1. Draw-out work-bench to prevent working on the floor and reduce back flexion

RESULTS

The results will be described for each step.

1. *Preparation*. The defined goal of the project was not surprising: reducing musculoskeletal loading and improving efficiency at the construction sites. It was decided to focus

the goal more after the analysis. Top management and the staff members involved in safety and health and in communication agreed on this goal.

2. *Analysis*. The main problems were transport (heavy manual handling) to and from the van, working kneeled and working in static postures. The staff members mentioned above together with the advisors (TNO) agreed on a specification of the goal. The specified goal was to reduce musculoskeletal loading and improve productivity in these three tasks.

3. *Idea generation*. Ideas were generated with 25 employees from different parts of the organization. From a large list of solutions, nine were chosen, because these were estimated to contribute most to the problems and were feasible. Two examples of solutions are shown in figure 1 and 2.

Fig. 2. A transport device to eliminate manual lifting and carrying .

4. *Testing*. The results of the tests on productivity and musculoskeletal loading are shown in table 1. Most improvements resulted in a productivity increase. Doing the same work with less employees in the new situation is seen as a productivity improvement. Most improvements also reduce the work load. Less time carrying or lifting or in an awkward posture is assumed to reduce the risk.

5. *Implementing*. The nine solutions were included in a solution book. Every part of the company received some books that were used in meetings. In the meetings additional improvements were asked for. This resulted in another 60 solutions. 12 were supposed to have a positive effect on productivity and health and were applicable in more parts of the company. These 12 were added to the solutions book.

6. *Evaluation.* The estimation of the number of additional solutions was 60 (see 5 implementing). 138 devices were in use. All of the nine chosen solutions were used weekly, 7 were used on a daily bases.

Table 1. Number of employees needed in the old and new situation and percentage of the time carrying and lifting (=lifting in the table) or in a more than 60° flexed back posture or in a kneeled position.

solution	nr of employees		% of time lifting/flexion/kneeling	
	old	new	old	New
1	4	2	34% lift	6% lift
2	2	2	6% lift	0% lift
3	4	2	32% lift	3% lift
4	4	4	14% lift	4% lift
5	3	3	45% flex	7% flex
6	2	2	23% flex	8% flex
7	2	2	34% flex	12% flex
8	2	2	45% kneel	2% kneel
9	2	2	31% kneel	4% kneel

Table 2. Estimation of the benefits of each of the first four solutions within one year.

solution	number of solutions in use	reduction in man-hours/week	reduction in man-hours (40 weeks)	cost reduction (€ 45/hour)
1	3	16	1920	86400
2	73	0,25	730	32850
3	3	8	960	43200
4	35	0,08	117	5265
				167715

The cost/benefit ratio was positive according to the company. The investment was partly man-hours (€ 50,000), partly buying new equipment (€ 14,060). Total investment: € 64,060. The benefits were especially found in solution nr 1, 2, 3 and 4 (see table 2). The reduction in man-hour cost can be € 167,715. However, the experience of the company is that in practice roughly half of these reductions are really paid off. This means that the benefit is approximately

16,000 within one year apart from the reduction in musculoskeletal load and improved well-being of the employees.

DISCUSSION

From the companies' point of view this project was a success. A part of the strategy is to pay much attention to the workers, because they are important in the production process and to improve productivity. This project contributed to both paying attention to the worker and improving productivity. 138 new devices are bought as well as 60 additional improvements were found. It is assumed that more improvements could be found, because these were the only one traceable by interviews. The solutions contribute to reduction in workload and well-being as is mentioned by some workers and the company estimates that there is a productivity increase with a return of investment of 25% (16,000/64,000).

From a research point of view the study is not a success. Only 198 solutions are available for 7,000 workers. That's 3%. According to Rogers (1995) 2,5% of a group are innovators and adopt an improvement anyway. In this case we could have reached only the early adopters. Also, the real effect on musculoskeletal workload is not measured. Only the minimal number of improvements is known. For a good estimation observations are needed. Also, the evaluation was done within half a year after the project. Another study (De Jong and Vink, 2000) showed that most improvements were implemented after two years, because investments in new equipment first have to be put into a budget for the next year. A thorough evaluation was discussed with the company, but not interesting for them. It is not the strategy of the company to help science further. Probably these questions are more of concern to governments.

A previous study (De Jong, 2002) showed that six factors play an important role in successful implementing:

-user tests by employees,

-improvements focused on the specific tasks,

-the active participation of management being able to inform more employees in the company,

-direct participation of employees and opinion leaders in the improvement process,

-good cost/benefit ratio, and

-usable products (not changing the work drastically).

In this project all factors play a role, because the tests are done by employees and the improvements were focused on the actual work. Cost/benefits are explicitly mentioned and management supported the improvements. Perhaps the weakest point in this project is the direct participation. Of the 7,000 employees only 2% was directly involved.

A good evaluation was missing and could be helpful for the company as well. This could show that only a part of the company is involved and more activities should be needed to spread the knowledge further. However, the company was not interested in a good evaluation, because the project was seen as successful. Perhaps ergonomists should train themselves in being better change agents and convince companies of the need of evaluation and further implementation.

CONCLUSION

Strategy and an ergonomics project are very well in alignment with each other in this project. Using a participatory process various improvements were implemented to reduce musculoskeletal load and increase productivity. The company evaluated the project as successful, because it contributed to the strategy. From a scientific point of view it is difficult to draw conclusions on the effects and more thorough research was needed especially concerning the evaluation.

Lessons learned from this project are that user tests by employees themselves are very important, employee involvement should be as direct as possible and explicit attention for costs/benefits is essential. Perhaps ergonomists should be more trained as change agents and convince companies of the usefulness of evaluation and further implementation.

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TUDelft

Corperate strategy and cost/benefits of reducing physical load: a case in installation work

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Hagg (2003):

dissemination ergonomics in enterprises and the work performed within a company is all too often overlooked

Neumann et al. (2003):

Need for knowledge on consequences of trends in company strategy for musculoskeletal health

TNO

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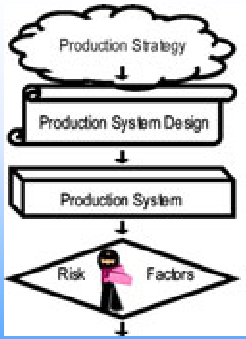

Injuries, productivity, quality

TNO

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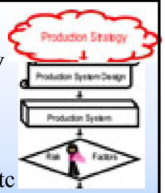
Strategy of the case company



- Installation work: varying workplaces
- Install central heating, electr. systems etc
- 7,000 employees in EU (mainly NL)
- Targets (strategy):
  - **to be the best in quality**
  - **To do more complex large projects**
  - **Without loosing the average projects**
  - **Take care of workers (are important part in production process)**

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Production system design

Each location of the company has a manager responsible for: planning, quality and health and safety

Almost every location has an HSE expert.

Every foreman has to decide on what is done central-local and design the work station (in fact decide on the mech. aids)

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Production system

The permanent local work stations are ergonomically well designed to speedup the work and increase quality.

At the construction sites conditions are difficult to influence.
Transport is often done manually. Employees work kneeled, in limited space or above the head in a static posture

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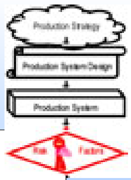
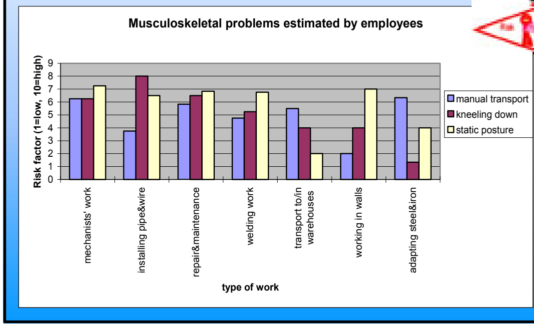
Risk factors





TNO

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Project **fys** was started: to take care of the workers and increase productivity

- Major hazards were estimated
- For every type of work solutions were gathered in a solution session
- These were tested by two teams on:
  - reduction in load and
  - increase in productivity
  - Solutions should at least be neutral and have an effect on one of the two

TNO

TUDelft

Some solutions:

Height adjustable mobile work bench:

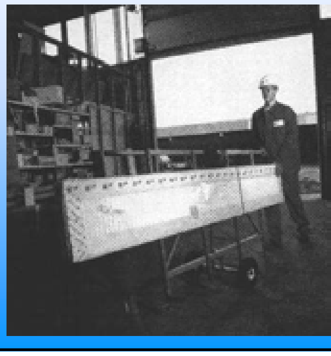
trunk flexion reduction

Reduction in manhours/week: 0,25

TNO

TUDelft

Some solutions:



Transport device for central heating

Eliminates carrying

Reduction in manhours/week: 8

TNO

TUDelft

Some solutions:

Transport device

Eliminates lifting and carrying

Reduction in manhours/week: 16

TNO

TUDelft

Benefits within one year

solution	number of solutions in use	reduction in man-hours/ week	reduction in man-hours (40 weeks)	cost reduction (€ 45/hour)
1	3	16	1920	86400
2	73	0.25	730	32850
3	3	8	960	43200
4	35	0.08	117	5265
				167715

TNO

Discussion

- Effect and evaluation research is not done thoroughly
- In fact only locally improvements are implemented (appr 200 solutions in use for 7,000 workers?)
- Company is not interested in evaluation, whether:
  - Musculoskeletal load reduces
  - Workers experience it positive
  - Financially positive effect

Conclusion

- Ergonomists can support a company having care for workers and productivity in the strategy
- Solution book worked well
- Use tests very needed
- Effect study, evaluation and implementation could be much better

THE EFFECTS OF ERGONOMICS, LEAN MANUFACTURING, AND REDUCTIONS IN WORKFORCE ON MUSCULOSKELETAL HEALTH

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Corporate strategies can have both positive and negative effects on employee musculoskeletal health. This paper will describe the overlapping effects of three different corporate strategies in the Boeing Commercial Airplane Group: participatory ergonomics, lean manufacturing, and reductions in the workforce. Participatory ergonomics activities, with the appropriate ergonomics infrastructure, should reduce work-related musculoskeletal disorders. Lean manufacturing activities should be initiated synchronously with participatory ergonomics, yet, when lean improvement processes focus too much on process improvement, health and safety sometimes suffers due to the creation of new ergonomics problems. Reductions in the workforce create new process and health and safety challenges for lean and ergonomics practitioners.

INTRODUCTION

Work-related musculoskeletal disorders (WMSDs) are affected, both positively and negatively, by numerous corporate strategies. This paper will discuss three different corporate strategies or practices within the Boeing Commercial Airplane Group that have had an effect on the incidences of WMSDs and on the ability to control them. The three different strategies of significance described are: the implementation of a participatory ergonomics program, lean manufacturing activities, and reductions in workforce.

ERGONOMICS

Ergonomics programs are initiated for various reasons. One of these is in response to state or federal regulatory regulations. At Boeing, a second is a planned, proactive approach to identify and mitigate WMSD risk factors in an effort to eventually reduce the development of WMSDs over time.

Phase I: Regulatory Compliance

Implementing ergonomics programs in response to federal or state ergonomics rules and regulations (Phase I) should result in the reduction or elimination of WMSD risk factors and WMSDs. Unfortunately, sometimes the regulatory WMSD risk factor thresholds are too high so that WMSDs still occur, even though regulatory compliance has been achieved. This is when ergonomics programs must go beyond only efforts at regulatory compliance.

Phase II: Participatory Ergonomics

At Boeing, we had to focus attention on what we call a Phase II approach, that is, taking the ergonomics program to the next level in order to reduce the development and occurrence of WMSDs while also being compliant with ergonomics regulations.

Develop Ergonomics Infrastructure. At Boeing, the objective is to improve the overall safety performance at our various production facilities. The method is to build the ergonomics infrastructure that will result in the reduction/prevention of injuries, improvement of production and quality, as well as improved employee morale. The following will describe how we built the ergonomics infrastructure within Boeing and how injuries have been reduced/prevented over time.

Management Support. The basic process for building the ergonomics infrastructure was following the participatory ergonomics model (Cohen, et al. 1997). A critical first step in this process was attaining management support and enforcement of the ergonomics program. We have found that support from management at all levels throughout the organization is essential. One of the ways in which management support is expressed is by assigning lead roles in the ergonomics infrastructure to designated persons who are known to "make things happen."

It is important that management provide support for prototyping/fabrication/mitigation efforts within respective shops since this may result in a greater sense of ownership and involvement. This is especially true within Boeing where unique fabrication and production processes take place and where ergonomics problems are often not amenable to so called "off-the-shelf" solutions.

Naturally, employee involvement in the ergonomics infrastructure is essential. Employees are, of course, very knowledgeable of their jobs and different processes and usually have very good suggestions concerning ways to improve the jobs from an ergonomics perspective. Involving the employees in the infrastructure will also result in a greater sense of ownership and a greater acceptance of job, workplace modifications

Establish ergonomics team. We have had the most success when ergonomics teams are composed of individuals from management, employees, shop union, safety, facilities/process engineering, ergonomics, and medical management personnel.

Training. We developed and delivered ergonomics awareness training for everyone. Job evaluation training was also provided to employees designated as ergonomics focals. (Ergonomics focals are shop mechanics that have the additional responsibility of helping to identify and mitigate ergonomics hazards in the work place.) Other types of specialized training was necessary for the ergonomic infrastructure to be effective, such as manual material handling, work methods, and power tool usage.

Analysis of Injury Data and Selecting High Injury Jobs. With the ergonomics infrastructure in place, the next step in Phase II is a concentrated effort to reduce injuries from occurring in an effort beyond that of regulatory compliance. We recommend analyzing injury data to sort our injuries likely due to WMSD risk factors, such as sprains and strains, inflammations, and carpal tunnel syndrome. These data should then be categorized according to job types or codes in order to determine where most of the injuries have been occurring.

After analyzing the injuries and identifying the jobs with the most injuries, a planned effort at affecting a culture change must be developed. This plan must be presented to and approved by senior management of the affected areas.

We have found success with delivering specially designed ergonomics training to crews with the highest injury rates. Our measures of success include fewer lost time injuries, fewer measured occupational risk factors, and greater productivity. This training includes basic features such as WMSD risk factors in the crew's respective work areas and methods they can employ to reduce them. We try to achieve this culture change through the delivery of customized ergonomics training that stresses that employees should take personal responsibility for their own health and safety and to not always rely on others to have their problems mitigated. We also try to encourage employees to work smart. Part of this training is discussing the various factors that affect lost time injuries beyond occupational risk factors (see Figure 1). Specifically, personal factors such as job stress, morale, and job satisfaction are mentioned. We believe if these factors can be improved, then lost time injuries can be reduced.

We have seen evidence that this specialized training emphasizing a culture change and providing greater ergonomics consultation in the high injury-rate work areas has resulted in improved employee morale and job satisfaction (as measured by employee interviews and surveys) as well as a reduction in injuries likely due to WMSD risk factors. In one of our targeted work areas with high lost-time injuries, 60% of the lost time injuries were classified as WMSDs. After implementing our specialized training in this work area, 0% of the lost time injuries are WMSDs. We view this as a highly significant ergonomics improvement.

Our concentrated Phase II ergonomics activities have resulted in the identification and mitigation of ergonomics risks that would have otherwise gone unnoticed while only focusing on regulatory compliance. Ergonomics programs must, of course, comply with state and federal regulations, but they must not be limited to only reducing risk factors covered by the regulations. The lesson learned is that a comprehensive ergonomics infrastructure can use ergonomics regulations as a starting point, and to provide further justification for the importance of ergonomics, but a truly successful ergonomics program must take activities to the next level.

LEAN MANUFACTURING

Lean manufacturing was derived from automotive manufacturing improvement processes in Japan in the 1950s (Womack, et al. 1990). Lean manufacturing activities are conceptually an effort to improve overall production processes through methods such as reducing unnecessary operations and steps, eliminating waste and errors, consolidating and combining machine and equipment functionality, and using the best equipment and procedures during fabrication and assembly operations. If lean manufacturing techniques are completely followed and delivered, the ergonomics climate, as well as the production environment, should also be improved.

Unfortunately, sometimes only the production and manufacturing aspects of the process are addressed during lean manufacturing improvement activities. There have been cases where lean activities have reduced the number of steps previously required during parts processing while also inadvertently increasing the amount of repetitive motion required on the part of the human operators. The fabrication processes have also been so tightened (or "improved" by lean) that human operators find themselves "tied" to their respective work stations while no longer having the ability to take important micropauses, thus increasing the likelihood of WMSDs developing over time. These, of course are important in order to allow muscles a short rest and recovery period.

Ergonomics teams have been called in to work areas after lean manufacturing improvements have been implemented to try to fix the ergonomics problems that were inadvertently created during the lean improvement process. These types of retrofits are expensive and our estimates are that they cost four times the cost of an initially correct design, thus stressing the importance of addressing all important components of a system during the initial design and development stages. We think the best solution is to integrate overall ergonomics activities into lean manufacturing initiatives wherever possible.

REDUCTIONS IN WORKFORCE

Reductions in workforce is an inevitable consequence of changes in the financial climate that result in decreased demand for products, such as the purchase of commercial airplanes due to less business and personal air travel. Reductions mean there will be fewer people in a work area to perform the required jobs. Even though there are fewer people in the affected work areas, the required work pace may be the same or greater for the remaining employees. From an ergonomics perspective, this may mean that there are fewer people available in order to implement an effective job rotation scheme. This could have a negative effect on musculoskeletal health if administrative controls, such as job rotation, are the only viable option due to the technical or economic infeasibility of implementing engineering controls.

Aging workforce. Seniority sometimes determines how workforce reductions occur. When employees are laid off strictly based upon how long they have been with the company, the result is an ever more senior, or aged work force. Referring again to Figure 1, another factor affecting MSD lost time injuries is aging. We believe there can be a correlation between an aging work force and the occurrence of MSD injuries.

Personal Factors. The factors listed under Personal Factors in Figure 1, such as job satisfaction, morale, and physical/psychological stress, also have an effect on MSD injuries. Reductions in workforce certainly have negative effects on these factors, therefore, this phenomenon may result in an increase in the reporting of musculoskeletal disorders.

CONCLUSION

There are numerous corporate efforts to improve production, processes, and health and safety. These efforts must be coordinated so that they are not accidentally undoing the efforts of the others. We emphasize following a systematic approach to musculoskeletal health. By this, we mean taking a systems engineering approach that takes into account and considers all important aspects of a system. Participatory ergonomics, if correctly and thoroughly delivered, should result in improvements in musculoskeletal health as well as possible process/production improvements.

Lean manufacturing, by its very roots and design, should facilitate the improvement of manufacturing processes while also paying attention to and addressing the effects on the human operators—the ergonomics issues. As previously stated, we recommend integrating ergonomics activities into lean manufacturing processes.

Reductions in workforce is, unfortunately, a corporate way of life. We hope that with new and creative ways of encouraging employees to work safely and to take personal responsibility for the own health and safety while being careful with their own "aging" bodies, that the development and occurrence of WMSDs over time will be reduced.

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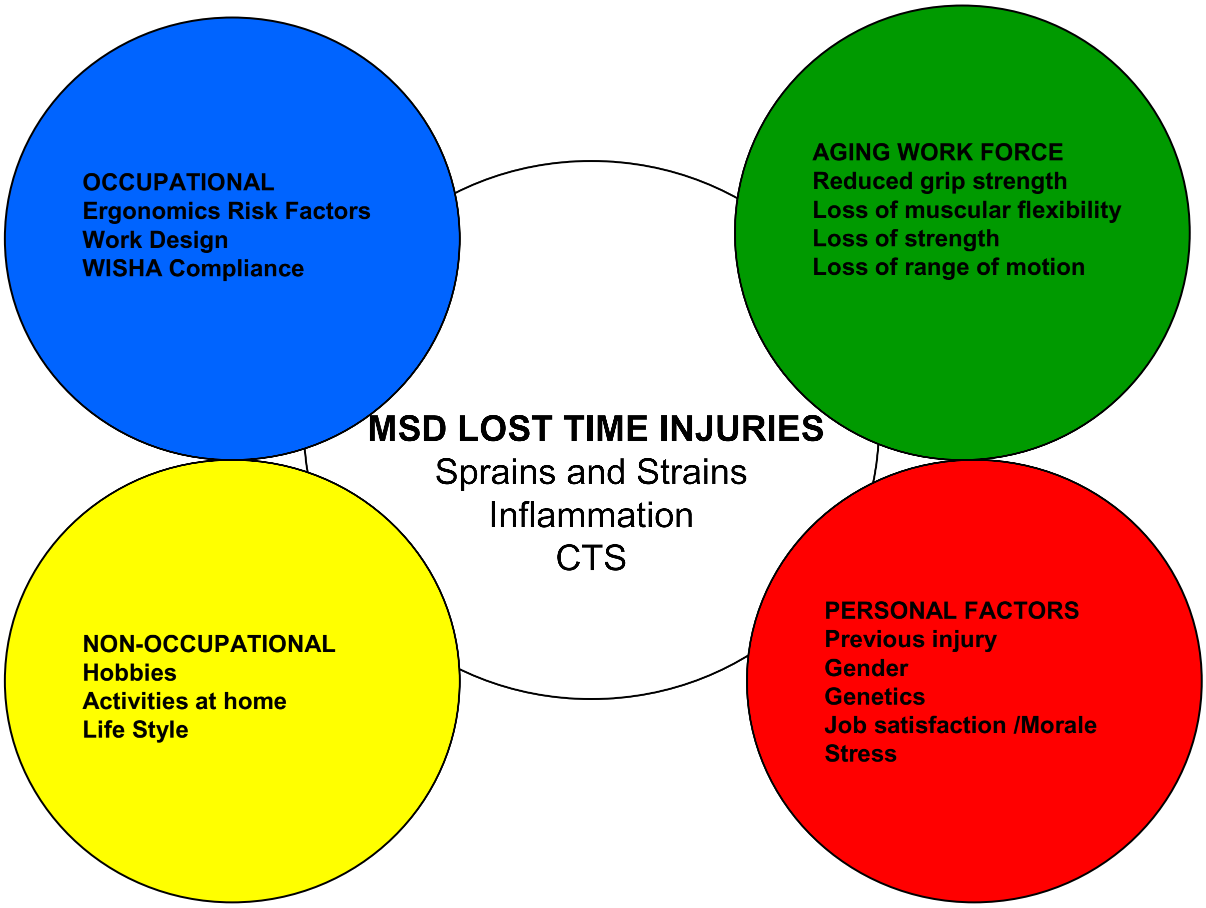

Figure 1. Some factors that affect musculoskeletal disorder lost time injuries.

THE EFFECTS OF ERGONOMICS, LEAN MANUFACTURING, AND REDUCTIONS IN WORKFORCE ON MUSCULOSKELETAL HEALTH

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Presented by
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Associate Technical Fellow: Ergonomics
August, 2003

Introduction

Corporate Strategies Effect Musculo-skeletal Health

Ergonomics Program

Lean Manufacturing Activities

Reductions in Workforce

Ergonomics Programs

Regulatory Compliance

Reduce Workplace Muscukoskeletal Injuries

Improve Overall Safety Performance

Participatory Ergonomics

Develop Ergonomics Infrastructure:

Management Support

Employee Involvement

Establish Ergonomics Team

Training

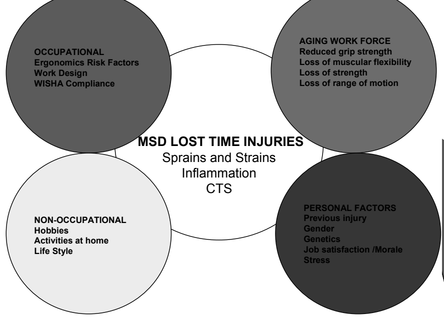
Participatory Ergonomics (cont'd)

Data Analysis

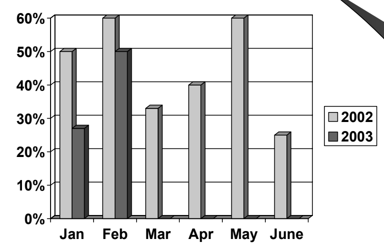
Planned Effort

Specific Ergonomic Training

- Personal Responsibility
- Work Smart
- Personal Risk Factors



Percentage of Ergonomic Related Lost Work Days Cases Within Assemblers and MPRF Job Codes



Lean Manufacturing

- Reduce unnecessary operations and steps
- Eliminate waste and errors
- Consolidate and combine machine and equipment functionality Employee
- Use best equipment and procedures

Lean Successes

Sanding Reduction Workshop

Stringer Splice Workshop

Stowbin Rail Build-Up

Thermal Anti-Icing Duct System

Lean Cautions

Only Production & Manufacturing Processes Addresses

"Domino Effect"

Increased Repetitions

Lack of Task Variety

Reductions in Workforce

Fewer people to perform jobs.

Workpace the same or greater.

Unable to implement job rotation.

Aging workforce.

Personal factors.

Conclusions

Follow a systematic approach.

Participatory Ergonomics.

Ergonomics integrated with Lean activity.

Workforce reductions – a corporate way of life.

- Employee Involvement

ERGONOMICS AND PRODUCTIVITY CONSEQUENCES IN ADOPTING A LINE-BASED PRODUCTION SYSTEM

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Ergonomic and production system effectiveness are evaluated in a case of a production system re-design: from parallel flow dock-based, to serial flow line-based assembly. The line-based system displayed much tighter coupling of operators to the technical system and introduced system, balance and downtime losses. We observed reductions in: cycle times to 6% of previous, decision latitude, influence and control over work, perceived work load, and perception of available pauses. Layout and technology changes helped improve co-worker interaction and support, and reduce instances, but not magnitude, of peak spinal loading. It is concluded that serial flows can negatively affect psychosocial conditions and, if losses are high, reduce physical workload. An 'Action Group' has been formed in the company to adopt an evidence-based approach to the development of systems that are sustainable from both productivity and ergonomics perspectives.

INTRODUCTION

In this paper we use a case study in the redesign of motor assembly system, from a long-cycle dock system to a line-based system (Figure 1), to examine the relationship between system design, technical performance and work related musculoskeletal disorder (MSD) risk. Recent surveys indicate societal trends of increased work intensity – a MSD risk factor. This case's scenario appears to be a trend in Sweden of returning to line based production models after decades of more sociotechnically-based approaches. However evidence suggests that parallel flow systems can be more productive with better ergonomic potential than conventional line systems (Medbo 1999).

Integrating human factors into manufacturing system design remains an under-utilised mechanism for ergonomics intervention (Westgaard & Winkel 1997). While we focus on MSD risk factors, we adopt a systems perspective (Neumann 2001) including also performance and productivity variables of traditional interest to factory design teams. Joint optimisation of all of these factors may allow ergonomic problems to be solved in a profitable way (Winkel & Westgaard 1996). This study is part of a line of research that aims to understand the basis by which a production model is chosen and the consequences of this choice in the realized system.

Figure 1: OLD system dock workstation (left) & NEW line system (right)

METHODS

A longitudinal case study with most measures implemented pre and post system re-design was performed. We integrate qualitative and quantitative methods. Informal interviews and document analysis were conducted to understand both process and outcomes in the system redesign project. Production and economic data were obtained from company information systems and interviews. Questionnaires (n=81 pairs) were used to assess operators' perceptions of pain status, workload, stress, energy and psychosocial conditions. Portable data loggers were used to measure postures of wrists, arms, head, and back while working under normal conditions (n=8 pairs). Video recordings were made synchronously with data logging and analysed with respect to the time used for work activities including direct (value adding) and indirect work. Posture data were obtained for each activity category. In order to understand operators' movement between work areas a position logging system (originally from orienteering) was implemented. Biomechanical models were used to assess individual loading and production simulation models were used to understand system behaviour and working patterns.

Follow-up measures, planned jointly with the company, were made 6 months after the change. While detailed quantified posture and task information is not yet available, qualitative, modelling, questionnaire, and preliminary system performance data will be reviewed. System performance data will be re-examined 12 months after baseline to control for seasonal and run-in effects.

PRELIMINARY FINDINGS

OLD system. The OLD production system, designed with 18 'dock' stations, was studied having 12 Docks and a small 'learning line' in parallel for newer Operators. Operators worked alone at each dock to assemble each motor. Operators were required to finish 5 engines per day that increased to 5.5 shortly before measurement. Operators could stop working once this quota was reached. The system was designed, based on standard times, to allow 6.2 motors to be completed per shift per dock but this target was not enforced and not all operators were believed to be capable of this pace. Hand steered motorized carts allowed transport and lift-tilt position adjustment of motors. Parts were supplied to the dock using a 5-shelf 'kit' stocked with variant specific components by stock 'pickers'.

NEW system. The NEW line system used a serial flow of 18 stations and reduced station cycle time to 6% of the 'dock' cycle time. Automated Guided Vehicles (AGVs) provided motor transport and eliminated short walks between assembly cycles. Parts were supplied directly to the line in large crates. Operators retrieved parts directly from the crates occasionally adopting awkward postures. The AGV contained a computer monitor providing part numbers for the particular variant to the operator. *The product itself* was largely unchanged between OLD and NEW systems requiring about the same component mounting work. There were however many product variants requiring different components that, for lower volume variants, were positioned further away from the operators' workstation resulting in load carrying.

Motivation for the re-design. Reasons for the change, examined through company documents and interviews, included overcoming current capacity limitations and was summarized in the project directive: *"A line will mean it is easier to come to clear the expected 70,000 rate, that we decrease learning time, simplify material supply, make it easier to make other changes (because we skip changing 18 places), have a more social workplace with fewer work injuries and, above all reach a reduced product price".* In apparent contradiction the corporation's own standard on work organisation stated: *"serial flows with short cycle times generate waiting times that are not experienced as pauses but as disturbances in the work rhythm. This also generates accelerated work with poor ergonomics as a consequence."* These waiting times were observed in the new system, with utilization times in the NEW system as low as 67% as seen in simulation modelling (Figure 2). Balance losses were not modelled but are also a relevant factor. These results were predicted by the corporate standard: *"leaving the concept of the traditional line means that the system losses are reduced since the time dependence between fitters/operators is reduced"* and *"parallel flows reduce the need of buffers and reduce balance losses."*

The Work Organization. The 5 motor quotas in the OLD system limited production to 81% of planned capacity (89% at 5.5 quota) and reduced the impact of other

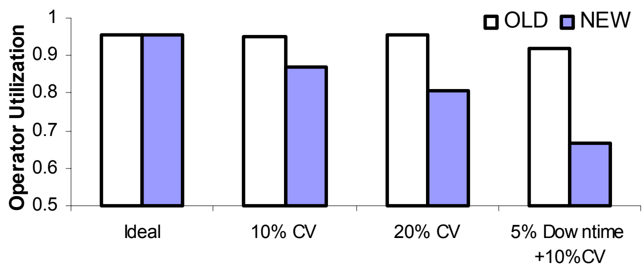

Figure 2: Sensitivity of NEW line and OLD dock systems' operator utilization rates to variability in operators' cycle time (10% & 20% coefficient of variation) and to machine downtime (5% downtime) based on flow simulation models.

losses seen in Figure 2. The OLD system appeared to invite faster work paces to accumulate rest time for operators who could reach the quota. The NEW system had a team structure in which operators rotated every break within the 4-6 stations of the team's area. Operators stayed on-line for the full shift. Waiting patterns in the NEW system, which may not be fully restful, was determined by system loss patterns. Neither system collected information on operators' work pace or work pattern related loading.

System performance. Planned comparisons of system performance are presented in table 1. Data is not presented for the NEW system as the effects due to design strategy were confounded by ongoing run-in activity and simultaneous increases in customer demands that placed unrepresentative pressures on the NEW system. Qualitatively we can report increasing output with similar staffing levels, despite the line system's losses. Labour was saved in 'kit picking' but added with line-'runners' who move along the line as needed. Investment in the AGV system increased capital costs. Extra resources were required to maintain quality levels during the run-in period. More detailed assessment of performance indicators, especially economic factors connected to MSDs, is currently underway.

Biomechanical loading. Affordability of lift-assists was seen as an ergonomic advantage of the NEW system and three were installed. These could not reach more distant component variants however, which then required manual handling and some carrying. Although all stations no longer handled heavy parts, the system-wide peak spinal loading was about the same in both systems with 470N shear loading and L4/L5 compression over 2600N. Nevertheless operators reported lower back loading on the Borg RPE-10 scale ($P<0.01$) on the new system. More detailed profiling of postures and load accumulation, now underway, must also account for system functioning and loss patterns. Duration of exposure to powered hand tools, for example, could be expected to rise as direct labour efficiency is increased in the new system. The company collects no systematic data with regards to operators' exposure to biomechanical load.

Questionnaires. Pair-wise comparisons of operators experienced in both dock and line systems (n=54) indicate significant ($p<0.05$) reductions in 'decision latitude', 'influence and control of work', and 'physical exertion' scales and increases in 'social support' and 'relationships with fellow workers' scales in the NEW system compared to OLD. While a trend ($p<0.11$) of reduced general 'physical discomfort' was observed, the 'Nordic' symptom instrument indicated increases in shoulder pain (3-month history). In this sub-sample of operators, 71% reported fewer pauses in the new system (6% said more) - consistent with the quoted corporate standard. Most operators also reported reduced work variation (68% vs. 19%), and reduced stimulation (63% vs. 16%) in the NEW system. These results are consistent with a shorter cycle, pace-controlled system with in which operators are close enough to talk to each other.

Table 1: System Performance Comparisons (Data normalised to the Total per motor costs in the OLD system, n/a indicates data not yet available)

Indicator	OLD	NEW
PRODUCTION- Volumes (normal to Old)	**100**	n/a
Standard Cycle Time (normal to Old)	**100**	6
Throughput time (normal to OLD)	**100**	n/a
STAFFING – Total Operators (% OLD)	**100**	102
Middle section (% OLD Total)	18	18
Picking (% OLD Total)	11	0
Docks/Line (% OLD Total)	34	46
USA Motor line (% OLD Total)	0	7
Other (% Old Total)	37	30
ECONOMICS* – Total Costs (norm/motor)	**100**	n/a
Direct Labour Costs (%OLD Total)	50	n/a
Indirect Costs (%OLD Total (%OT))	50	n/a
Ind. Costs – Labor (%OT)	42	n/a
Ind. Costs – Capital (%OT)	4	n/a
Ind. Costs – Maintenance (%OT)	1	n/a
Ind. Costs – Other (%OT)	3	n/a

DISCUSSION

This is a case study and therefore represents a particular instance and time-point of these two production strategies. Table 2 presents an overview of specific system design elements and their apparent consequences for system effectiveness and ergonomics. These results are consistent with previous case studies (eg Neumann 2001) and generally show internal consistency across qualitative and quantitative domains. Of the many measurement issues affecting this study the interpretation and stability of company data systems posed a particular challenge. The dynamic nature of the production system itself, where coefficient of variations in monthly production indicators ranged from 10-25% or more during this run-in period pose interpretational challenges. To overcome this variability we applied a broad range of measures to triangulate on the ergonomic and

Table 2: Analysis of some of the consequences of key design elements on system effectiveness and ergonomics.

Design Element Change	System Effectiveness		Ergonomics	
	Benefit	Deficit	Benefit	Deficit
Parallel to serial flow	Facilitated change in work organisation	Sensitive to system, balance, and downtime losses	Production disturbances may provide break opportunities	Reduces possibility of spontaneous breaks, reduced job control
Reduced cycle time	Easy to learn station More control of operator time		Easier to tell if work pace matches system	Reduced physical movement variation
Changed system & workstation layouts		Adding components for new variants difficult due to space constraints	Increased opportunity for interaction, not all stations handle heavy parts	Lift assists can't reach all heavy parts
Change from Kitting to Line Picking	Picking of kits eliminated (positions eliminated)	Operators must walk further to some parts	Lift assists (3) available for picking heaviest parts	Lifting parts from bins still cause high loading.
Manual to automated guided vehicles (AGVs)	No manual steering work On screen checklists for variants	High capital & upkeep costs, prone to breakdowns (losses)	Adjustments can reduce biomechanical loading	Reduces physical variation, Contributes to reduced job control
Work Organisation change (solo to team-work, eliminate quota)	Operators remain 'on-line' for full shift.	'Runners' needed to assist with line disturbances (positions added)	'Team' structure may foster co-worker support	Work pace steered by system, Reduced job control

productivity consequences of production system design choices (Table 2). This analysis sets the stage to identify system elements that could be strengthened or modified to improve both ergonomics and effectiveness simultaneously.

Assembling motors is largely a job of getting components and bolting them on. An important aspect for MSD risk will be how concentrated these activities become for operators. If efficiency gains are sought by maximising operators' nut-running time, for example, then MSD risk will increase. If, on the other hand, current losses could be filled with productive work that does not increase critical biomechanical exposures then both good ergonomics and good productivity could be achieved. This is the challenge for the company's 'Action Group', recently established at this site. This multi-stakeholder group is to make 'evidence based' improvements to 1) current systems, 2) future system designs, and 3) the product by which both human factors and other productivity goals can be met in a sustainable production system. We will operate in an action research mode offering tools and using information feedback, including the analysis presented here, while monitoring both process and outcome factors during the development project. The objective is to see if productivity can be improved in a sustainable way by working smarter - not just harder.

CONCLUSIONS & RECOMENDATIONS

While physical load amplitudes were controlled by workstation layout factors, system-flow & work organisation strategies controlled individuals' exposure time patterns. Adoption of the line system bypassed work organisational barriers in the OLD dock system (the quota) that limited productivity and rewarded operators who rushed with longer rest periods. Instead system and other losses in the NEW line system created many small waiting periods during the day and resulted in reductions in productivity, work autonomy, and decision latitude. The current case shows both systems to be sub-optimal when ergonomics and productivity are considered jointly. Companies should adopt tools and processes to generate and evaluate evidence of both human and technical factors in designing production systems. We suggest that hybrid systems with parallel elements and team-based work may provide new opportunities for innovation. Follow-up monitoring is necessary to track system stabilisation and aid the ongoing joint optimisation of ergonomics and productivity in this manufacturing system.

ACKNOWLEDGEMENTS

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CASE STUDY:

Ergonomics and productivity consequences in adopting a line-based production system

W.P. Neumann, J. Winkel, R. Magneberg, S.E. Mathiassen, M. Forsman, M. Chaikumarn, G. Palmerud, P. Medbo, L. Medbo

Aug. 2003

Arbetslivsinstitutet WEST National Institute for Working Life

VOLVO
Powertrain – Skövde Plant

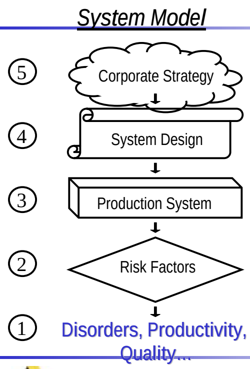
D12 Final Assembly

- Production System re-design
- Good-bye DOCKS… …Hello LINE!
- new AGVs
- New work organization

A RESEARCH OPPORTUNITY!

OLD	NEW
’DOCK’ Station	’LINE’ System

‘Causal Cascade’

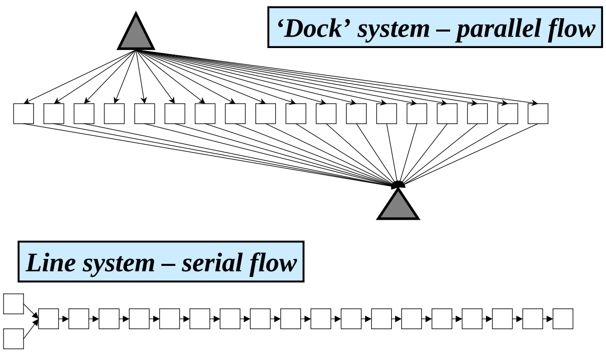


Key Stakeholders:

- Senior Managers
- Production Engineers
- Production System Staff
- Individual Operators
- Varies (Individual, Company, Society)

Methods & Triangulation

- Qualitative Assessments – informal dialogue
- Questionnaires (psychosocial, pain, psychophysical, work organisation)
- Document Analysis (Economic, production, quality, strategy)
- Video Recordings
- Direct Posture Measurement (Lund loggers)
- Flow Simulation (Automod)
- Biomechanical Modelling (Watbak)
- Economic Modelling (M. Oxenburgh)

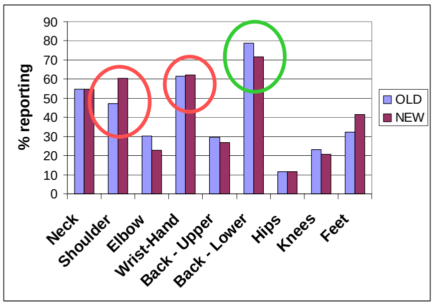


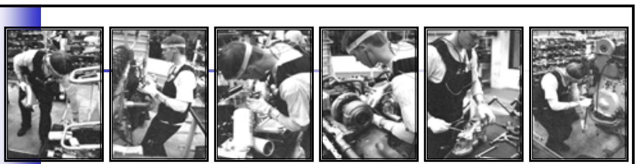
Document Analysis

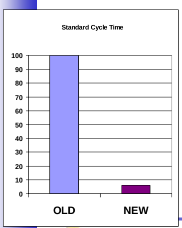
"leaving the concept of the traditional line means that the system losses are reduced since the time dependence between fitters/operators is reduced" **and** *"parallel flows reduce the need of buffers and reduce balance losses."*

- Volvo Corporate Standard

Pain Reporting







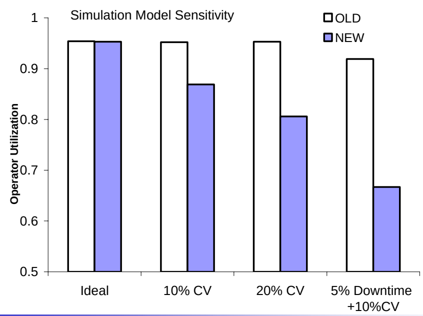
Cycle Time Down to 6%

Knowledge inside the company…

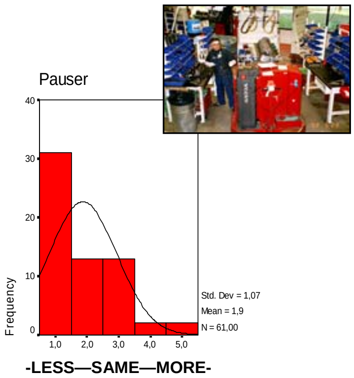
"serial flows with short cycle times generate waiting times that are not experienced as pauses but as disturbances in the work rhythm. This also generates accelerated work with poor ergonomics as a consequence."

- Volvo Corporate Standard

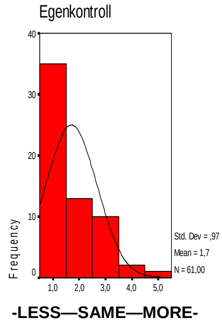
FLOW SIMULATION MODEL – Sensitivity to operator variance & disturbance



Fewer Pauses & Reduced control over work-pace



Line Flow linked to Decreased Control/Autonomy



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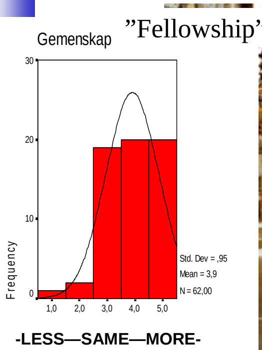
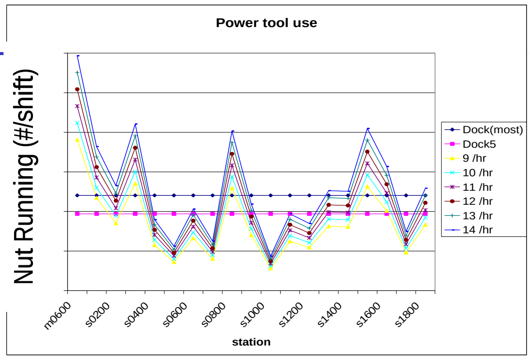
Layout & Teamwork Increased Social Support





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Conclusions

- Layout controls exposure amplitude, flow strategy controls exposure pattern
- Serial flow associated with:
  - Increased repetitiveness (less variability)
  - Increased Output
  - Decreased efficiency (System losses)
  - Decreased control & perceived pauses
- Layout and Work Organisation increased co-worker support

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Recommendations

- Both Systems were suboptimal - Hybrid systems using team-work and parallel flow elements have good innovation potential

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Ergonomics

Productivity	Better	No Change	Worse
Better	*Go!*	OK	$ + pain
No change	OK		X
Worse	**Hidden Gains?**	X	X

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ORGANIZING FOR CHANGE

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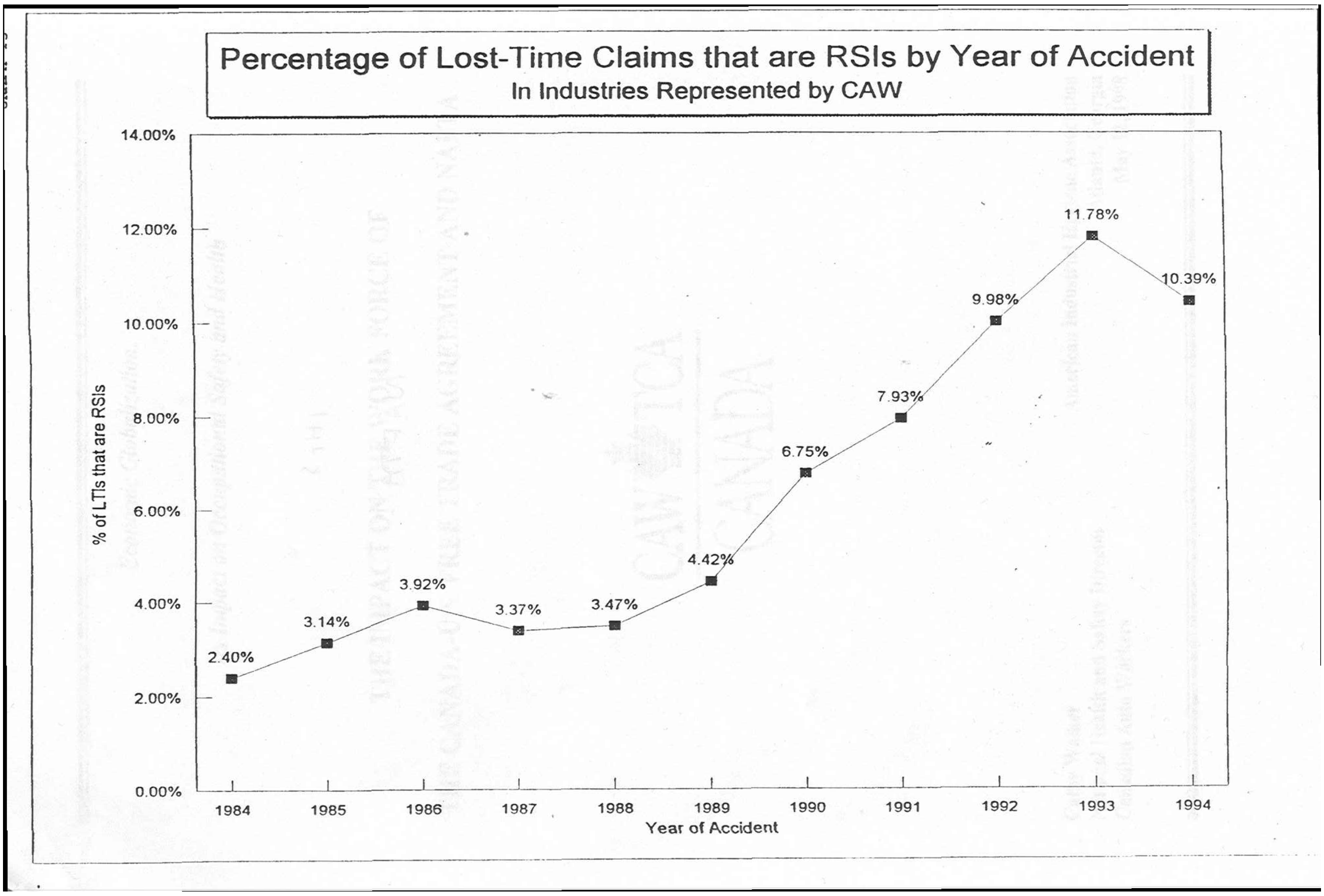
The papers have all centred around a common theme. Simply put, corporations have the control over the workplace and workers suffer the consequences. Work intensification caused by the corporate strategy of globalization and competitiveness, create problems for workers. Physically, they cause musculoskeletal problems and both physically and emotionally they cause stress which leads to a variety of health effects. Unions are workers' organizations that need to organize to attempt to change this state of affairs.

According to an August 12, 2003 report by Statistics Canada, almost 2.3 million Canadian adults suffer from repetitive-strain injuries and almost one-third of them live in chronic pain.[1] This report gathered data from 125,000 respondents. In 2001, the Statistics Canada report said 10.1 per cent of the Canadian population had the condition, up from 8 per cent in 1996, with half the respondents reporting their conditions were work-related. Among women workers who describe their work as "extremely stressful", the rate of RSI tops 18 per cent – almost double the rate in the general population.

Pain takes place in the context of our economy. In 1989 the Free Trade Agreement was signed between Canada and the United States and lean production methods manifested themselves in the context of uncertainty about job loss. In response to this, a dramatic increase in musculoskeletal injuries began to occur in the automotive, auto parts and aerospace industries in Ontario according to statistics produced by the Workers' Compensation Board in 1995.

Ontario Workers' Compensation Board, 1995:



Under the leadership of David Robertson, Director of the CAW Work Organization and Training Department, the CAW studied conditions among our auto parts and automotive assembly members in 1995-6. These are the results for the 1,600 members in the auto parts study:

Conditions are bad:

- 61% said their workload is too much
- 40% said they worked in pain at least half the time
- 44% said their job is more tense than it was 2 years ago
- 55% said they couldn't keep up the current pace until age 60
- 53% said they worked as fast as they could most of each day
- 37% said they worked in an awkward position at least half of the day

And they're getting worse:

- 41% said their health risks at work are higher now than 2 years ago
- 45% said they are more tired after work than 2 years ago
- 52% said their workload is heavier now than 2 years ago[2]

The point, however, is not simply to measure the problem, but to do something about it.
Research in our union takes place within overall strategic goals so we can put research results into action. Just before bargaining with the Big 3 automobile manufacturers (General Motors, Ford and Chrysler) in 1996, we published the results and issued them at a press conference. The results confirmed our concerns about speed up and work intensification in the context of the North American Free Trade Agreement of 1994 which with the addition of Mexico was both the successor to the Free Trade Agreement between Canada and the United States, and the proving ground for the World Trade Organization which came into existence the following year.

Publishing the research results just before bargaining in 1996 validated the reality of the membership's concerns and solidified their support for our demands to improve ergonomics and time study provisions in our collective agreements. We convinced the employers of the need for progress in this area. During negotiations with General Motors, a strike over the issue of contracting out was an important element of the fight against uncertainty about job loss which is part of the corporate strategy of globalization. We now have extensive provisions for ergonomics in our master agreements with General Motors, Ford and DaimlerChrysler. Improvements continued to be made in our 1999 and 2001 bargaining so that now the wording of the master agreements includes the following provisions:

- National Ergonomics Coordinator, chosen by union, paid for by employer for each of the Big 3
    - National Joint Ergonomics Committees
    - Input into overall corporate ergonomics process
    - training of local ergo committees
    - production systems
    - access to all completed ergo studies
- Local Ergonomics Committees
    - Local joint ergo committees and most plants have full time union ergonomics representative
    - 40 hours joint training
- Fitting jobs to people strategies:
    - Identify priority jobs through medical records, worker reports, risk factor checklists and assessments
    - evaluating job stresses to reveal causes of injury/illness or complaint
    - reduce or where feasible eliminate causes by changing work methods, machinery, tools, equipment and workstation design
    - Implement and test the changes to determine their effectiveness
    - document changes
    - follow-up to make sure issue is corrected and job changes are used
- Factors to be considered:
    - movement and postures of limbs and whole body as workers perform a task
    - energy expended in performing a task over a given period of time
    - amount of physical strength required for task or job
    - relationship between worker and machine, equipment, workstation and workplace

    - design and layout of control panels and displays
    - repetitiveness of the task
    - pace of work
- CAW Health and Safety Training Fund: 40 hour union course for all union leadership in Big 3
- In each plant, the union health and safety representative is encouraged by company to actively participate in the health and safety review and approval of machinery and equipment at manufacturers facility (including Europe, Japan, U.S.) and in plant prior to start up to provide recommendations to management.

As well, we recognize our role in the fight for ergonomics to protect all workers, not only our members. We have been in the forefront of the lobby for ergonomics regulations in Canada which we now have in three provinces and are part of a government-employer-labour working group which is drafting regulations for the federal jurisdiction.

These activities all take place in the international fight over globalization which took the world stage in Seattle in 1999, where our union's western Canadian members took part. Our union was present in force at the Quebec City protest against the Free Trade Agreement of the Americas in April 2001.

The fight for improvements for workers is an international one. We acknowledge and applaud the landmark agreement arrived at by the Hyundai Motors Workers Union late on August 8th who succeeded in negotiating a five day work week to begin September 1st, and no unilateral layoffs or voluntary early retirement programs without co-determined decisions with union   The corporate response to the union's partial and full strikes which began on June 25th, was sensible, despite other employers' concerns about the erosion of "management's rights". We salute the Korean Metal Workers Union's struggle and achievement in auto parts, now duplicated in Hyundai.

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1. *Health Reports,* Statistics Canada, August 12, 2003.
2. CAW Benchmarking Study, Auto Parts, 1995.

Corporate Strategy, Production System Design, and Musculoskeletal Health, Response

Cathy Walker
National Health and Safety Director, CAW-TCA Canada

Each of these excellent, thoughtful papers has raised the issue of how the way work is organized influences the health of workers. In the international context of globalization, deregulation, privatization and free trade, we see that the corporate drive for competitiveness has produced leaner manufacturing.

We must ask, does lean production have to be mean production? In other words does lean production automatically result in an increased incidence of musculoskeletal disorders (MSDs)? Is there an inherent contradiction between the needs of this system of production and the needs of workers?

The examples we've heard this afternoon are from Northern Europe and the United States. In both areas the economic system which is the foundation of the production system is capitalism. In these two geographic areas, separated not just by the Atlantic Ocean but also by differences in social norms, what are the similarities and what are the differences which set the framework for the productive process and its effect on workers?

Must workers simply be factors of production? If we are to reduce the incidence of musculoskeletal disorders in the workplaces of the 21st Century, must workers remain the objects of production or can they be transformed into the subjects of production?

If this is possible, what is the role of professional ergonomists in this transformation? Do professional ergonomists simply engage in "charity", helping out disadvantaged workers or should they express solidarity with the workers, the very people whose disabilities they seek to prevent?

If ergonomists challenge the employers' agenda of lean production, will ergonomists be effective in advocating change? If ergonomists intervene in the design stage or in the retrofit stage, making work less difficult, easier and more comfortable for workers, but employers respond by reducing the workforce and speeding up production, have we accomplished anything? Have we helped workers?

If the employers' goal of lean production is to reduce the workforce with the remaining workers working harder and faster in order to keep up, with MSDs the result, what should the role of ergonomists be – silence or action? If the role is action, what should it be? In the context of lean manufacturing, is it possible to move beyond simply preventing MSDs to promoting health, the highest state of physical, mental and social well being? And if it is possible, how? And what should the role of ergonomists be?

And a final point needs to be noted. My counterpart in South Korea, Mr. Park Seo Min, Health and Safety Director of the Korean Metalworkers' Federation is not able to join us for this conference, despite a high degree of interest in the issue. The reason he is not here is because he is in jail, together with three of his colleagues for participating in a demonstration and allegedly obstructing an officer of the peace. But the real reason for their imprisonment is engaging in a public campaign to have repetitive strain injuries recognized as compensable injuries in South Korea. Sentencing will be on Monday, September 1, 2003 and the prosecution seeks jail terms of three years. This outrage puts this session and indeed the whole conference, into perspective, doesn't it?