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(Eds)

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National Institute for Working Life

National Institute for Working Life

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- musculoskeletal disorders,
- chemical substances and allergens, noise and electromagnetic fields,
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Foreword

Ergonomics has its major scientific roots in the late 1940-ties. Over the years the field of ergonomics has gradually been broadened and increasing research efforts have yielded a considerable body of knowledge concerning the design of tools and work stations as well as organisational design to prevent worker discomfort, illness and absenteeism but also to improve productivity and product quality. An awareness of the fact that investments in improved ergonomics may in many cases be profitable is noticed.

One consequence of this is that tailored ergonomic programs are set up for whole companies or groups within companies, e. g. office workers, floor workshop personnel or designers of products. Such programs may consist of guidelines concerning work-load aspects such as work postures and movements, lifts, but also guidelines concerning equipment, product design, noise levels, vibration, lighting, climate, safety and even work organisation. The idea is to educate the personnel of the company in good ergonomics using a corporate program to improve health, well-being, productivity and quality. The program can be a stand-alone ergonomics program or be integrated with a quality program. As this idea is fairly new, only few companies have experiences in the field apart from the normal occupational health survey programs.

The aim of the seminar was to bring together interested management, health and safety personnel to discuss the design and experience of such programs. Both representatives from companies and researchers have given presentations on the subject.

Solna, april 1999
Bengt-Olov Wikström and Göran Hägg

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Ergonomic programs and rationalisation

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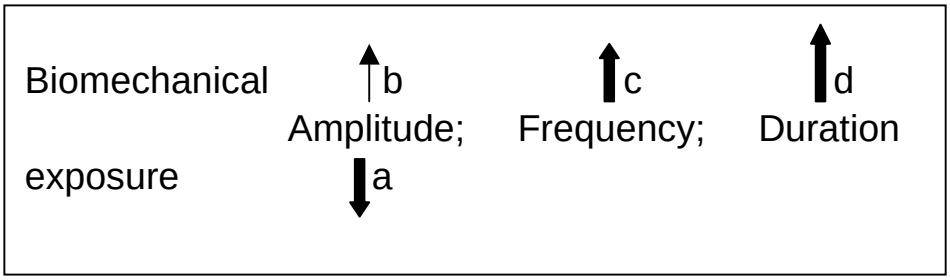
Introduction

Occupational musculoskeletal disorder is a significant worldwide problem in terms of human suffering as well as economic loss. Appropriate ergonomic programs may thus offer a considerable potential for improved musculoskeletal health.

However, an overview of the literature regarding documented intervention programs against occupational musculoskeletal disorders seems in general to cause a low impact (2). One reason for this can be that ergonomic interventions often intervene only against a minor fraction of the problem; e.g. individual factors such as health education or relaxation training or workstation and tool design leaving out the basic problem: the design of the production system. Crucial decisions concerning production systems are made by 'production planners' (including management) and not by ergonomists. Thus, two main groups of stakeholders influence ergonomics at the workplace.

Mechanical exposure ('physical work load')

Ergonomic programs traditionally have focused primarily on one of the three main exposure dimensions: the exposure *level*, as indicated above. In addition, also the exposure *frequency* (i.e. repetitiveness or "variation pattern") and the *duration* constitute important aspects of the exposure quantity when it is evaluated in relation to risk (3, 4). Production planners may strongly influence the time dimensions when assessing and developing the rationalisation strategy of the company (see figure 1).



a: effect of the ergonomic intervention; b, c, d: effects of the rationalisation

Figure 1. Illustration of possible interactions between two kinds of intervention, based on ergonomics and Taylorism (Fordism), with regard to exposure. The exposure quantity depends on the amplitude of the load, its "variability" (i.e. the frequency content or repetitiveness) and the exposure duration. Ergonomists usually focus on workstation and tool design, which may reduce the exposure amplitude (a). Time and motion studies combined with introduction of piece-rate may increase all three exposure factors (b, c, d), thus eliminating any ergonomic effects.

Furthermore, the ultimate objective is different for the two groups of stakeholders: the ergonomist emphasises *health* and *comfort* while production planner aim at *productivity*, *product quality* and *effectiveness*. Traditionally, the ergonomic literature focuses on the actions taken by the ergonomists. Only marginal understanding and attention is addressed to the ergonomic significance of rationalisation.

Rationalisation and ergonomics

The aim of rationalisation is to maximise productivity under the prevailing conditions, e.g. legislation, educational level of available work force, culture, etc. The rationalisation strategy of a production system is defined by its technology level and work organisation. The *technology level* may be defined as the distribution of work tasks between machines and employees, and the *work organisation* as the distribution of work tasks between the employees. Thus, it seems obvious that the rationalisation strategy of a company strongly influences the exposure latitude, within which the ergonomist may act.

The conflict between ergonomics and a common rationalisation strategy like Taylorism (Fordism) may be illustrated by citing a classical textbook for production engineers ((1), page 674):

"The arguments in favour of division of labour are numerous:

1. High degree of specialisation enables the worker to learn the task in a short period of time.
2. A short work cycle permits rapid and almost automatic performance with little or no mental direction required.
3. Less capable people can be employed to perform highly repetitive short-cycle operations - with a lower hourly wage being paid.
4. Less supervision is required, since the operator soon learns his job, and with the standardisation of materials and parts coming from preceding operations, there is little chance of interruptions during the day."

However, new market conditions arising during the recent decades have caused development of new management approaches. To-day many companies emphasise team building, flat organisations, training of multiple skills, and so on. This kind of rationalisation may, under the right circumstances, improve not only productivity but also ergonomics, which in turn may increase the productivity (4).

The awareness of good ergonomics as a tool to increase productivity seems to arise in some highly competitive companies. Acceptable biomechanical and psychosocial exposures may influence productivity positively directly and through high level of musculoskeletal health. On the other hand, undue productivity demands may cause undue biomechanical and psychosocial exposures and endanger musculoskeletal health independent of rationalisation strategy (5).

On this background the R&D program COPE was initiated in 1996 (Winkel et al., In press). An important aim of COPE is to develop a 'tool box' to enable companies to balance production and ergonomics by themselves. COPE is an abbreviation of 'Co-operative for Optimization of industrial production systems regarding Productivity and Ergonomics'.

Conclusion

Ergonomic programs need to pay attention not only to individual factors, workstation and tool design but also to *usage of time* during the working day. Accordingly, the ergonomists and production planners need to co-operate in order to optimize the production system, i.e. the short-term needs for high productivity should balance ergonomic needs.

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Musculoskeletal disorders – statistics and regulations

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Statistics

In Sweden ergonomics has been and still is, almost equivalent to prevention of musculoskeletal (m-s) disorders. In accordance to this, what follows will deal with these aspects. The basis for good prevention is knowledge of the problems, i.e. statistics on both exposure and effects. In Sweden there are two major sources of information; statistics on occupational injuries (workers compensation claims collected and reported in the so called ISA-system, administrated by the Board, (4)) and a database from a biannual survey on people judging their working environment in different aspects (here called the SCB-survey (5)).

M-s injuries (both accidents and diseases affecting the m-s system) are the major cause of occupational injury. About one third of all injuries are m-s injuries (fig 1).

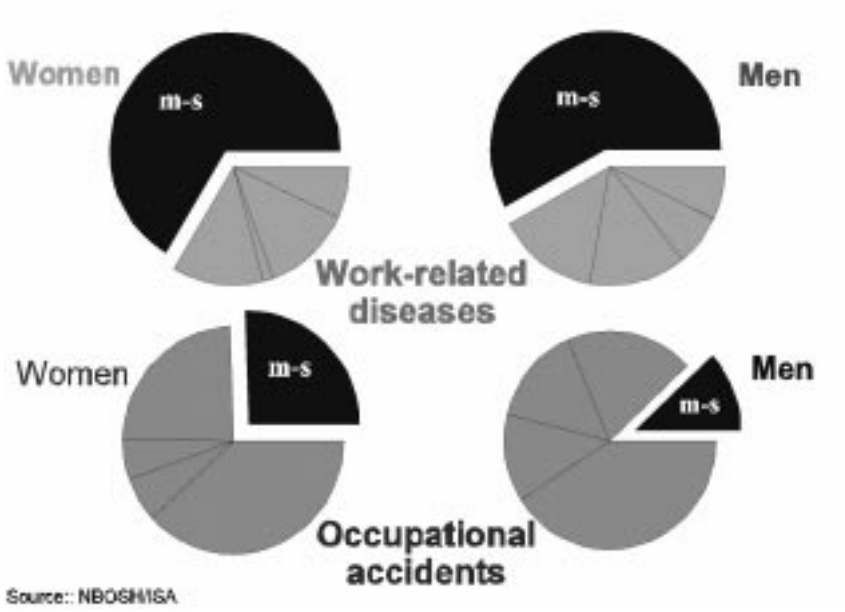

Figure 1. Work-related diseases and accidents in 1997.

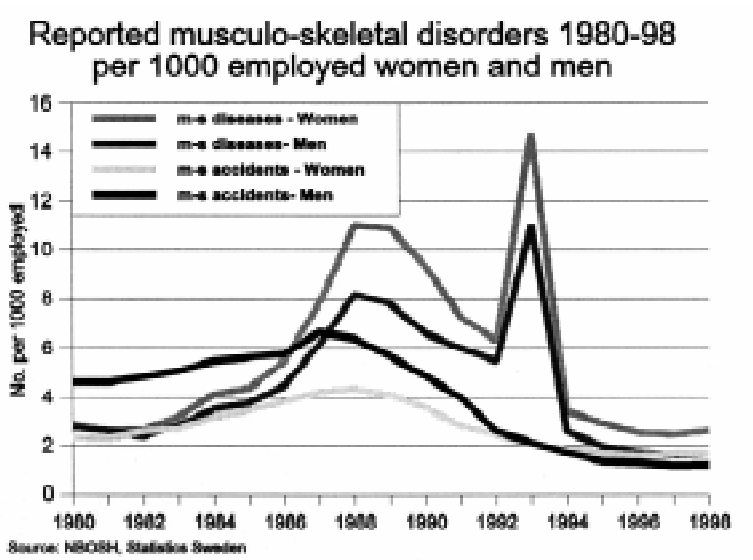

Figure 2. The development of occupational m-s injuries.

The big fluctuations in the development of occupational m-s injuries are mainly caused by amendments in the workers compensation regulation (fig 2). Common causes to m-s disorders are heavy manual handling of goods, assisting patients/clients and bad working postures with "stress" as a contributing factor (fig 3 and 4).

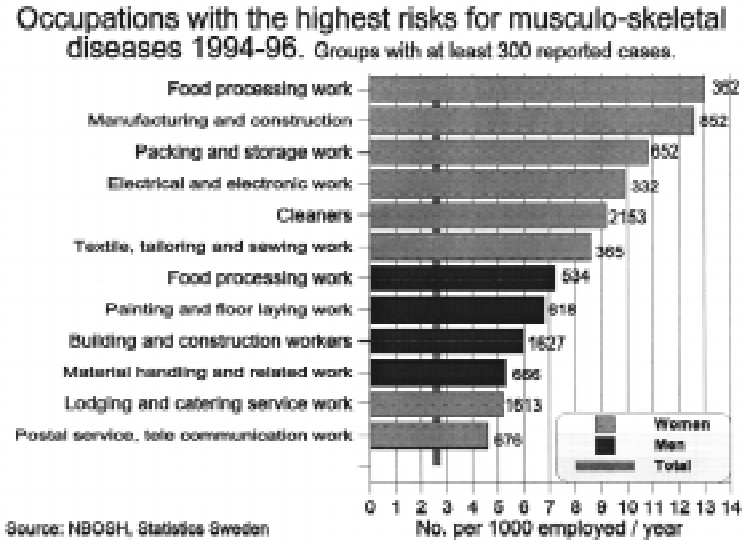

Figure 3. The "Top ten high risk occupations" for m-s accidents and diseases respectively.

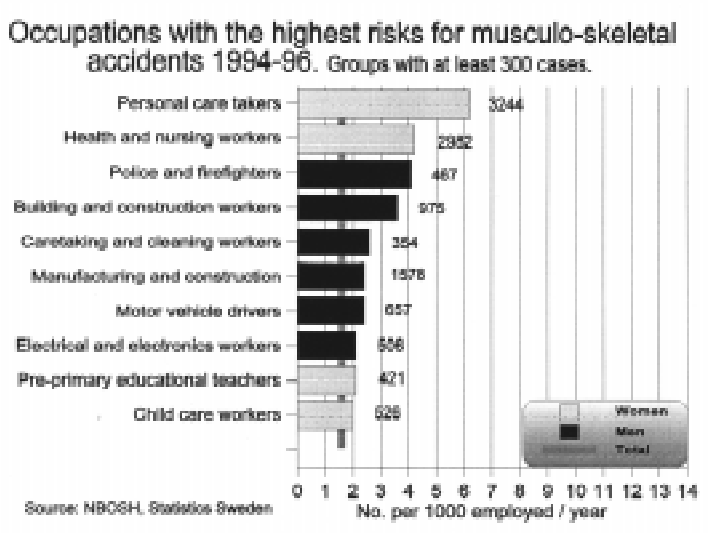

Figure 4. Occupations with the highest risks for musculoskeletal diseases.

The SCB-surveys give us information about how people judge their working environment. Some examples of survey data are shown below (table 1). When comparing figure 3 with table 2 you may wonder why female food processing workers do not show up in table 2 "repetitive work" as obviously as in figure 3. You find them under "craft and related trades workers" as they are only 60 respondents and have to be presented together with other closely related professions to pass the number of 100. Only groups of more than 100 persons are presented in tables in the SCB-survey.

Table 1. Heavy weights – persons have to lift between 15 and 25 kgs several times every day.

Women: (total 14%) 1995/97	%	**Men**: (total 21%) 1995/97	%
Assistant nurses and hospital ward assistants	48	Building frame and related trades workers	58
Child-care workers	39	Skilled agricultural etc workers	49
Home-based personal care and related workers	35	Stock clerks and storekeepers	47
Skilled agricultural workers	28	Heavy truck and lorry drivers	45
Nursing associate professionals	25	Other craft and related trades workers (food processing, wood treaters)	42
Pre-primary education teaching associate professionals	23	Painters, building structure cleaners and related trades work	41

Source: Statistics Sweden, NBOSH

Table 2. Repetitive work - persons that have repetitive tasks (several times per hour) at least half of the time.

Women: (total 44%) 1995/97	%	**Men**: (total 36%) 1995/97	%
Cashiers, tellers and related work	92	Agricultural and other mobile-plant operators	79
Assemblers	83	Motor-vehicle drivers	72
Helpers and cleaners in offices, hotels and other establishments	79	Painters, building structure cleaners and related trades workers	70
Other personal services workers (hair-dressers, undertakers)	79	Other craft and related trades workers (food processing,wood treaters)	64
Craft and related trades workers	77	Machine-tool operators	60
Client information clerks	73	Elementary occupations	59

Source: Statistics Sweden / NBOSH

The SCB-survey also gives possibilities to look at combinations of exposures and how they affect the individual. From the examples you can see the aggravating influence of combinations of load factors and also an indication of the fact that women often experience more disorders than men (tab 3 and 4).

Table 3. Proportion of individuals with ms-disorders in shoulder/arms the last 12 months.

		Repeated similar operations many times per hour			
		Men		Women	
		half work shift	< half work shift	half work shift	< half work shift
Work with hands at or above shoulder level	1/4 work shift	13.5	8.6	20.9	9.7
	<1/4 work shift	6.9	3.9	11.2	6.7

Table 4. Proportion of individuals with m-s disorders in the low back the last 12 months.

		Work in twisted position			
		Men		Women	
		1/4 work shift	< 1/4 work shift	1/4 work shift	< 1/4 work shift
Lifting 15 - 25 kg several times	every day	18.6	11.6	21.3	11.0
	every week	12.1	4.8	13.0	5.6

Regulations

There is more to be said about the disorder panorama in Sweden but more interesting is perhaps how we try to counteract the adverse effects of all these load factors. One considerable basis is to have effective and wellknown regulations. The Board's Ordinances for the working environment in Sweden are based on the *Work Environment Act* and provisions concerning the prevention of m-s disorders have been present since 1984 (1, 3). In fact these were the first provisions in this field in the world. A lot has happened since 1984 not only in research but also within international standardisation and supervisory methods. There has been a need for revisions for quite a long time and the first of July 1998 new ordinances came into force (2).

We all know that there is a need for wider knowledge among these groups. This lack of knowledge holds for both legislation and facts about ergonomics. We all need to contribute to diminish these deficiencies. The revision had three major purposes:

- to comply with tightened up demands on employers´ responsibilities regarding control and adaptation of work places in accordance with a widened understanding of the interaction between physical, psychosocial and organisational factors
- to clarify the responsibilities of the employer and others in the working environment e.g., the employee himself, designers, manufacturers, suppliers, planners and co-ordinators
- to provide a clear and quantitative guidance for the assessment of ergonomic risks to the musculoskeletal system

The provisions are applicable to the whole working life in accordance to the Swedish Work Environment Legislation, i. e. pupils from the first grade (6-7 years of age), employees performing telework and personnel within the military service included (3).

The provisions *Ergonomics and the prevention of musculoskeletal disorders* (2) contain:

1. Mandatory ordinances disposed into 12 sections. The main ideas refer to the achievement of good and favourable ergonomic working conditions including job content, job diversity and autonomy.

2. Comprehensive general recommendations intended to elucidate the provisions by giving background information and examples illustrated by a multitude of drawings from different working situations. The recommendations, which are not mandatory, also explain suitable ways of meeting the requirements expressed in the ordinance.

3 a. Four pedagogic models serve as guidance at the assessment of ergonomic conditions such as; work postures, manual materials handling, physically monotonous repetitive work and pushing/pulling operations.

3 b. A general checklist for the identification of musculoskeletal stress factors, which may have injurious effects.

You also find among other ordinances from the National Board, sections which deal with working situations, professions or branches where m-s disorders are obviously apparent e.g. *Presses AFS 1987:15*, Use *of high Pressure Water Jet Equipment AFS*

1994:54, Work in Checkouts AFS 1992:19 and of course the likewise newly revised *Work with visual display units (VDUs) AFS 1998:5*.

In addition there is the Ordinance *Internal Control of the Working Environment AFS 1996:6*. These provisions state that the employer has to have a system for handling the working environment. Among other things he/she shall continuously investigate working conditions and assess the risks of ill health and accidents at work. Another obligation is to inquire the causes of ill health, accidents and serious incidents at work and annually make up a written summary of what has happened. These sections, as all the others, also apply to ergonomics.

The European Directive on the minimum health and safety requirements for the manual handling of loads where there is a risk particularly of back injury to workers (90/269/EEC) has been implemented in the new Swedish Ordinance. The international work on standardisation both in Europe and worldwide has been considered as well.

There is a section in the Ordinance 1998:1 addressing manufacturers, importers, suppliers and providers. It says that they shall as far as is practically possible ensure that the technical devices, substances and packaging delivered do not cause physical loads which are dangerous to health or unnecessarily fatiguing in connection with installation, normal use, maintenance or other commonly occurring handling. It is to be noted that this section does not apply to products coming under EC Directives for the purpose of eliminating impediments to free trade between the Member States. In these cases you have to follow the EC Directives. CEN-standards will become guidance how to comply with these Directives. A Directive with great influence on ergonomic conditions at the work places is The EC Machinery Directive. Examples of standards based on this directive are *SS-EN 614-1 Safety of Machinery - Ergonomic Design Principles - part 1 : Terminology and general principles and SS-EN 547-3 Safety of Machinery - human body measurements - part 3 Antropometric data.* The prefix “SS” means that the standard is adapted also to a Swedish Standard. Other examples, still under preparation, are *prEN 1005-2 Safety of Machinery - human physical performance - part 2 Manual handling of objects associated to machinery* and prEN 1005-3 in the same group concerning force limits. The prefix “pr” means “preliminary”.

Although there are quite good regulations, no law or regulation will ever be better than their interpreters. These interpreters are, as mentioned above, meant to be the employers, designers, manufacturers, suppliers, planners and co-ordinators etc. We all know there is a need for wider knowledge among these groups. This lack of knowledge holds for both legislation and facts about ergonomics. We are all needed to contribute to diminish these deficiencies.

The full English text of the Work Environment Act, Ergonomics for the Prevention of musculoskeletal Disorders, Internal Control of the Working Environment and some of the other ordinances mentioned above are to be found at web-address: www.arbsky.se. Literature can also be ordered from this web-address.

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Economics and ergonomics - the use of cost benefit analysis - the productivity model

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Introduction

Economic models can be used to illustrate the benefit of an ergonomics intervention and assist in implementing ergonomics in a workplace (1, 3). To introduce better working conditions management will usually require a ***financial return***. This is no different to the engineer wanting new equipment – he/she must show its return in monetary terms. A major difference between the engineer and the ergonomist is that the economic models used by the engineer have been long accepted whereas the ergonomist is yet to reach that point.

But are we yet at the stage, in ergonomics, where we can show an economic return? For example, in back injury causation or the development of upper limb disorders there is a lot we do not know; do we stop trying to prevent such injuries because we are not sure of all the reasons or do we go in and take a best guess, based on our present knowledge? We go in!

However, let us go in as economists not as ergonomists or OH&S (occupational health and safety) people. I cannot vouchsafe for Scandinavia but in much of the English-speaking world OH&S is seen to be very low on the industrial/social scale and hence those who try to implement it have very little power. Let us drop our health hat and go in as people who want to improve the productivity of our employer.

How do we do that? We stop talking about regulations, laws, being nice to people and so on; we talk about ***money and profit***.

Firstly I will show you two recent examples of good ergonomics that achieved a good financial return and then I will show you a cost-benefit model to assist you to think in financial terms.

Although both these examples came through the health/personnel people, I want you to look at these the other way about; that the ideas were financially sound and gave a good return on investment (and also prevented back injuries).

1. Retail Store

In a department store's haberdashery section (in Swedish: "Sybehörsaffär") in 20 months there had been a loss of ten days work through injury with a staff of only eight people. Investigation was called for - cotton reels and buttons are not that heavy! The answer was that as well as cotton reels they also sold sewing machines and ironing presses. These machines weigh between 7 kg and 18 kg.

An hour's discussion between the staff and management decided on the solutions, all of which were very simple. The changes reduced the physical effort required on the part of the sales staff, there were no more back injuries, and it enabled the staff to improve their display and demonstration of the equipment. This is where the financial

return came in: the improved display led to increased sales of the ironing presses and improved demonstration of the sewing machines led to increased sales of the more expensive machines.

The cost of the changes was $750 (about SEK 4000); there was an increase in sales of 30% (for commercial reasons I cannot give the actual value of the sales); the pay-back period was considerably better than one month.

Putting our expertise in ergonomics into finance is a powerful tool.

2. Old People's Home

This was a nursing home for about seventy old and disabled people (the residents), the majority of who could not walk and many were senile.

Look at the nursing home from the point of view of the owner who wants to make a profit (capitalism in Australia does have its ugly side). How do we use ergonomics to increase the productivity of the nurses and hence profit?

What is the daily routine? Two nurses work together to get the residents up in the morning; it takes four lifts to get a resident to the dining room for breakfast and to the sitting room afterwards: from bed to wheel chair; from wheel chair to dining table chair; from dining table chair to wheel chair; from wheel chair to lounge chair. If you put the lounge chair on wheels it only takes one lift to do the same task.

Other control measures included purchasing more electrical lifting machines with sufficient slings; putting the commodes (toilet chairs) on wheels so that the staff can wheel them from room to room (without the resident) rather than carrying them; and replacing the manually adjustable beds with electrically adjustable beds.

As well as minor changes to equipment and major capital purchases, information to the nurses was also improved. Each resident was assessed for their requirements in lifting and notices prominently placed above each resident's bed.

The release of extra time available to the nursing staff enabled organisational changes to be made, which further increased their productivity, as well as increased their safety. It is noticeable that the nursing staff now goes home not exhausted and this has led to an increase in morale.

The cost for capital equipment in the first year was $64 000 (about SEK 320 000) but the savings in insurance costs was $156 000 (about SEK 780 000) and continuing each year. This is a payback period of 5 months.

With less time taken up in unnecessary patient transfers there was a marked increase in services that could be provided to the residents. In a competitive world, better service at the same or a lower cost gives an enterprise an advantage over its competitors.

Reduced costs, increased productivity, improved quality of service, reduced back injuries - all it took was a fresh look at an old problem.

The Productivity Model

The Productivity Model is a cost benefit computer program designed to *ask the pertinent questions* and to handle the data (2). An advantage with this Model is that different solutions may be tested to derive the optimum solution. Thus the Model can be used for sensitivity analysis to determine which of several alternative solutions may be

the most cost effective as well as determining the payback period for any one program.

Firstly the data pertaining to the present or original situation is entered and then the projected information at the completion of the program is entered. If the Model is used retrospectively then the data can be measured rather than estimated.

The Model is a difference model in that the cost parameters of the implemented program are subtracted from cost parameters of the original work place.

The Productivity Model comprises about 28 working tables grouped together in four steps or cost groupings. However, only information pertinent to the particular health and safety program is required and most often only five to ten working tables are required.

STEP 1. Calculation of the Productive Hours Worked

It is only when the employee is gainfully employed that he is paying his way and providing income and profit for the company. Thus absences (holidays, illness, injury leave and so on) which are paid for by the employer are a ***loss*** of income to the company and add to the cost of the product or service.

STEP 2. Calculating the Wage or Salary Cost

To the wages paid directly to the workers must be ***added*** charges such as workers' compensation premium, payroll and other taxes, clothing and travel allowances, etc as well as direct management (supervisory) costs there are administration charges (including the personnel department) and the company overheads (e.g. head office services).

STEP 3. Employee Turnover and Training Costs

To employ a new person, whether full- or part-time, requires considerable time and effort to ensure that a suitable person is engaged. There is the time required for training - which includes the time required by the supervisor and fellow workers to show him or her "the ropes" and the consequent loss in productivity for these people. For a manager, for instance, it may require a year or more to be fully functional. No matter what people expect, full effectiveness does not happen on day one!

To transfer people to new jobs within a company also carries a price tag in reduced production/quality until they know the new work.

STEP 4. Productivity and Quality Short-fall

When people are away due to illness or injury, production is usually maintained through overtime or even over-employment. Many of the factors included in this Step relate not solely to lost time injuries, but to poor working conditions (ergonomics). Poor working conditions may not always lead to absence; they may result in tiredness and lead to employees working at a slower pace than otherwise or result in employees leaving their work station more frequently than needed for their work. Poor working conditions which include, for example, excessive manual handling, incorrect or poor quality tools, glare leading to difficult-to-see computer screens, awkward working postures, etc., are frequently "corrected" by over-staffing.

It is through poor working conditions that quality is likely to suffer although quality reduction is often not recognised as it becomes ingrained in the customary system of work. Such poor working conditions will lead to a loss (or lack) of quality in the

product or service and to loss of customers through increased variability, errors, slow delivery and loss of reputation.

STEP 5. Pay Back Period
Plans for improving the situation may be made and the cost (investment) calculated. The benefits gained due to changes at the workplace are calculated and the payback period is used as a measure of cost-effectiveness.

The payback period is usually very good for ergonomics interventions, frequently under six months, which is a rate of return greater than most other types of investment.

step 1. The Productive Hours Worked

step 2. The Wage or Salary Cost

step 3. Employee Turnover and Training Costs

step 4. Productivity and Quality Short-fall

step 5. Labour costs, benefits and pay-back period

$$\text{Pay-Back Period} = \frac{\text{Cost for improved working conditions}}{\text{Benefits due to improved working conditions}}$$

Figure 1. Flow diagram of the productivity model.

Acknowledgements

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Integrated development of ergonomics and quality

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Definitions of Ergonomics and Quality

The Nordic Ergonomics Society defines ergonomics as the "Interdisciplinary field of science and application considering integrated knowledge of human requirements and needs in the interaction human - technology - environment in the design of technical components and work systems". The main purposes are to create work conditions that promote safety, health, well being and efficiency (productivity and quality). Another purpose is to create jobs that support the development of skills and knowledge.

Quality is defined as "The quality of a product or service is its ability to satisfy the needs and expectations of the customers". Today, it is often stated that it is desirable not only to satisfy but also to exceed the expectations of the customer. The manufacturing personnel in an industrial context are considered to be internal customers, and the end-users are considered to be external customers.

The definitions show that there are overlaps and similarities between the two disciplines.

Cases

Case 1 Car assembly

The study was performed in a traditionally organised car assembly plant. The purpose of the study was to evaluate relationships between certain ergonomic conditions and product quality. The most physically demanding tasks, the tasks with the most difficult parts to assemble and the most psychologically demanding tasks, were identified by interviews with experienced assembly workers. The quality deficiencies were obtained from the internal quality statistics of the company. In the assessment of ergonomically demanding tasks from plant, a total of 58 tasks were identified on the basis of the three criteria set. The results showed that the quality deficiencies were three times as common for the work tasks with ergonomic problems, compared to the other tasks, and that this difference was statistically significant. An increased risk of quality deficiencies was seen for all three categories of ergonomic problems investigated. Another way of expressing this is that 33% of all quality deficiencies were due to ergonomic problems. Direct causes of quality deficiencies were identified, e.g. discomfort from strained parts of the body, organisational hindrances, bad design of parts and stress. The results also showed that an important factor for job satisfaction was the opportunity for the workers to perform their tasks with high quality.

Case 2 Component assembly

This study was performed in two car engine assembly plants. There was an emphasis on improvements of the work organisation and workplace design. The purpose of this study was to identify relationships where ergonomic problems contributed to or caused quality deficiencies, and to investigate to what extent ergonomics improvements resulted in quality improvements. Quality deficiency statistics were collected for both plants. The five most frequent quality problems were selected in both plants. A participative problem-solving group with broad representation was set up for each plant.

In total 41 and 59 causes of the five quality problems were identified in the two plants. There were 50 solutions proposed in plant A and 82 in plant B. 28 of the 50 solutions proposed in plant A were selected to be included in the action plan. 15 of the 50 solutions proposed were related to ergonomics; not only physical but also psychosocial work conditions. Out of the 82 solutions proposed in plant B, 25 were selected to be included in the action plan. 49 of the 82 proposed solutions in plant B were related to ergonomics.

Stress and time pressure were identified several times as a cause of deficient quality. Too short an introduction course for newly employed personnel and insufficient information about the quality demands was also observed. Difficult work postures, lacks of space and low motivation levels were other causes identified. The problem solving activities revealed a large number of difficulties that could occur; many of them avoidable with improved design.

During the four month time period for this study, nearly half of the proposals in the action plan were implemented, and many of the other proposals were being planned in plant A, while no proposals had been implemented in plant B. Unfortunately for this study, the quality report system was changed so that it was not possible to make an accurate follow up for more than one of the five quality problems, after actions had been taken. The number of quality remarks were halved (from 10 to 5 on average per week) during a 13-week period, while no changes could be identified for the quality problems where no changes had been introduced. This difference was statistically significant. It also shows how actions to improve the ergonomics situation also improve the quality.

Case 3 Component assembly

This study was conducted at a Swedish subcontractor to the car industry. The assembly was performed on a relatively traditional assembly line. The purpose of this study was to identify relationships between ergonomics problems and quality deficiencies, and to investigate to what extent ergonomics improvements resulted in quality improvements.

Assessment of work postures was made through a questionnaire and assessments using the RULA method. Bodily symptoms and psychological load were assessed through the questionnaire, and assembly ability through the questionnaire and an analysis according to Boothroyd and Dewhurst. The quality statistics used for this study were based on wasted parts and were collected by the assembly workers. One of two assembly lines were redesigned, where the ergonomics situation was improved, which also brought with it better assembly ability and production engineering improvements. The reference line was not changed. The improvements included

improved information and education, improved workspace, easier materials handling, better work postures, better lighting, improved fixtures and less strenuous assembly by altering the product design. After the improvements a follow up questionnaire was distributed to the 10 workers at the changed and the reference lines.

The results showed significant correlation between difficult assembly on one hand (due to lacking space, fixation of parts, bad fittings and details getting stuck) and on the other hand adverse working postures, the perception of strenuous movements and postures, and discomfort from neck, shoulders and arms. These difficulties also correlated significantly with psychologically demanding tasks. In a further analysis of this data, the quality deficiency rate was found to be almost 10 times higher for the worst posture compared to the best posture.

After the ergonomics changes, several improvements could be identified in the improved line but not in the reference line. These included fewer musculoskeletal problems, improved work postures and movements and better assembly ability. Also quality had improved in terms of waste ratios. The average improvement in relation to the reference line, measured over a 16-month period, was 39%. All these changes were statistically significant. The pay-off time for the improvements was less than 7 months.

Relationships between ergonomics and quality

The result show that quality deficiencies and human errors often have ergonomic problems as causes (1, 2, 3, 8). In other situations, the design of work, workplace and environment, e.g. noise, light, postures, loads, pace and work content give rise to both ergonomic problems and quality deficiencies. In addition, the possibility to perform good quality at work is an important prerequisite for satisfaction and wellbeing. The studies above confirm close relationships between ergonomics and quality, and thereby point to the possibility of conducting integrated change programs aimed at improving quality and work conditions simultaneously.

Continuous improvement

Continuous improvement is one of the basic elements of Total Quality Management. The term refers to organised activities in order to involve employees to improve production, work processes and products. The concept stands for the idea of improvement as a problem-solving process. According to the new quality paradigm, it is always possible to improve quality in many ways without increasing costs. The concept of continuous improvement advocates that improvements to products, processes and production systems should be sought continuously, with involvement all the time (3). This includes mainly incremental improvements of existing systems, even though radical innovations should not be omitted.

The Deming PDCA cycle (Plan, Do, Check, Act) for problem solving (or PDSA - Plan, Do, Study, Act) symbolises continuous improvements based on a circular pattern, which implies that the problem-solving activities are repeated. Participation in problem-solving create several positive effects for the individual due to the process, e.g. personal development, learning broader job content, variation, feedback, possibilities of influence, social contacts, social support, challenges and a safe and healthy

job. All these factors enhance motivation and quality of work. The transition of an organisation to participative problem-solving means a move towards coherence with the characteristics of good work (4, 5, 6, 7). In addition, improved physical work conditions become direct results of the changes carried out. The use of small group activities for improvements or quality circles is a very important reason behind the quality and productivity increases obtained in Japanese companies. The results have, however, not been particularly successful in the West. According to several surveys, at least one third of the total number of suggested improvements are ergonomics related.

Systems for participative problem solving may be outlined in numerous ways. The table below shows different characteristics in a number of dimensions.

Table 1. A classification of participative problem solving applications.

Aims	top-down / bottom-up
	integrated system / isolated system
	level of participation
	reactive / proactive
	radical steps / incremental steps
	motivation / relationships / effectiveness / learning
	productivity / quality / cost / safety / ergonomics
Focuses	controlled focus / free focus
	structure / process
	strategic management / process management / daily activities
	work routines / workplace / products
	abstractions / empirical findings
	result improvements / process improvements
Working methods	representative participation / direct participation
	formal / informal
	voluntary membership / mandatory membership
	individual / group
	mixed skills / uniform skill
	within ordinary work activity / outside work
	permanent / temporary
	structured / unstructured
	participation in proposals / idea development / implementation / evaluation
	decisions: individual-group-supervisor-committee-management
	type of feedback / time to feedback
Rewards	extrinsic rewards / intrinsic rewards
	financial rewards / other rewards
	within ordinary salary / extra rewards
	profit sharing / fixed sum per suggestion
	low budget rewards / non-maximised rewards

There is of course not one best system. The use of a systematic classification will enable the identification of inconsistencies and incongruences within the system and the organisation. The elimination of such contradictions has the potential to amplify strategic aims and to improve effectiveness.

Conclusions

There are close relationships between ergonomics and quality. The ergonomics situation is an important determinant of the quality output. Important preconditions for quality include the following:

* Information
* Knowledge
* Experience
* Ability
* Desire or motivation
* Resources
* Allowance

Ergonomics improvement programs and quality improvement programs have a substantial positive mutual influence on one another. The application of continuous improvement or participative problem solving has a good potential to improve quality as well as ergonomics.

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Action for change at the enterprise level

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Introduction

Long times gone are the days when the rationalisation experts were looked upon as the bad guys and ergonomists as the good guys. Nowadays the situation is different and rationalisation experts and ergonomists many times work hand in hand and reinforce each other's issues (5).

In Sweden this has been even more evident since the sick leave insurance system was changed and the employer has to bear the sick leave costs to a much greater extent (4). Also the designs of many of the new production systems and new rationalisation strategies facilitate such co-operation between ergonomists and production system designers (3).

When it comes to action for change processes the two issues have many similarities. Starting an action for change in ergonomics often implies changes in the production system design or the other way round. Actually the holistic view of the workplace and the worksituation, including both ergonomics and production system desi@ is often the best way to approach an action for change process (2).

Whatever change you intend to make some of the same crucial points appear in the processes. Some of these crucial issues in a change process, further explained below, may be classified according to:

- the way you carry out the process, i.e. the start, the goals and the track
- the persons involved in the process
- the type of process
- and the resources needed in the process

The start, the goals and the track of a change process

All processes have a starting point, a route and a goal. In the beginning the starting point may be very confused and perhaps not even a single one but may be experienced as many different ones, as we do not describe or see our conditions in the same way. It is very important to set aside time to discuss and try to find a common standpoint to describe today's situation. Without such a common platform one cannot expect that the involved persons will move in the same direction, and the rest of the change process may fail.

The goals may differ even more than the starting points. And as the goals most often are virtual and more or less far away it is even more difficult to come to a common standpoint. A lot of time is needed for such discussions to be able to define the goals of the change process. Some goals may be within the pure ergonomic field, others may be classified as economic ones and others still may be of technological

character. It is important to try to group the goals, to distinguish the different groups and to examine which ones go together.

This is even more important taking into account that changes in the goals will be increasingly expensive as the process runs. It will also be more and more difficult to have any influence on the goals. Unfortunately the graph of the comprehension follows the same track as that of the costs (fig 1). Thus, in the beginning of the process, we will have big difficulties in understanding where the process will end up. An extensive use of time at the beginning, to define the starting point and the goals of the change process, will pay back.

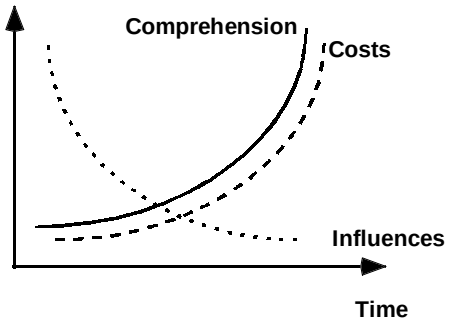

Figure 1. Changes in the goals will be increasingly expensive, and the influence decrease, as the process runs. The comprehension follows the same track as the costs.

The route between the start and the goal is not an engineer's straight line but a deviating meander (fig 2). The responsible has to accept this and let the process deviate but also be ready to force the process back on the track when the deviation has gone too far and the goal lost out of sight. This deviation can in a way be seen as the assembling of knowledge among those involved in the process and a maturing phase.

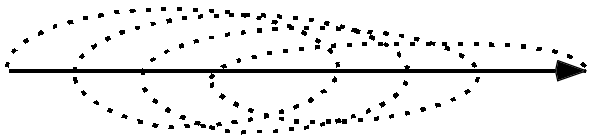

Figure 2. The route between the start and the goal is not a straight line but a deviating meander.

Persons involved in the process

The management must support the process all the way and encourage all those involved. Information is essential. Updating is needed even when there is no new information to give, just to stop the spreading of rumours that may occur in a vacuum.

In many earlier change processes it was too common to let an external expert being the main actor. The process was then not only a top-down process but an

external top - internal down process, often with implementation difficulties and consequently an inefficient result. It is important to let the persons involved and finally affected by the result, to have enough time and information to understand the process and to provide useful participatory tools (6).

Dedicated persons are essential for success. It is easy to say but they are hard to find. If you find dedicated persons, support them!

In Sweden the unions' representatives have earlier played an essential role in the change processes at least in the first part of the processes and still do when it comes to general agreements between employers and employees. The unions' representatives can, however, never replace all those affected by the changes. The operators' profound knowledge of his or her own workplace is an important input in the change process.

Type of process

During the creation of the Volvo Uddevalla plant Ellegård (1) formulated the conceptions:

- Generative change and innovative change

The first may be expressed as small change, not threatening and in a way quite natural. It will normally be accepted without fear and hesitation. The second on the other hand is a threatening action. It is an innovative change, and shocking, but perhaps nevertheless an imperative necessity. Although quite different in nature, both have to be planned as far as possible. A way to define a change process, beside the participatory bottom up approach or a top down expert approach, is the technological-organisational aspect (fig 3).

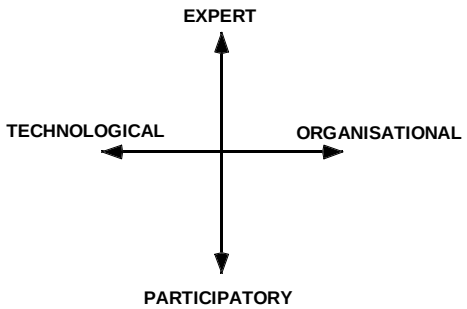

Figure 3. A change process can be classified according to the expert-participatory and the technological-organisational aspects.

Many times, at least in earlier days, changes were treated mainly from the technological aspect. It was a question of buying this or that equipment or machinery. Much less emphasis was put into the organisational impact the change would have. Acting in a change process from a participatory and organisational approach is important to achieve a good result.

Resources needed in the process

Besides those inputs in a change process already mentioned above, time, management commitment and dedicated persons, some other inputs are essential (2). The needs must be known. All involved have to be aware of the critical situation. Without understanding the necessity of a change the process will encounter difficulties. Practical examples, for example from a similar workplace may be a good starting point and can help to play down the situation. There will most often be a drop in the profit during the process. Energy is consumed by the change process instead of the daily production. A readiness for costs is important and endurance essential not to interrupt the change process in a critical period. Training is needed but is not a starter of a change process. Training should instead be a just-in-time-training, put into the process when demanded.

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Practical approaches to ergonomic interventions in industrial workplaces

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Introduction

A common misconception is that ergonomics in many cases is not taken into account in the design of workplaces. In fact, the opposite is true. Every workplace reflects some thinking, albeit many times uninformed or even negligent, of human factors. What kind of machinery is needed for the materials handling? Can the operator see and reach what is necessary in order for him to be able to fulfil his task? How can product quality be ascertained?

It is a trivial observation that essential ergonomic properties of a workplace result from the thinking by the manager in charge or jointly by the group of people involved in the product design or production layout work. As ergonomists we strive for finding ways to make ourselves heard by being involved as experts in the design process. However, much too often we find practitioners being polite but uninterested, simply because the cost-benefit analysis of involving an ergonomist in the process does not come out favourably.

Ergonomists have of course observed the problem and devised approaches in order to enhance the legitimacy of ergonomics in the view of practitioners. Macroergonomics and participatory design are but two terms reflecting a changing focus with respect to how ergonomists relate to production systems and to the personnel engaged in them.

The present paper endeavours to summarise the results from studies carried out at Lindholmen Development in Göteborg, Sweden, where ways have been sought to legitimise ergonomics in the view of practitioners, by developing methods supporting existing systems and processes rather than replacing or adding new ones. Three illustrative examples drawn from case studies carried out in Swedish industry are reported. In Case study 1, a new method was developed and applied with the aim to integrate ergonomics evaluation and participatory design. Case study 2 incorporated CAD techniques in participatory design. Case study 3, finally, we endeavoured integration of ergonomic predictions in the MTM based planning tools that are used by production engineers in the assembly industry. All these case studies are in process or have been completed recently.

Case Study 1: Operator based ergonomic analysis of complex manual work

Ergonomic evaluation of complex work involving materials handling is a time demanding task, in particular when the work is complex and involves work at several workstations for the individual operator. There is a need in industry for methods that

can provide input in ergonomic interventions, and which make available results with a minimum of delay. Conventional observation methods used by ergonomists do not meet these requirements fully.

A new method was developed, called VIDAR (Acronym for *VIdeo och Datorbaserad ARbetsanalys,* Video and computer based work analysis; Kadefors and Forsman 1998 (1)). It is based on video and computer interaction. Looking at the video film displayed on the computer screen, the operator using a hierarchy of menus, identifies situations inducing pain or discomfort, marks the affected body parts and rates pain or discomfort according to the Borg CR-10 scale. The computer produces a library characterising the situations thus identified.

VIDAR analysis of order picking work was carried out in an automotive assembly industry. The study comprised seven workers aged 29-47 years. They were filmed for a whole working day. The study focused on operator understanding, discrimination between high and low strain tasks, as well as coherence in task identification, and rating of pain or discomfort.

The operators carried out the analysis one or two days after recording. All subjects were able to understand and provide input to VIDAR. Analysis time was less than twice real time. From the whole day recordings, each operator identified about twelve different situations as strenuous. Most situations identified involved forward bending or work at or above shoulder level. The body parts mostly affected were consequently the back and the shoulders. Borg ratings were typically moderate (3-4 on the CR-10 scale).

The method was easy to understand by the operators. The high strain situations identified were considered trustworthy. The method discriminated between high and low strain tasks. The task identification was reasonably consistent between operators, although there were individual differences, both with respect to task identification and discomfort threshold.

It can be concluded that VIDAR, with moderate effort, makes available information that is relevant and easy to operationalize in industrial interventions. It should be realised that VIDAR represents an alternative to conventional expert evaluation, recognising that the operator is an expert of his or her own work.

Case Study 2: The use of CAD based methods in participatory design

In major changes of production layouts in manufacturing industry, there is often a need to devise new solutions based on existing knowledge in the organisation. Good practice is to involve experienced operators in the design process. However, in the case of major reorganisation on the shop floor it tends to be difficult for the operators to get an adequate understanding of the consequences of decisions to be taken early in the process.

In the same system as was analysed in Case Study 1, and following the VIDAR study, a new system for order picking was going to be developed and introduced. There were several options available, applying different technologies and organisational solutions. The object of the study was to apply Computer Aided Design (CAD) in order to develop and visualise solutions in a participatory process.

A simple basic CAD program (ROOMER) was used (4). This program was used to create three-dimensional sketches of workplaces based on inputs from production engineers and operators.

A group of six people representing operators and technical personnel was constituted. The group met regularly during a period of a few weeks. In the process, different layout alternatives were introduced, discussed and modified.

In a follow-up study, the individuals participating in the group were interviewed with respect to how they perceived the CAD supported process in comparison with conventional change processes in which they had been involved.

Results from this interview study showed that the CAD techniques enhanced the understanding of consequences of technical decisions, and made possible a more active involvement by the operators in the process. In was felt by all that the quality of the solution that was produced at the end was higher than could have been attained in the conventional way.

Conclusions from this study were that CAD representations are useful in order to enhance participation and ergonomic quality. In the case that the designers and the production engineers use CAD routinely in the planning process, endeavours should be made to integrate technical and ergonomics planning.

Case Study 3: MTM based ergonomic planning

In large portions of manufacturing industry of to-day, the time-to-market for new products is reduced, and there is little time allowing testing out solutions and to take into account basic ergonomic principles. For instance, production systems for automobile assembly are designed in software by engineers who often have insufficient insight in the ergonomic consequences of the decisions made.

Many Swedish companies are using a higher level of MTM (Method-Time-Measurement), called SAM, where the production engineer specifies tasks to be carried out in the manufacturing process. The SAM system predicts the time needed for completion of the tasks, as a basis for production system planning. However, the existing SAM system does not allow for prediction of ergonomic properties of the work tasks to be performed.

The present study was aimed at development of a method, called ErgoSAM, allowing integration of ergonomic aspects in the planning of new production systems. Therefore, the SAM spreadsheet was complemented with data entries concerning predicted force, and posture. As a method of ergonomic evaluation within ErgoSAM, the Cube Model (2) approach was used. Here force, posture and time related demand indices are multiplied, providing a compound ergonomic index. ErgoSAM analyses using a prototype version were carried out of assembly work at three existing workstations in a manufacturing company (3). The predictions were compared with surface EMG (upper trapezium and wrist extensor) and operator assessment using video-computer interaction (VIDAR, see Case Study 1 above).

Correlations between ErgoSAM predicted values and EMG (ARV value, wrist extensor) were significant in two workstations out of three. The peak load predictions coincided well with VIDAR assessments.

The prototype ErgoSAM method predicted high ergonomic workload in some cases, but missed out on others. There were differences between predictions and the way that the operators chose to carry out the work. Hand ergonomics was not sufficiently covered. Nevertheless, the production engineers concluded that the approach has great potential in production planning using MTM-SAM.

Discussion and conclusions

The three case studies summarised in the present paper illustrate different methodological approaches to the problem how to make ergonomics an integrated part of industrial production systems design. In fact they are not competing, but rather complementary in nature, since ErgoSAM can be applied at the product design stage, whereas VIDAR is used to assess existing workplaces, and CAD techniques is applied in the design of future workplaces. However, ErgoSAM should not be regarded as a participatory design tool, since it can be applied even before the organisation of a production system for the product. VIDAR and CAD techniques on the other hand, are both good examples of tools involving operators in the design process.

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Ergonomic prevention in computer work

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Ergonomic prevention in computer work

The very rapid development of information technology has entailed extensive and decisive changes in working life. More than half of the Swedish working population use visual display units at work. The relative frequency of users has increased rapidly during the last 10-year period and it is supposed to continue to increase. Additionally, the time we spend in front of the VDU is also increasing and one fourth of the working population use VDU 50% or more of their working time. Many office workers use VDU about 70-80% of their working time.

The increased computerisation has influenced the work environment to a great extent. Regarding the physical work environment computers have replaced some heavy and risky work tasks, while new problems have been created. An increased occurrence of static and awkward postures and monotonous repetitive work have been created, which have entailed an increase of musculoskeletal disorders especially in the neck/shoulder, upperarm, elbow, wrist and hand/fingers.

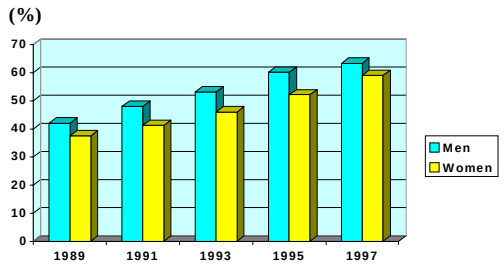
Besides the physical ergonomic problems, the psychosocial work conditions are an increasing work-related problem. A higher proportion of VDU users, compared with non-VDU users perceive significant stress during at least half of the working time. The stress related *to information technology*, sometimes called" techno-stress", includes stress related to both *information and new technique*. It comprises stress related to all new things one has to learn all the time, new equipment, programs etc. Stress related to computer and network malfunctions and interruptions, stress related to the increase of information and the increase in accessibility and always being able to be reached by e-mail etc. I think we all recognise these situations.

Of all compensation claims regarding musculoskeletal diseases "work with computer or mouse" was reported as the cause of the problems among 15% of the women in 1997, which is an almost 3-fold increase since the beginning of the 90´s. Among men the relative frequency is lower, but a continuous increase over the years is observed.

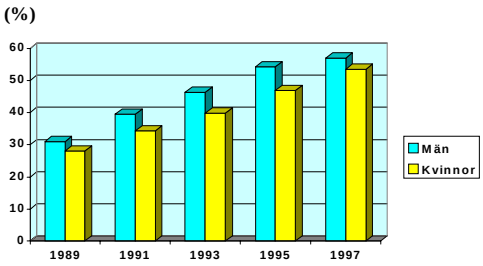
There is scientific evidence for multifactorial causes of work-related musculoskeletal disorders, and that work organisation as well as physical ergonomic and psychosocial factors may cause musculoskeletal disorders.

Ergonomic prevention in computer work

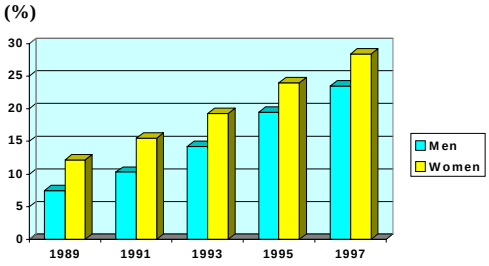
Computer use at work



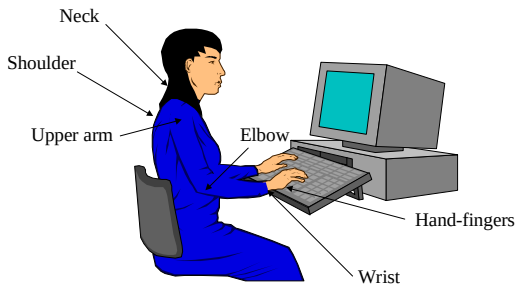
VDU use at work



VDU use at work ≥50% of the working time

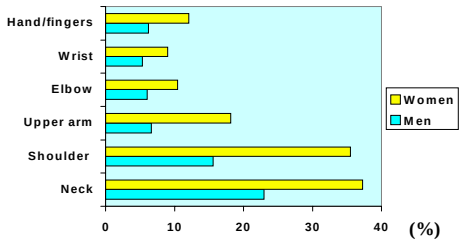


Musculoskeletal disorders

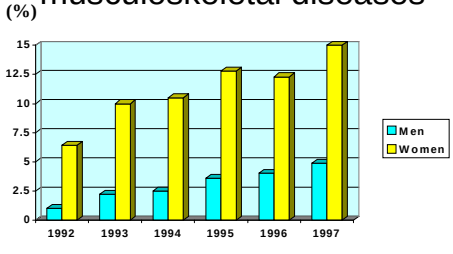


Musculoskeletal symptoms among male and female CAD operators

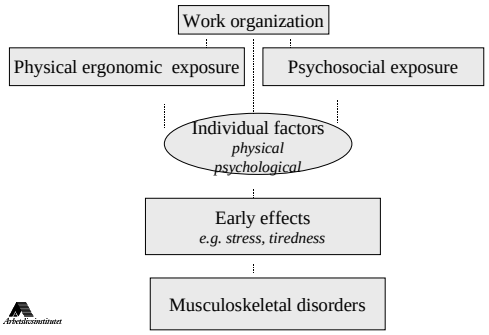
(modified from Karlqvist et al-96)



Work with computer and mouse as the cause of compensation claims for work-related musculoskeletal diseases



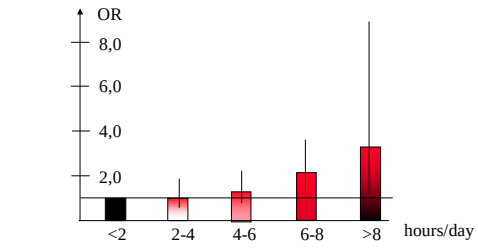
Simplified model between work-related factors and MSD



Work organization

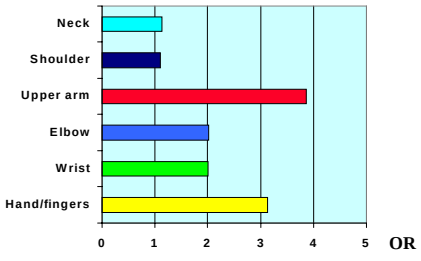
- Hours of VDU work per day
- VDU task types,
- Variation and distribution of tasks and rest pauses
- Time pressure and dead-lines

Hours of VDU work per day and symptoms in hand/wrist (Bernard et al -93)



Mouse use (≥5,6 hrs/week) and symptoms

(Karlqvist et al-96)

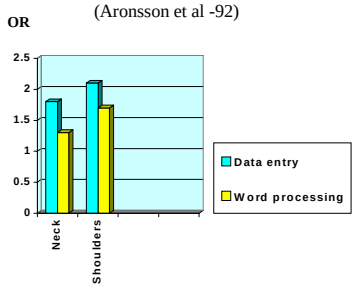


What is the mouse-arm syndrome? Probably no specific injury

-Myalgia
-Inflammation (tendon, tendon attachment, tendon sheath)
-Nerve entrapment

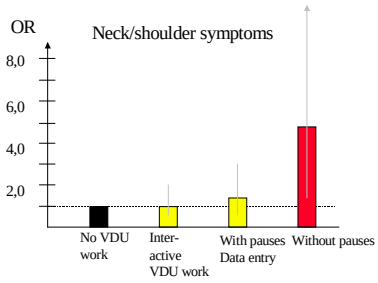
Type of VDU task ≥50% of the working time compared with "mixed" VDU tasks

(Aronsson et al -92)



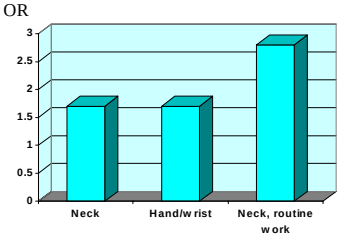
Data entry rest pauses

(Bergqvist et al -95)



Dead-lines (Bernard et al -93, 94)

Work under dead-lines 30-39 vs 0-10 hrs/week



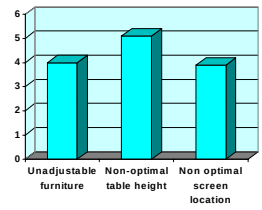
Physical ergonomic exposure

- Workstation design
  -equipment, dimensions and placement
- Postures and movements
  - *awkward postures*
  - *static load*
  - *repetitive hand/finger movements*
  - *pressure against wrist*
- Visual conditions

Workstation design

(Hoekstra et al- 94)

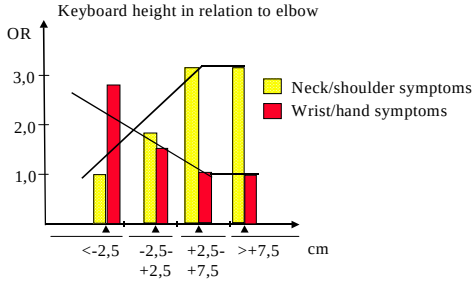
OR Shoulder symptoms



Workstation design

(Bergqvist et al -95)

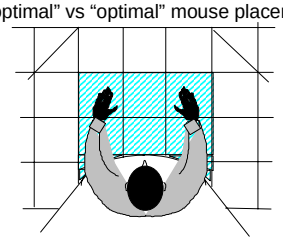
Keyboard height in relation to elbow



Work postures

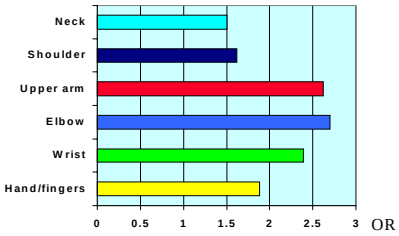
(Karlqvist et al -96)

"Non-optimal" vs "optimal" mouse placement



"Non-optimal" mouse placement

(Karlqvist et al-96)



Psycho-social exposure

- Too high/low mental demands
- Low control and decision latitude
- Poor social and instrumental support
- *supervisor*
- *work-mates*
- Job dissatisfaction
- Fear, insecurity

Psycho-social factors and MSD

(review by Punnett & Bergqvist -97)

Proportion of reviewed studies showing associations

	Neck/shoulder	Upper arm	Hand/wrist
Decision latitude and control	5/7	1/3	2/5
Social support and co-operation	4/7	1/3	3/5
Fear and insecurity or job dissatisfaction	4/6	1/5	2/5

Prevention

- Correct adverse working conditions

(e.g.time pressure, decision latitude, conflicting demands)

- Limit the VDU working time

Vary with other tasks and rest pauses

- Recurrent education and training

- in using new equipment and programs
- optimal workstation design and working technique

- Visual examination for VDU glasses

Prevention

- Check the workstation design
  - optimal chair and table height
  - possibilities to vary sitting position easily (and vary between sitting and standing)
  - space to support the forearms
  - space for working material
  - space for the legs
  - optimal vision distance and angle to the screen (>15^0)
  - optimal placement of keyboard and mouse
  - optimal lightning (no glare or reflections in the screen)

Prevention

- Work with the forearms close to the body and with forearms relaxed and supported on the table
- Try different non-keyboard input devices (to fit your hand)
- Vary between different input devices (e.g. mouse and trackball)
- Vary between right and left hand

Prevention

- Learn and use short commands
- Adjust optimal sensitivity and speed on the input device
- Clean the input device regularly (e.g. the ball in the mouse)
- Try arm/wrist support

Ford Motor Company Global Ergonomics Process

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Definitions & Introduction

At Ford Motor Company, ergonomics means fitting jobs to people. Ergonomics examines the interaction between the worker and the work environment, including such factors as machinery, the workstation, climate, etc. If the match between the worker and the work environment is poor, the worker's ability to perform the job will be severely compromised. Over the short term, this poor match may lead to fatigue and worker discomfort. If the conditions persist long enough, physical injury and disability health effects may occur. With the pressure of growing competition in industry, management and labor alike have had to jointly embrace the principles of ergonomics for finding even better ways of doing business. In ergonomics, this involves listening to the people who assemble the parts, as well as to the engineers who design them.

Even before the health effects are documented in the plant medical records, poorly designed jobs can affect employees and Company operations. Bad job design hinders the worker's ability to perform at peak efficiency and to produce high quality parts (operational effects). It also results in increased absenteeism and decreased job satisfaction. In short, bad job design is expensive to the worker and to the Company.

Ford Global Occupational Health and Safety Operating System

The Ford Ergonomics process began with simple research projects between Vehicle Operations, Powertrain Operations and The University of Michigan in Ann Arbor. These research projects showed the positive impact that can occur when ergonomics is applied in manufacturing operations. It also showed that ergonomics can be implemented with workers and management problem solving teams if they are trained properly and given appropriate plant support. Consequently, in the third quarter of 1989, the UAW-Ford National Joint Committee on Health and Safety funded the development and implementation of the Ford plant ergonomics process. Formal training began in the spring of 1989 for U.S. Plants, and in the fall for Canadian Plants. Full implementation began later in the 4th quarter. In addition, during the first half of 1990, Mexican affairs translated the materials into Spanish. A slow and progressive implementation plan was developed. Over the next several years, this process produced many positive results for both the Company and the workers.

In 1995, the Ford Occupational Safety and Health Group began to look into better coordination of our services through globalization within the Ford 2000 initiatives. Ergonomics was chosen as one of several areas to globalize.

A Global Ergonomics Team, consisting of representatives from operations, safety, industrial hygiene, medical, and industrial hygiene, was formed to evaluate the current state of the ergonomics process. The results of that exercise were as follows:

1. The United States based process was a cost effective and beneficial method to implement ergonomics in the plants, without utilizing additional headcount.
2. The ergonomics process in the United States could be translated and launched globally if the countries were allowed to alter the structure of the plant organization to meet local needs and requirements.
3. The Ergonomics Process Training Course developed in the United States should be the base training class for all LECs worldwide.
4. A single system to document the plants ergonomics process and resulting actions would have to be implemented and eventually automated to facilitate communication of Best Practices and Lessons Learned.
5. Continuous Process Improvement of Ergonomics would be centered in the United States through the use of Joint UAW-Ford Funds. Once the process was implemented and tested, global implementation would occur (e.g., Supervisors training course, Automated Evidence Book).
6. Because of the lack of central funding, the Global roll-out would be a partnership between Corporate, Division, and the individual Plant Operations.
7. The strategy for the roll-out would be country based. Corporate and the host country would set up a meeting and invite one or more ergonomics champions from each operation, a training coordinator, and the country champion to attend a three day training/roll-out seminar. A strategy would be developed to implement the process using existing resources. If needed, the country would be responsible for cost of translating materials.
8. Measurement of the process would reside within Ford Production System's existing plant auditing system. The Global Ergonomics Team developed an audit element specifically to measure Ergonomics.

In late 1995, a workshop was held in Europe for ergonomics. The workshop was to determine the level of interest in globalizing the current ergonomics process. The workshop was successful and in 1996, a team was assembled to develop a final plan. This plan was presented to senior management from Occupational Safety and Health, including plans to globalize ergonomics by establishing Local Ergonomics Committees in every manufacturing, assembly and distribution facility worldwide. Several pilots were conducted in manufacturing operations in Europe to demonstrate the benefits of using ergonomic principles on the plant floor. They have yielded, and continue to yield improvements in employee health and safety while increasing product quality and productivity.

Ford Global Ergonomics Process

The Global Ergonomics Team developed a vision for the ergonomics efforts. The Vision states that:

> *Through the effective use of ergonomics, Ford will be a global leader in providing a highly productive work environment for all employees worldwide that is safe, injury/illness free, and facilitates continual improvement of quality and total cost for today and in the future.*

In order to achieve this vision, three requirements were identified:

1. Ergonomics would be available to all levels of the Company.
2. Ergonomics would co-exist with existing processes.
3. Ergonomics would be developed with a participative approach.

The Company's ergonomics program has three parts that are aligned with the Global Health and Safety Operating System–**Global Strategies, Prevention of Ergonomics Issues from occuring when designing and developing new products and facilities,** and **Managing Ergonomic Events after facilities are in place and issues are discovered.** Below is a summary of the efforts of the Global Ergonomics Team.

Global Ergonomics Strategies

The Ergonomics Process needs to be constantly reviewed and updated. Best practices from all areas of the Company need to be incorporated into the Process. Global and local regulations will have to be evaluated and implemented on a timely basis. These activities are referred to as Global Strategies. It is a system of constant evaluation and process improvement.

Much thought has already been given to long-term strategies of the Ergonomics Process. Three areas of critical need were identified:

- A need for specialized training–as the process matures, participants will require advanced and specialized ergonomics training.

- A need to communicate ergonomics–a main reason for bringing together the ergonomics committee is the multi-disciplinary nature of the science. Successful implementation of ergonomic principles is both reactive (changes to existing jobs) and pro-active (designing new jobs ergonomically). Successful activities in identifying and correcting poorly designed jobs must be communicated to the engineers and others who are responsible for developing new processes in plants, so the same “mistakes” will not be repeated.

- A constant need to review and improve the process–as time goes on, many Ford sites will recognize the benefits of ergonomics. They will want to increase their plant's level of activity.

Obviously, these visions will be modified as new needs are identified.

Summary of Tasks involved in Developing and Implementing Global Strategies–

- Coordinate the development and maintenance of worldwide ergonomics process recording, data collection, and communication systems:
  - work with Health Care Management (HCM) to implement an Ergonomics Web Page for the Ford IntraNet and link to appropriate Web sites inside and outside the Company.
  - work with HCM to implement and maintain computerized evidence book and incident response recording system and tie it to the Corporate Lessons Learned and Best Practices Data Base.

- Work with Ford Land to develop and maintain Office Facility Managers Manual.
- Ensure ergonomics issues are appropriately represented by reviewing furniture and seating guidelines for administrative workplaces.
- Participate in Ford Land Value-Analysis Teams.

- Provide technical support and act as a resource to advance manufacturing cross-functional teams, manufacturing forums, vehicle centre teams, and simultaneous engineering teams.

- Work with ergonomics coordinators to develop pre-program guidelines that can be published and distributed to appropriate engineering functions to help evaluate and prioritize ergonomics issues during product and process design.

- Participation in the development and deployment of advanced ergonomic analysis tools (e.g., simulation and other related evaluation tools) to support proactive analysis process. This involves leveraging opportunities by identifying common needs and focusing efforts on a single corporate wide solution. Some of the current efforts are outlined below:

  - Dynamic Hand Impact Measurement Tool
  - Manual Material Handling Process Improvement Research
  - Connector like Insertion Forces Measurement and Evaluation Process
  - Developing a Risk Assessment Tool for plant floor surveillance of existing jobs

Managing Ergonomics Events

Managing Events involves the identification, evaluation, and fixing of existing jobs that exhibit ergonomic risk. Discussions were held to determine the best way to implement a comprehensive and effective effort. The outcomes of these discussions included the use of joint labor/management teams known as Local Ergonomics Committees (LECs).

The process agreed upon by the Global Team was based on the UAW-Ford Ergonomics Process that was launched in 1989. This process was later introduced into Canada, Mexico and in several plants in Europe. It has been extensively evaluated and reviewed by the Global Team and was found to be very effective. It was recommended that a similar process be implemented worldwide.

The process is discussed, in detail, in a book called **An Ergonomics Process**. The process consists of two parts–**Process Implementation** and **Job Improvement Cycle**. Two publications are available to aid facilities in developing the program: *The Ergonomics Implementation Guide* and *The Job Improvement Guide*.

The Job Improvement Cycle

The Manage Events Process uses a problem solving circle called the Job Improvement Cycle. Figure 1 shows the substeps of the cycle. It is a six-step approach to practical ergonomics that includes methods for identifying priority jobs to fix, evaluating job stresses, developing and implementing job improvements, and documenting and following up on individual projects. Since the cycle is so important, the ***Job Improvement Guide*** was written to explain, in detail, each of the six steps.

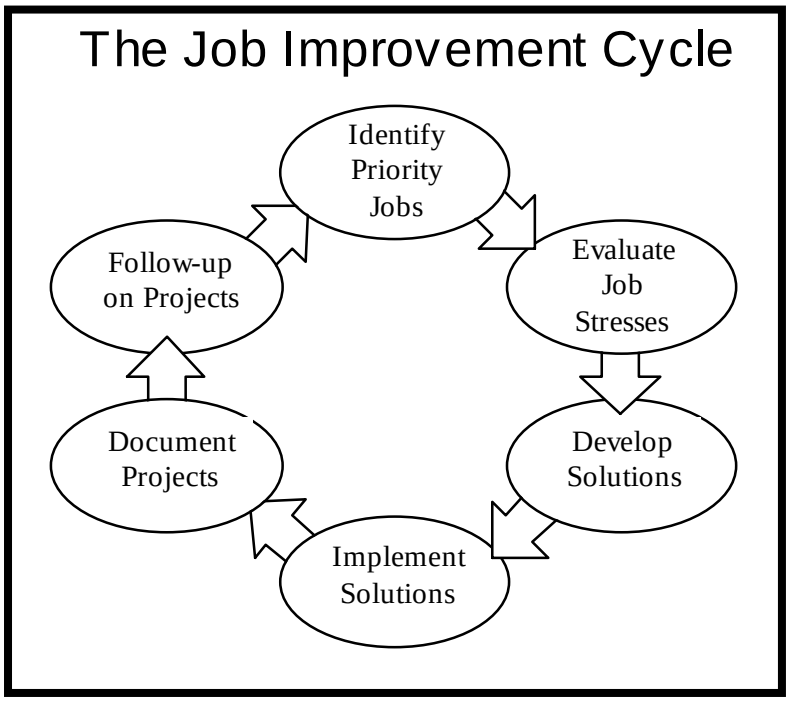

Figure 1. The job improvement cycle.

An important addition to the process was the development and launch of the Evidence Book in 1991. The Evidence Book is similar in design to evidence documents developed for the Ford Production System checkpoint evaluations. All necessary documents are available in one place. In order to more readily share this information, a specification for a computerize version was developed and is currently being piloted in the United States.

In order to implement this process, it is recommended that formal pilots be run in each country. Below is a summary of the tasks that are necessary to implement ergonomics in a new region:

Step #1

Securing Leadership Commitment (plant management and key employee representatives)

A preliminary leadership orientation meeting should be scheduled and organized to make the leadership aware of the incoming ergonomics process. The meeting should be approximately 2 hours long and have the following objectives:

1. To create an awareness among local leadership of what ergonomics is, why it is important, and why the facility needs it.

2. To provide the leadership with an overview of the design and structure of the process and to inform them of their roles, and to solicit and gain leadership support for the process. Leadership support will be in the form of sufficient time allocations for the LEC members to complete job analysis and to attend regular LEC meetings. In addition, support will be required for resources to implement job modifications where ergonomic hazards have been identified and require engineering changes, changes to the job process, or administrative controls.

3. To discuss and review local laws and contracts that may affect the implementation of the process.

Step #2

Development of the Committee

Shortly after the preliminary leadership orientation meeting, members of the local ergonomics committee should be selected and trained in the process.

The core of the Manage Ergonomic Events process is a joint employee-management team. This team consists of carefully selected individuals who will meet regularly as your local ergonomics committee. The committee should represent both labor and management equally. Exact membership, location, and reporting requirements of the committee will depend on the facility and its relationship with labor and current organizational structures. However, at a minimum, it is recommended that members represent a variety of disciplines within the facility including engineering, safety, supervision, production employees, skilled trades, and key employee representatives.

Step #3

Development of a Mission Statement and Teamwork Process

Mission Statement–A Mission Statement sets the direction of the committee. Key elements of a mission statement include:

- Overall goal of the ergonomics process;
- The objectives toward which your LEC will work;
- The strategies by which the team will meet the objectives.

The mission statement should be updated at least yearly to ensure the LEC is efficiently using its resources.

Teamwork Process–Each facility is responsible for handling the day to day activity of

the ergonomics process. It is important for the LEC to identify a working process that will enable it to effectively make progress toward its objectives. Some issues that need to be considered in developing an effective teamwork process are:

- Release time for the committee to attend meetings and to complete assignments;
- Setting concise agendas and recording meeting activities
- Updating the Ergonomics Committee Evidence Book and other related documentation.

Step #4

Adjustment of the Process

After the facility has gained experience in the deployment of the LEC process, it is recommended that another leadership meeting take place to review results and make adjustments. Modifications of the process should be made at this time before facility wide implementation.

Step #5

Evaluation and Auditing

The manage events ergonomics process will be evaluated at two levels–the process level (Voice of the Process, VOP) and at the customer level (Voice of the Customer, VOC). The process evaluation (VOP) will be conducted using the FPS auditing system. It is recommended that the process audit be conducted at least once per year. The results from the audits will be used to meet the requirements for Ford Production System checkpoints and to coach plants on process improvements.

Customer needs and expectations will vary within each facility. Evaluation of the customers needs (VOC) will depend on a set of measurable that are developed as part of the facility mission statement and action plan. It is recommended that at a very minimum, injury/illness and absenteeism data be reviewed and targets set.

Ergonomic Prevention Process

A more effective and cost-efficient approach is for the Process to be pro-active–that is for ergonomic principles to be applied during product research, design, and plant layout in order to prevent ergonomic stress. In this way, problems will be designed out of the product and process before reaching the operation phase. These efforts will help establish Ford Motor Company as the continued leader in ergonomics applications and research. However, it is essential to the success of these efforts that all parts of product and process development be linked to the Ergonomics Process.

Figure 2 is a flow chart that identifies opportunities for ergonomic (and other safety and health) input during the World Class Process (currently called the Ford Product Development System) timing plans. Future product and process development is made up of a series of specialized functions in separate organizational units that work together in co-located teams called Vehicle Centers. Units at the division level typically perform design and planning functions; and units at the plant perform operation and maintenance functions. Often, these units are separated geographically and organizationally (e.g., division and plant) making it difficult to coordinate efforts. This figure illustrates that there are several points in time where the Ergonomics data

can be applied. With all organizational groups participating in ergonomics efforts, current problems can be fixed and future problems can be prevented.

The Global Ergonomics Team discussed Prevention in detail. These discussions resulted in the development of a process called Design for Ergonomics (DFE). It is important to note that this process will only work if the linkage between Advanced Manufacturing Engineering and the individual Vehicle Centers are made through World Class Process and the Ford Production System. Currently, Ergonomics has linked to these systems through the Advanced Manufacturing Engineering Office's Manufacturing Technology Development and Applied Engineering Group.

The Design of an Ergonomics Process must be implemented early in the development cycle. Implementation involves similar steps outlined above in that a team needs to be identified, trained and it needs to develop a teamwork process. A course has been developed called Design for Ergonomics. It outlines a process by which engineers, equipment suppliers and others work together to identify, evaluate, develop and implement solutions on new productions systems.

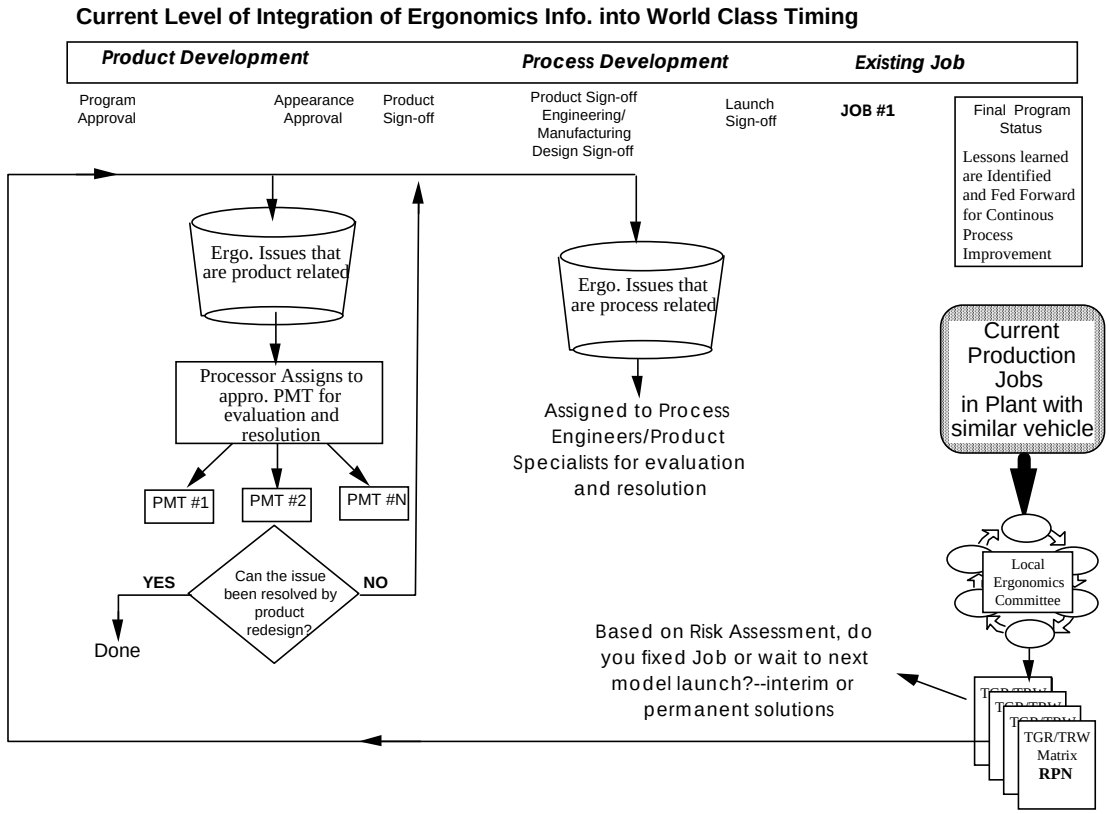

Figure 2. Product/process design process with key timing points.

Summary

Ergonomics is involved throughout the product and process life cycle. The first stage has two parts and is called Prevention. It begins its involvement early in product development by training and consulting with engineers to design products that supports the ergonomics of the production process. Next, process design engineers and

suppliers are trained on how to evaluate early process designs for potential ergonomics issues. The training includes methodologies and tools to help support the process.

The second and last stage is called Manage Events. Manage Events is involved if ergonomic issues are discovered to exist after the production process is launched. Joint labor/management teams are trained to evaluate and fix these issues. In addition, lessons learned are fed forward into future product and process planning so that these issues are not introduced in future programs.

The Ergonomics Process is dynamic and requires full involvement of all organizations within the Company. At the core of the process is the Local Ergonomics Committees. These committees must be in place and functional to achieve full implementation of the process.

Production ergonomics in car manufacturing - implementation for everybody's participation

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KLE strategy

At the beginning of the 1990s the Torslanda Factory was in a critical situation. Our ability to compete was unacceptable.

Back in 1989 we took part in MIT's international study, IMVP, International Manufacturing Vehicle Program, which demonstrated that we were a long way from being what we classified as World Class. We were even outside what could be classified as European Class. We decided to take on the challenge of transforming the Torslanda Factory into a World-Class factory.

Before I continue with describing the strategy we adopted and its link with our focus on ergonomics, I would like to point out the change that we can deduce from the latest IMVP study, which was carried out in 1994.

This shows that the Torslanda Factory has undergone vigorous development towards World Class and is now among the best European motor-vehicle manufacturers. It can also be pointed out that we are the only European motor-vehicle manufacturer to receive prizes 3 years in a row as one of the 3 best motor-vehicle manufacturers in J D Power's widespread investigation on how customers perceive the quality of the vehicles.

In 1991 a number of organisational changes were implemented, but above all we established the strategy that still applies, and according to which we have consistently worked since then. We call it the KLE strategy, which in Swedish stands for Quality, Delivery Precision and Economy. In order for Quality, Delivery Precision and Economy to succeed, Human Resource and Technology must underpin them.

This strategy applies to everything we do, irrespective of whether it is the product, process, services or people, etc.

To support the strategy, we have developed a number of working methods within various fields. Those I would like to mention today, as a link with ergonomics, are our teamwork, our way of creating customer-supplier relations and our way of working on continuous improvements.

The important factor, however, is not just to create methods. Most important of all is to get the employees to think and work in the right way and have methods that support this.

Our team concept captures employees' commitment and participation. We afford our employees the opportunity to have an influence on and vary their jobs, at the same time as the work content increases. Each team has a common, goal-oriented production-work task, which they carry out with trained team members. In order for the team to achieve or surpass its KLE goals, we have even incorporated a number of job tasks that the support organisations usually perform. The team members may perform them

when they have been trained for these tasks. The role of the support organisations is to back the team in achieving its KLE goals by developing and establishing systems and routines in the team, broadening competence and even providing back-up in those skills that have not yet been developed or will never be developed in the team. The support organisations are also responsible for ensuring that every functional area acts in a similar way throughout the entire organisation, irrespective of hierarchical level.

Link between ergonomics and KLE strategy

Over the past 5-6 years we have finished producing three different car models: Volvo 200, Volvo S90/900 and Volvo S70/850, at the same time as introducing both the Volvo S70/850 and our latest car model, the Volvo S80, which is the first model on our big platform. For the new platform we have rebuilt the factory into a flexible production plant with the means to manufacture three different models simultaneously in the same process. With each new change in product and/or process, work positions could be affected by other work content, other ways of stacking and sorting materials, modified process plans, new equipment, etc.

Already at the end of the 1980s we noted that we had certain work positions that were not ergonomically correct and caused us a number of negative consequences, such as absenteeism due to illness and staff turnover. We then started a Production Ergonomics project in the Torslanda Factory, the object of which was to increase knowledge and awareness of ergonomics within the organisation, partly to do something about the existing set-up, but also to do the right thing when building and rebuilding. Other speakers will provide more information on this later.

With our established KLE strategy, we found from the management's side that we could link up the ergonomics work with our other focal points in a natural way. The ergonomics work is not a separate entity, but is based on our strategy. We deal with these issues at the same time as we deal with other issues. We found it was much easier to get our leadership and other employees to understand, realise, accept and engage themselves in the ergonomics work when they saw the link with our KLE strategy. We didn't need to create other concepts or "letter combinations" in order to bring the ergonomics work into focus, it was already naturally there in the KLE strategy.

When the teams work on their production tasks, they are constantly discovering improvements that can be made in the ergonomics field. They are also included when it comes to setting standards for future products and processes with regard to customer and supplier relationships along with the projects/organisations that develop these.

In order to cope with changing the existing set-up as well as establish standards for future set-ups, the team members must have developed their own competence in the field of ergonomics. We have chosen to use our own Company Health Care Division, which is organised within a wholly owned company, Celero, in order to support the teams in their ergonomics tasks. You will hear a little later on about how this is being done.

We have even linked up our working environment system with the main business operations system already in place. This means that we have a simple system as a basis for our ISO 9002 and 14001 certification. One of Volvo's core values is "Envi-

ronmental Care", and in this obvious way we have demonstrated the link to our strategy and focus.

Gains from focus on ergonomics

By dealing with the ergonomics work as described we support the team concept, since a number of the team members can perform several stages of a job. We do not need any specialists. With such work positions, recruitment is simplified since the choice is greater, both with regard to sex, age and skills. We have generally found that mixed teams are stronger than a team with members that are too similar.

We have also established that our personnel costs are lower within several areas, such as by a reduction in staff turnover, which in turn means lower recruitment costs and education costs. Our teams will also become more effective due to lower staff turnover.

We also achieve lower absenteeism, which means that we partly need fewer stand-in staff and partly that we do not need to develop the competence of so many employees just to be on the safe side. It could also be difficult to keep this competence up-to-date if it is not in continual use.

With ergonomically proper work positions we have fewer industrial injuries and in this way we have lower costs for the rehabilitation of employees so that they can return to work again. All companies in Sweden are required by law to implement rehabilitation measures.

Our KLE strategy states that we shall give priority to Quality and always do everything properly from the start. It is therefore a matter of course that we have good work positions, job stages, ways of stacking and sorting materials, equipment, etc. By creating the conditions for our employees to do the job properly, we automatically achieve better product quality.

Because we create work positions that cause fewer manual or mechanical disruptions, productivity increases. We can even make the most of a faster pace since ergonomically proper job stages don't wear out our employees.

Production ergonomics in car manufacturing - prerequisities and evaluation of a program for load ergonomics

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Introduction

I will here describe the prerequisites and evaluate the effects of the work in ergonomics carried out in two projects - the Production Ergonomics Project and the P80-project at the Volvo Torslanda Body Shop, Sweden, where 210 white collar and 1682 blue collar workers worked at the time. The evaluation aims to show what is needed to ensure that ergonomics in the present operations and in alteration work will be satisfactory.

At the Volvo Amazon time in the sixties the working environment wasn't good at the Body shop. At the end of the eighties, the management was tired of the high absenteeism due to musculoskeletal problems, and of the great personnel turnover at the Body Shop. Many operators had to give up work because of musculoskeletal problems. The Body Shop was about to be involved in important new projects and to be partly converted. This was a good opportunity to make changes. The management of the Body shop gave The Occupational Health Department the task to solve this.

I knew by experience that it was not enough to build technically good ergonomic workplaces and the reason is the chain of co-operating factors from construction to production. One has to work with overview to get good results.

How the car body is designed, which materials and which manufacturing concepts are chosen decide how the work in the workstations turns out.

How the process is planned is important. Does it permit group organisation, will there be short or long cycles, stationary car bodies or car bodies on a moving line etc.

How the workstation is built decides how the work movements, postures and workload turn out. How the individuals (the operators) use the work place is important. They have to know their responsibility to cooperate, to perform a good work technique and to have consideration to each other and themselves.

The last peace of the chain is the work organisation. What content is there in the work?

How long do the workers stick to the same task? With what and how often do they change to get variation? Have they got any influence?

To reach the whole chain and to achieve good ergonomics results one has to train all categories involved in load ergonomics, the preproduction technicians, the production technicians, the managers, the safety delegates, the operators etc.

Accordingly, the Production Ergonomics Project was started. The goal was to increase knowledge and awareness of ergonomics in order to prevent work-related musculoskeletal problems and the need of rehabilitation by introducing suitable meas-

ures to deal with this in the existing production and to do the right thing from the beginning when complete changes and conversions were made to the Body Shop. I got responsible for the planning and the realisation and this became my method.

Adapted target group training in load ergonomics for all personnel categories concerned and methodical work on all workstations should be the key to a good ergonomics result. During three years we were two ergonomists working full time in the project. The project was partly financed by the Swedish Working Life Fund. The P80 project in the Body shop was a project covering the building of an entirely new production plant for the manufacture of the Volvo 850 chassi. The aim of the work on ergonomics in the P80 project was to build work places, which should have a so-called medium load level and also offer the operator a chance to vary his or her work. The training method of the Production Ergonomics Project is to train everyone and in categories towards a specified goal and to provide him or her with ”tools” such as checklists corresponding to the function of the respective category. Everybody get the same basal knowledge. The idea is to facilitate co-operation and development in the area of ergonomics. Some 1900 persons from the named categories working for the Press Shop, Body Shop and Paint Shop have been trained.

I worked out a specially adapted method for the work on analysis; measures and classification into levels and a system for securing ergonomics shortly described here. At the Press Shop, Body Shop and Paint Shop, some 250 unique tasks have been analysed and classified and many improvement measures have been carried out. This is now being done again in the whole plant i.e. the Press, Body, Paint and Assembly shops after having been rebuilt for the S80-car.

The ergonomics efforts within the project group of the P80 Assembly section was concentrated on work heights, work distances, lifting tools, hand-held machine tools, packaging (height, tilt, placement), personnel training and, to a certain degree, work organisation concerns.

Results

The evaluation of the project is based on personal observations, the comments of the various people involved, questionnaires, analyses and classifications of the work places.

The evaluation shows, via a number of concrete examples that there is a higher level of knowledge and awareness of the importance of ergonomics and of good collaboration.

Some examples:

- Increased number of requests for training in load ergonomics, causing a distribution to other groups and other areas within Volvo.
- Load ergonomics documents, filling various needs, have been created over the years, such as Requirement specifications for load ergonomics, Product requirements and Quality checklists in projects including ergonomics etc.
- “Tools” for work, during and after lessons, have been designed to facilitate and ensure daily ergonomics efforts, for example a Preproduction technician checklist.

- Improved crossfunctional co-operation, within project groups and ergonomics securing groups, has been developed. This saves time.
- Larger ergonomics technical standards and awareness within new construction have gradually been attained. Tilting for welding the roof and adjustable platforms are good examples. It is satisfying and a little astonishing to see how the technical ergonomical improvements such as individual adjustable height and good lifting aids suddenly are looked upon as human rights, (which are here to stay).
- Occupational damages and illnesses as well as absenteeism have decreased.

Conclusions and recommendations

The conclusion is that it pays to train all the personnel and to carry out work in ergonomics of the work place applying the methods of the Production Ergonomics Project and that the goals are gradually reached. The possibility to carry on ergonomics work with a comprehensive view has increased.

The work on ergonomics in the projects on new products and in the projects on new and converted production areas is being developed very much because of the great training program.

Recommendations for ergonomics work to be successful are:

Training

- Start with training/information for the entire management group and explain the employers' responsibility according to the Swedish Work Environment Act. The project can not be completed without the support of the management. Report on the results to the management on a regular basis.
- Plan the training with well-defined targets for each category. Train everyone by category using a common basic content and with various "tools" for continued efforts within each person's area of operation. The responsibilities and obligations of the employer and the workers should be emphasised in the training
- The instructor must have a comprehensive view of ergonomics concerns and both overview over and in-depth knowledge of the product, process, production, and personnel.

Securing Ergonomics in existing operations

- The analysis, corrective measures, and classification efforts must result in the creation of ergonomics securing groups formed in each department for follow-up work.

Securing Ergonomics in projects

- There must be methods for the ergonomics efforts, within new production and new and rebuilding projects. The project organisation is to include ergonomics as a separate segment, along with working environment and safety.
- Work to obtain an understanding for work organisational aspects at an early stage of the project.
- The process, layout, production, and organisation must be planned to make it possible to properly handle any adjustment work on the product from the point of

view of ergonomics. Modern shape of cars puts great demands on the press technique and often results in adjustment work.

- Train/inform designers and engineers so that they know what causes the greatest ergonomic problems in the production.
- Involve the operators in the design of lifting aids and other production tools and machines and specify the requirements of all interested parties to the supplier.

Continual efforts

This work has now continued in the Assembly Plant. Personnel and technology are developing further and good solutions are invented. Today everybody realises how good ergonomics and a good working environment affect the quality of the work performed and the quality of the cars.

Production ergonomics in car manufacturing - from construction development to the assembly plant: what does the ergonomics state look like today at Volvo Torslanda plant

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Today 1999, the Production Ergonomics Method is fully implemented in all four factories: the press shop, the white body shop, the paint shop and the assembly shop. Approx. 90% of the staff have gone through education in load ergonomics adapted to their specific task meaning that nearly 4000 people including all pre production engineers have passed education since the start of the project. This in fact has created the necessary platform of knowledge, which is the basic condition for success and co-operation.

The education must continue perpetually to maintain the high level of knowledge although the main task now is performed. As soon as there is a need for it, we start a new course. However learning by practise afterwards is the best way to confirm the knowledge.

In the early stages of a project, there are routines for participance of the ergonomists such as particular routines for the work surroundings in projects and alteration work. There is also the special checklist for pre production engineers consisting of claims of load ergonomics. Certain work routines have been established during the years with frequent contacts and co-operation between the pre production engineers and the ergonomists in order to achieve good solutions and to solve ergonomical matters which do not follow ergonomical claims. As the different gates of a project appear the SHE-checklist (Safety, Health and Ergonomics) is used which is controlled by the Quality department to guarantee that the Requirement Specification for Load Ergonomics is followed.

Thus we take part in all project meetings, test buildings of the car and work groups necessary to make sure that the very best possible solution is chosen to avoid work related ailments in the future.

We particularly want to emphasise the importance of the participation of the assembly workers in the projects and continuous work. They have detailed knowledge about the assembly and operations that cannot be left out. In the S80 project some 150 assembly workers and operators were directly involved in the project. This fact has very much influenced the chosen concepts.

The work with the S80 project is now finished and is succeeded by a follow-up-phase where each work station and assembly or operation in production is judged according to the standards and classified according to load level by the ergonomist in charge.

All plants have been thoroughly classified continually since the beginning of 1992 and a great number of actions have been taken to solve problems that might cause work-related injuries. Solving problems is mainly done in the ergonomics securing groups but the best form of following up is when ergonomics in a natural way is included in the daily work.

In our continuous effort to improve the load ergonomics in production there are a few matters we want to mention in particular:

1. The checklist for load ergonomics for pre-production engineers (table 1, fig 1). The checklist is developed and evaluated in co-operation with pre-production engineers.

2. The load levels and example from the paint shop (fig 2).

Table 1. Checklist for load ergonomics at Volvo Celero Support.

Load factor	OK	Not OK	Comment	Process remedy	Product remedy
WORK LOAD Lifting diagram					
Centre of gravity pos					
Seizability					
Other heavy handling					
WORK MOVEMENTS Lifting diagram					
Time					
Unchanging / repetitive work					
Precision / Power					
Pressure / Insertion					
Movement					
WORK POSTURE Height					
Distance					
Grip					
Gripping force					
Vision requirements					
TOOLS (acc to spec./factory)					
PACKAGING (Evaluate by process)					

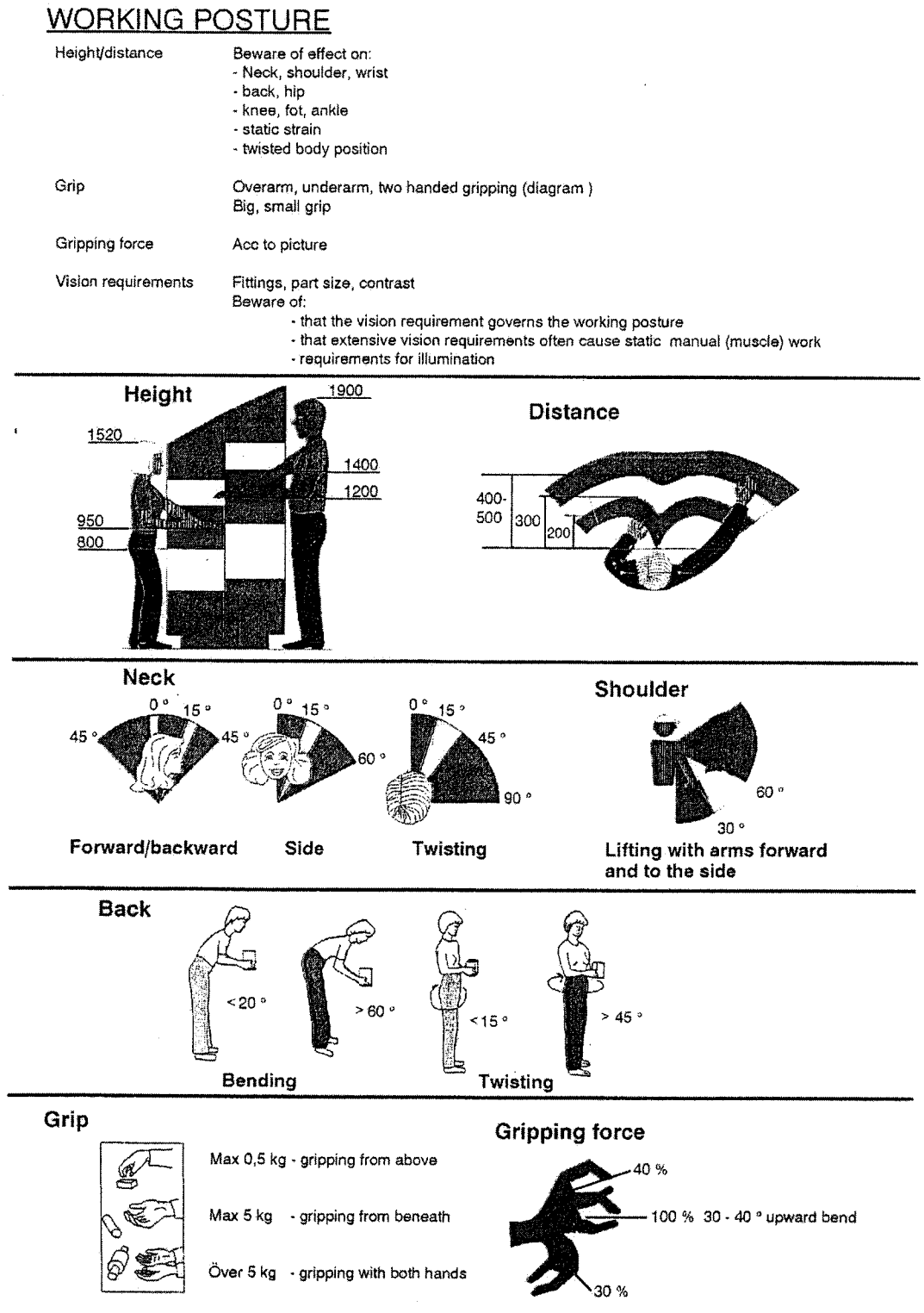

Figure 1. Example of guideline used for evaluation of work postures.

<table>
<tr><th>Demands made by the work on movements and support organs</th><th>The job´s harmful influence on movements and support organs</th><th>Work should be managed</th><th>Classification Load level</th><th>Intended action</th></tr>
<tr><td rowspan="2">Major</td><td rowspan="2">Harmful</td><td></td><td>very high (3+)</td><td rowspan="3">To be corrected</td></tr>
<tr><td>Possibly by young strong males for short periods of time</td><td>high (3)</td></tr>
<tr><td rowspan="3">Moderate</td><td rowspan="3">Probably not harmful</td><td>By healthy young individuals with the proper work tech-nique</td><td>relatively high (3-)</td></tr>
<tr><td rowspan="2">By ordinary healthy male or female individual</td><td>moderate (2+) and (2)</td><td rowspan="2">Rational goal in car manufacturing</td></tr>
<tr><td rowspan="2">relatively low (2-)</td></tr>
<tr><td>Minor</td><td>Not harmful</td><td>By older individual or person with minor physical impediment</td><td></td><td>For rehabilitation for older indi-viduals</td></tr>
</table>

Figure 2. The load ergonomics analysis of the work/work place may be coordinated and evaluated into a load level classification.

Production ergonomics in car manufacturing - continual efforts in significant areas

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Hand-held machines

In the working environment programme that is being implemented at the Volvo Cars' assembly plant in Göteborg, the problems associated with injuries to and problems with hands/wrists have been a focal point for many years. The occupational health department has attempted to identify the environmental factors which are to blame.

Assembly work includes the extensive handling of hand-held machines, first and foremost wrenches. One possible environmental factor, which could contribute to the occurrence of problems, is the relationship between handling these machines and large assembly forces.

The reasons for making assessments of musculoskeletal (load-oriented) ergonomics have thus become even more clear-cut.

Assessment group

At the Volvo Cars' assembly plant in Göteborg, a basis has been established for assessing the musculoskeletal ergonomics related to the choice of tools, when new tools are purchased, for example. The other requirements relate primarily to production, economy and quality.

A special group for assessing hand-held machines meets once a month. It is made up of representatives from the hand-held machine centre, ergonomists, working environment engineers, assembly workers, repair workers, planners, purchasing staff and safety representatives. We study new developments in the area, even when it comes to peripheral equipment and devices such as suspension equipment and air hoses. The group also follows up the situation in relation to musculoskeletal injuries/problems, which can be attributed to different machines.

The assembly workers are involved in the assessment of machines as these machines are tested in production. Needless to say, the quality of these machines must be approved in accordance with the Volvo Group standard before they are tested by assembly workers. The machines are assessed on the basis of an assessment plan and the group's own views and opinions.

Only machines, which have been approved by the assessment group and in accordance with ergonomic criteria, as well as being assigned type approval in accordance with the Volvo Group standard, are to be used in production.

As a result of the systematic work that is being done by the assessment group, more and more suppliers are starting to comply with our requirements.

In economic terms, it has been found that the company stands to gain a great deal.

The work of the ergonomist in association with hand ergonomics at the plant consists of the following:

- Acquiring knowledge of assembly workers' views and opinions and assessing hand-held machines.
- Participating in assessments of the ergonomic characteristics and quality of hand-held machines.
- Passing on our ergonomic requirements to suppliers.
- Participating in the purchase of new machines and peripheral equipment.
- Organising training in hand ergonomics and the use of hand-held machines.

Fasteners

When it comes to assessments of assembly forces, we apply the same methods to some degree, but we do not use the same expert group.

One example that deserves some extra attention is the fitting of clips (fasteners). Here, too, we have a specification of requirements which we have incorporated in Volvo's description of functional requirements and which we pass on to our suppliers.

On previous car models, the number of unacceptable clips was around 70-80%. The current situation is exactly the opposite. We are collaborating with assembly workers, designers, planners and production technicians to develop clip fasteners that can be approved in accordance with our specification of requirements.

Reduction in problems

We can currently see a clear-cut reduction in the number of wrist problems.

This results in a number of benefits:

1. The awareness of many professional categories has created an understanding of the existence of problems and their scope.
2. The assembly workers often know who they can contact to discuss and obtain some response on assembly forces.
3. There is a real determination to solve these problems.
4. It also produces good quality in the work that is done - quality benefits.
5. Working technology.

Work technique

Alongside all the ergonomically oriented projects at the assembly plant, a great deal of time and effort is being devoted to working technology.

Objective

To integrate good working technology in the production process.

Sub-objective

To improve the environment at workplaces by producing ideas/concepts for good working technology.

Method

The work is done by assembly workers who:

- are interested in ergonomics
- have received training in this area
- have long experience of building cars
- have experience of ergonomics
- are able to present the subject pedagogically

Implementation

- Run preventive activities when it comes to working methods for assembly workers (working technology)
- Collaborate with ergonomists/registered physiotherapists
- Be able to make a rapid working technology analysis in the event of acute problems
- Support and monitor working technology in production
- Develop and adapt working technology methods for assembly workers
- Collaborate with ergonomic resources at the department
- Pass on experience to new car projects - both negative and positive experience

Benefits of this project

- Increase and pass on knowledge of working technology (working positions, movements during work, work load, use of strength, pressure forces and so on)
- Pass on good experience of working technology
- Demonstrate in concrete terms how good working technology can be applied
- Create an holistic approach to working technology at the assembly plant and pass on knowledge from different departments
- Cut costs

Production ergonomics in car manufacturing - working environment* - management organisation at Volvo Car Corporation

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Background

During the latter part of the 20th century Sweden has upheld a tradition of working with environmental issues. This is also true within the Volvo Car Corporation (VCC), primarily in the production units at Torslanda, Skövde, Köping and Olofström. In the Research and Development units, with primarily blue-collar workers, their own working environment is today integrated in their ordinary working tasks.

Working environment today

Work concerning working environment has been constantly improved within Volvo. In the local operational system the quality of a product and the environment is measured. The working environment is integrated into this.

Development has come so far that problems regarding ergonomics are already assessed at the design and construction stages. During recent years great improvements within the design and development units have been accomplished for the individual working environments of the designers by developing methods of working and the work organisation. Working methods and working place design have been improved in an entirely new work organisation.

The overall operation is pursued and co-ordinated from the VCC Working Environment Board, the chairman of which is the Senior Vice President of VCC and the secretary works full-time with co-ordinating the operations.

The word working environment what does it mean? Here are some examples:

- stress-related symptoms
- work-place layout
- related to cost of product
- ergonomics
- risk assessment
- musculo-skeletal diseases
- occupational health and safety
- management system (OHS) including accidents
- work organisation
- efficiency
- related to quality of product
- chemical hazards MSDS**
- noise
- psycho-social environment

* Working environment = OHSA (occupational health and safety)

** Material safety data sheet

Working environment management system

Working Environment Policy
Our policy states the company goals and how responsibility should be distributed in order to arrive at these goals. Every year each unit develops plans of action. A quality assurance system - an internal control system - should exist in line operations to deal with working environment issues.

Delegating working environment issues
The President and CEO has delegated the task of responsibility for the working environment within operations to those in management immediately subordinate to him. In turn, these delegate the task further down in the line organization. Responsibility for the task is based on the fact that the person in question has the necessary competence and authorisation to carry out the job. The CEO always maintains an overall responsibility for the environment.

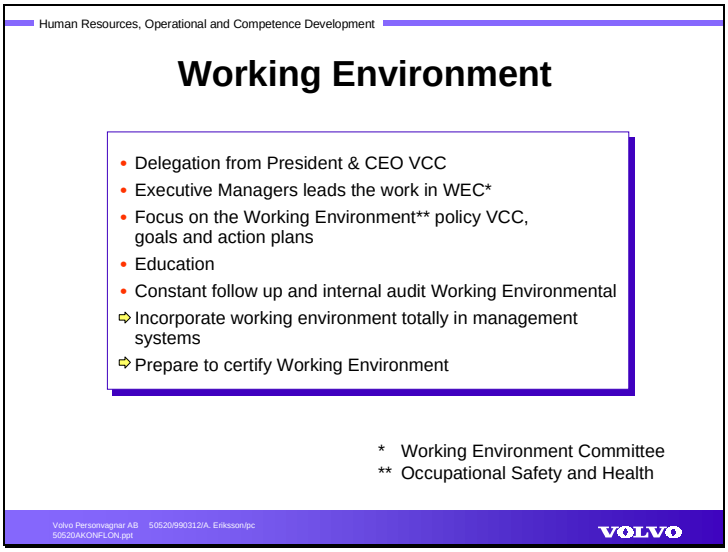

Figure 1. Working environment delegation at Volvo Car Corp.

- Delegation of working environment tasks from the President and CEO VCC according to the line-organisation in the company. Competence and authority leads to responsibility.
- Executive Manager leads the work within the responsibility area.
- Focus on the working environment policy VCC. Explain the content and the directives. Create goals and action plans. Concentrate on constant follow-up procedures.
- Education in the working environment field starting with Executive Management and then at all levels together with safety representatives from the unions.
- Internal audits according to our model for internal control of the working environment. Risk assessment. Local models which corresponds to local processes.

The VCC Working Environment Board
On the board there are three participants from executive management at VCC, a secretary and representatives for the labour organisations in Sweden. The company health

service has one representative. Working environment operations are chiefly directed towards operations in Sweden.

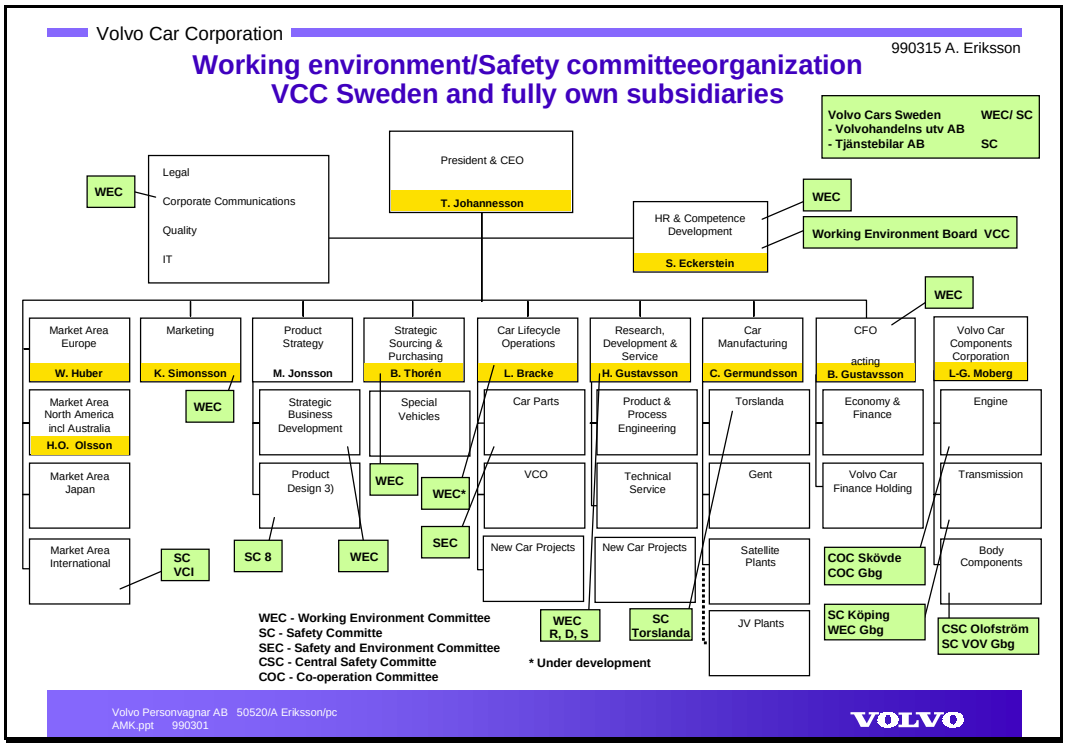

Figure 2. Working environment organization at Volvo Car Corp.

Executive Management leads the work

During the last two years working environment operations have been integrated into the management groups within executive management and have been broken down within each unit.

The Swedish Occupational Safety and Health Act requires that employers systematically plan, manage and control activities within the working environment sector and that working environment committees (AMKs) should exist to co-ordinate this work.

The management group is reorganised into an AMK four times per year and during this process safety representatives from labour organisations and representatives from the company health service participate.

The company's policy within the working environment sector is set into practice in the form of goals and plans of action.

Education

All managers receive 1 to 4 days training within the working environment sector. A major part of the training is devoted to an internal control of the working environment.

Internal control system
In respect of Volvo's own working environment requirements and the requirements of the Swedish authorities, there are internal control systems developed that include risk assessments with regard to risks of physical and mental ill health.
A model for an audit of an internal control of the working environment has been developed and is used within the company. We also have a Volvo Group standard within the work environment sector.

Constant follow-up and audits
Follow-ups are carried out on a regular basis within each sector and this is the most significant part of working environment operations. The Working Environment Board initiates internal audits of the working environment within the different units.

Ergonomics at Saab, from design to the shopfloor and back again

Saab Automobiles Ergonomic process

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Introduction

Here at Saab Automobile we do not have a program for ergonomics we have a process. Our process has taken about 5 to 6 years to evolve and is of course developing and improving continuously. The process can be divided into two main parts, the reactive part and the proactive part. Both are necessary and integrated with each other. In turn these two major parts can be broken down into specific tools that we use in practice in our daily work.

The reactive process

The reactive process consists of the following tools:

Saabs Health department
The health department uses two systems to validate and track ergonomic problems. The first system is a computer code system that is used to track areas, workplaces or products in production that cause CTD's. This system is used when the physiotherapist or doctor is convinced that the patient's problem has arisen through work.

With our coding system we can track frequency of different diagnosis where in production they have arisen and which parts are responsible for producing CTD's. Once we know where or what product has caused the CTD's we can put a price on how much these CTD's cost the company by using our diagnosis pricelist. The calculations are based on Pula Liukkonen method. We have put a price on the most common diagnoses at Saab tension neck, wrist problems, tennis elbow, shoulder problems and low-back pain. These figures are used in business cases to motivate alterations in products or /and workplaces.

The coding system is an extremely important part of our knowledge base for ergonomics but it can't work without an "open clinic" that is to say a clinic high accessibility. We have that type of clinic our employees know that they can see the physio or doctor on an emergency basis and that all physiotherapy treatment is free of charge and is performed during work time with no loss of pay. Last year alone the 4 physios gave over 6800 treatments approx. One third of these were due to work.

Production Ergonomic checklist
We have developed our own checklist for ergonomic evaluation of workplaces and products in production. It is based on a red, yellow and green classification where a red represents a no go. We have trained our industrial engineers to do the evaluations using the checklist; every single workstation will be evaluated by the checklist. The reds will be grouped in process reds and product reds. That is to say a red, which is

caused by a bad workplace design, is a process red and one caused by product design is a product red.

The inventory of the whole plant will soon be completed then we will know the present status of the factories, essential knowledge for our proactive work in the new car projects. When creating any kind of checklist it is important to keep in mind who is going to use it and how. A checklist have good intra and inter personnel reliabity, it must be quick and easy to use it other words based on the universal KISS principle KEEP IT STUPID SIMPLE. Not because the people that are going to use it are stupid but because doing an ergonomic evaluation is just a small part of their job, remember they are not trained ergonomists they have been trained to use and understand a checklist.

Safety Audits
We have taken the traditional safety audits and turned some of these into ergonomic audits. The audits are performed on a regular basis in all the factories.

The Proactive process

The proactive process consists of the following tools:

Saab Automobiles Health and Safety policy
We have the conviction and ambition that all occupational illnesses and injuries can be prevented. Our policy is to safeguard the health and safety of each employee.

- We must design products and workplaces with respect for our employees' capabilities.
- It is the responsibility of each employee, contractor, and visitor to strictly adhere to all regulations and rules regarding health and safety.
- Systematic leadership, planning, training and internal control of all health and safety related activities are our tools.
- Continuous improvement of the working environment is a responsibility for all of us.

Design ergonomic checklist
Alongside our production checklist we also have a design checklist for ergonomics based on the same principles as the production checklist. We train all our manufacturing engineers and product design engineers in how to use the design checklist, and it has become a routine part of their work.

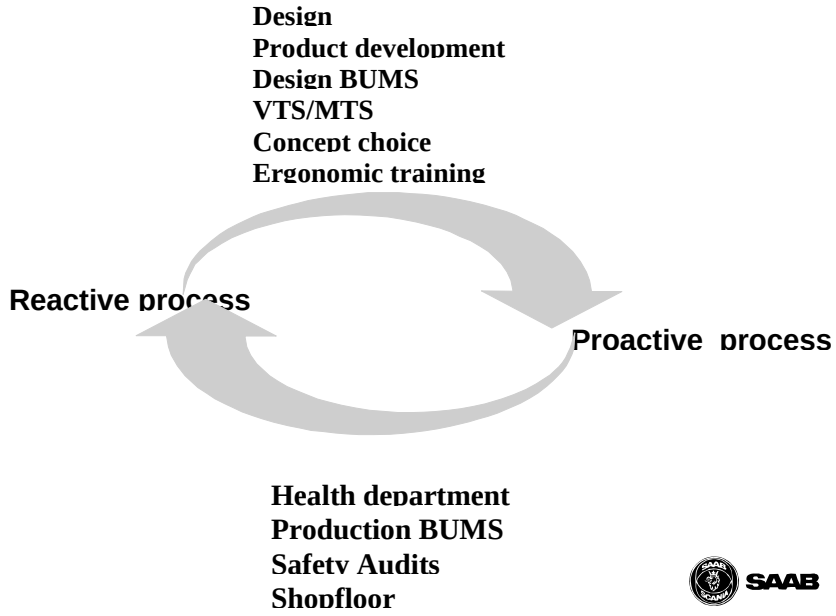
VTS/MTS
Vts is short for Vehicle Technical Specification this is document used in product development that specifies the demands on the product during the development phases. In the VTS it is stated that if an article or product is red according to the ergonomic checklist it's a no go and back to the drawing board.
MTS is short Manufacturing Technical specification and specifies the different on a product before it can be approved for manufacturing. No red products or articles are allowed into production before they have been reviewed and evaluated by the ergonomic steering committee. As you understand we do not live in a perfect

world we make cars and it is impossible to avoid that any red product finds its way in to our production, but the ergonomic steering committee acts as early warning system for production in these cases so they have time to develop sound ergonomic workstations to compensate for the red product.

Ergonomic Training
We train all our manufacturing engineers and product design engineers in basic ergonomic understanding and the use of our ergonomic checklist. An important part of the training is to show the connection between good ergonomics, productivity and quality. Once they realise that there is more then health issues involved and that the company's economy and ergonomi can improve simultaneously they become more motivated to use ergonomics as a natural tool in their daily work.

Reactive - Proactive process

The reactive process is a precondition for the proactive process. Without it the proactive process would be groping in the dark, not knowing what the main problems are today makes it very difficult to prevent them arising tomorrow. What I'm trying to say is that very often ergonomists stress the need for prevention and that is all well and good, but you have to have a good picture of your present status and the only way to get that is to have a good reactive process.



Health management at VOLKSWAGEN

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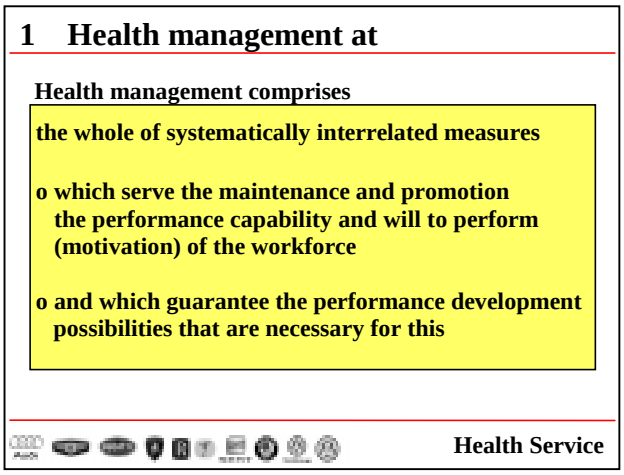
What is health management?

At VOLKSWAGEN, health management comprises a complex of some interrelated measures (fig. 1):

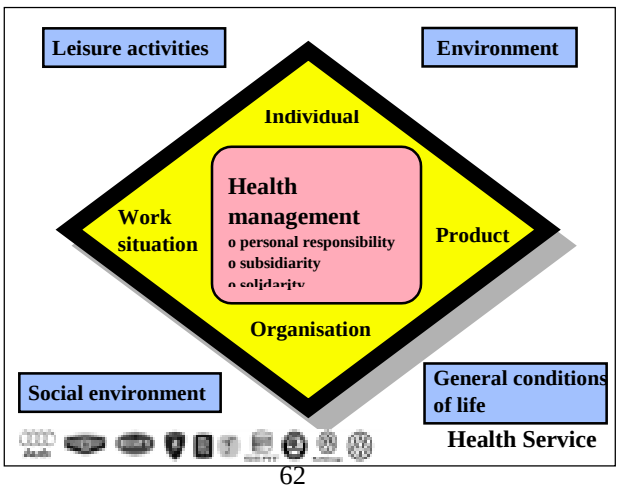


o which serve the maintenance and promotion of the performance capability and motivation of the workforce
o and which guarantee the performance development possibilities, which are necessary for this (e.g. group work).

Health management is an integral component of our personnel policy and a part of personnel and organisational development.

At VOLKSWAGEN, health management involves not only the individual employee, but also the work situation, the entire company, our products and the corporate environment (fig. 2):

Health management at VOLKSWAGEN



What are the principles of health management?

Health management at VOLKSWAGEN is aligned to three principles:
- o personal responsibility: each is co-responsible for his own health;
- o subsidiarity: self-help has priority over support from the company;
- o solidarity: mutual support and commitment between company and workforce.

The objectives of health management

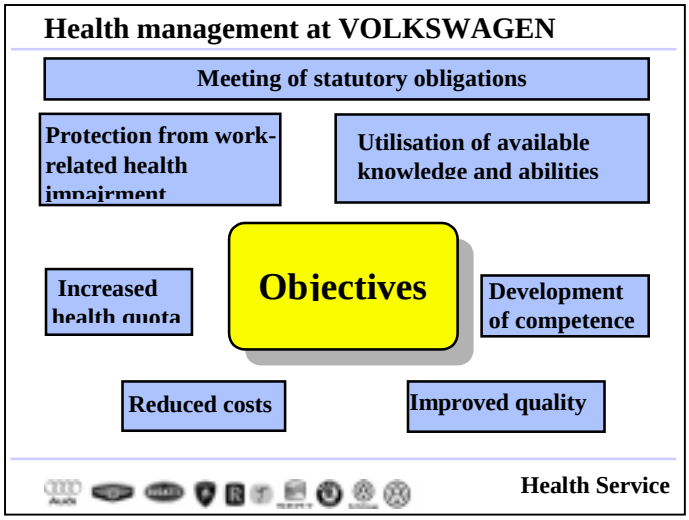
In health management at VOLKSWAGEN, a number of objectives are pursued (fig. 3). In the first place it serves to meet the statutory requirements of industrial safety and health. In addition there are some social and economic objectives:

o protection and promotion of health,

o development of competence,

o cost reduction

o and quality improvement.

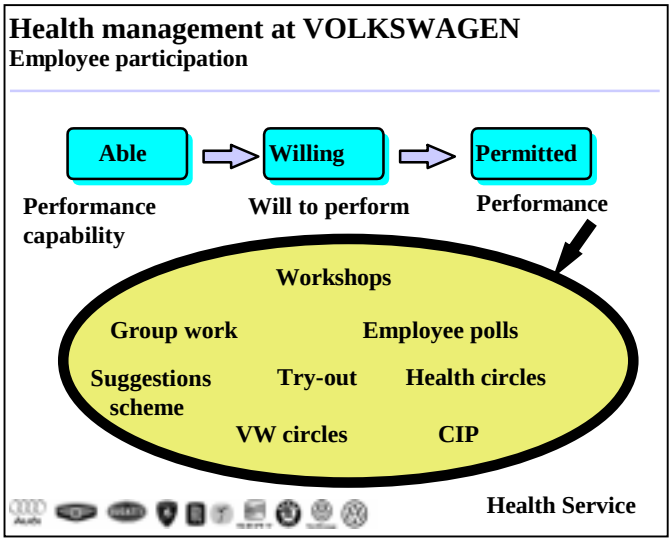


Structure of health management

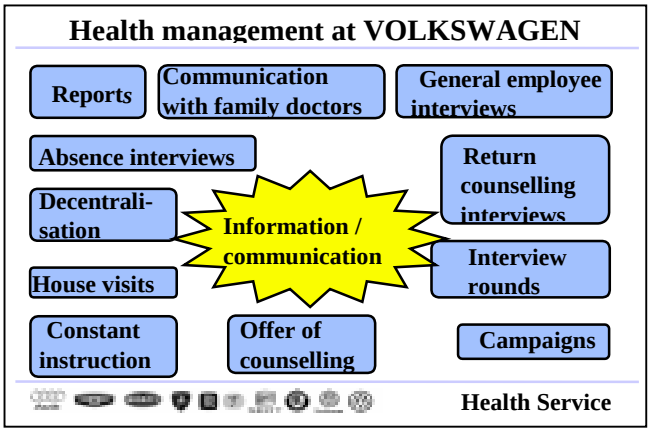
Health management at VOLKSWAGEN has a modular structure. This makes it possible to relate action directly to problems and target groups. The most important modules are work design, employee participation and information/communication. The other modules are meaningful too but they are more supplementary.

o ***employee participation*** (fig. 4)

At VOLKSWAGEN the employees are as far as possible actively involved when their health is directly or indirectly affected.
Forms of participation include health circles, extended workplace viewings, special workshops, the continuous improvement process and the try-out process. In addition, employee polls are carried out on various questions.

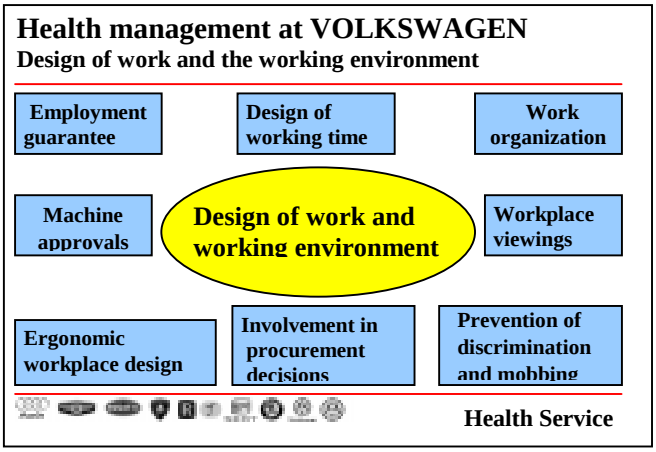


o ***information/communication*** (fig. 5)



The "Information and communication" module comprises various instruments. It includes communication on different levels.

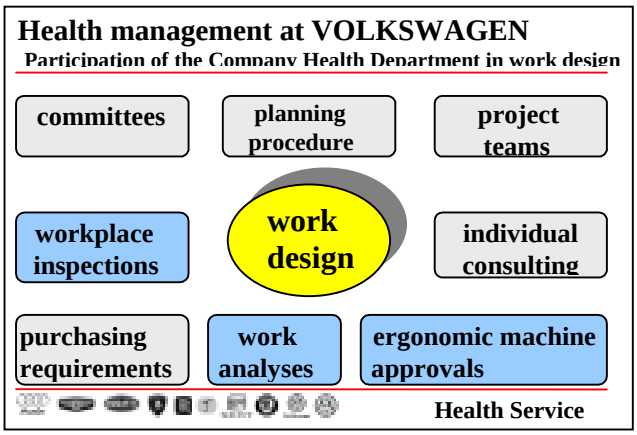
o ***work design*** (fig. 6)



At VOLKSWAGEN the health-conscious design of work has priority over other measures. We are convinced that work design is the best way of protecting and promoting the health of the workforce.

At VOLKSWAGEN health-conscious design of work comprises more than ergonomic workplace design. It involves employment guarantee, progressive working time models, new forms of work organisation, time accounts and rules for the prevention of discrimination and mobbing at the workplace.

In various ways it is ensured that health-relevant aspects are taken into account in work design (fig. 7). Important instruments are:

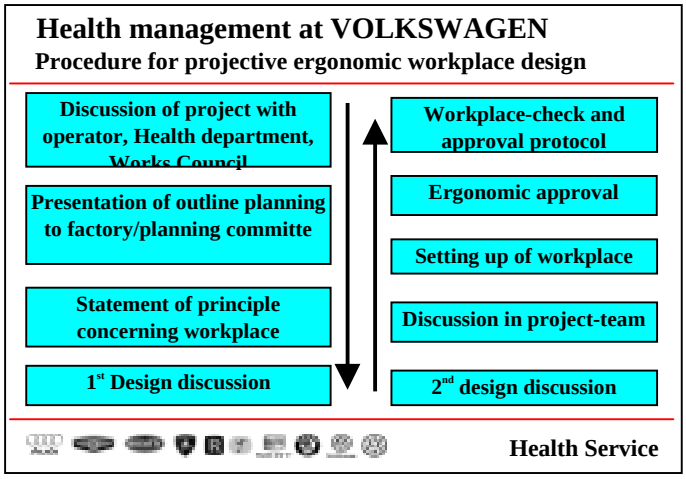


o committees (in charge of the clarification of basic questions, strategy discussions),
o work in interdisciplinary project teams,
o workplace inspections (participants are Medical Doctor, Head of Production Department, Works Council and other),
o purchasing requirements (comprehensive VW-requirements that a supplier of machinery must meet),
o ergonomic machine approvals (every machine is checked-up under ergonomic aspects before putting into operation),
o risk analysis and
o a comprehensive medical consultation system.

Our **procedure for prospective ergonomic workplace design** ensures that health-relevant aspects are taken into account from the planning phase of new systems. The procedure involves close co-operation between the production planning and the company health department.

The procedure was signed by the Board and by the Works Council and applies to all workplaces in the production area.

The procedure of ergonomic workplace design comprises a total of nine elements (fig. 8):



1. The procedure starts with a basic-discussion of the project with the operator, health department and Works Council.
2. Then the project is presented to the factory / planning committee. The rough planning is discussed, in particular personnel consequences of the project.
3. After that, the workplace and the sequence of operations are determined and described in a detail-plan.
4. The next stage is the first design discussion. The design plan is presented and discussed. Suggestions for changes are called for.
5. In case of alterations the first design discussion is followed by a second design discussion. Here, the design plan is discussed again, together with the improvement suggestions. If necessary, further design discussions take place. In addition, the checklist “Health Department Requirements” and the checklist ”Job Description” are filled out.
6. In the following stage, the design plan and the checklists are presented to the project team and explained by the planning department. If there are no further alterations the design plan is confirmed (“paper confirmation”).

Employees are involved in the project team.

7. After that, the workplace is set up and checked. This is called “try-out procedure”. The employees are involved too.
8. Then the workplace is ergonomically assessed. For this ergonomic approval the workplace has to meet certain ergonomic requirements. The result of the assessment is notified in an ergonomic approval protocol. After that the workplace is taken into operation.
9. During the start-up phase workplace inspections are conducted by the project team. In the course of this inspection, the entire workplace is approved.

The procedure is completed with the approval protocol.

The planning procedure is chiefly intended to prevent damage to or impairment of health. It is a first step towards promotion of health through work design.

Benefits of health management

What are the benefits of health management? In our experience health management contributes to maintaining and promoting the performance capability and willingness of the workforce. And health management is meaningful in **economic** terms.
Some examples (fig. 9 – 11):

o Through the reduction of exposures it was possible to cancel special medical examinations. In this way we have a cost-reduction of about 240.000 DM annual.

Health management at VOLKSWAGEN
Cost reduction through cancelling of special medical examinations
- Examples plant Wolfsburg -

Exposures	Division	Employees	Turn of invest.	Cost reduction in DM/annual	
Chrom, Blei	painting shop	800	18 Monate	Labor Wegezeiten, U-Zeit	48.000,- 43.000,-
Abdichter	painting shop	2000	24 Monate	Labor, Lungen-funktion, EKG, Wegezeiten, U-Zeit	80.000,-
Lärm	painting shop	1000	36 Monate	Wegezeiten, U-Zeit	27.000,-
Epoxidharz/ PVC-Kleber	body shop	500	36 Monate	Labor, Wegezeiten, U-Zeit	13.000,-
Isocyanatkleber	assembly	400	24 Monate	Labor, Lungenfunktion Wegezeiten, U-Zeit	16.000,-
Klimakammer	research	400	36 Monate	Labor, Ergometrie, EKG Wegezeiten, U-Zeit	11.000,-

Health Service

o In a production area we could reduce skin-problems through counselling, a special skin-protection-plan and a changed machine-cleaning-turn. Results: reduced health impairments, improvements in health quota (health quota means 100 minus absenteeism rate).

Health management at VOLKSWAGEN

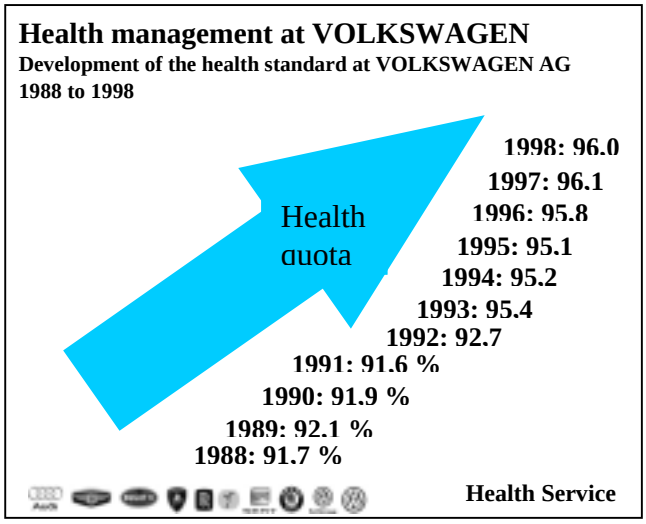
Skin problems
o increasing complaints about skin problems
o raising absenteeism rate from 5,2 % to 6,7 %
o assumed cause: new cut oil

Measures
o tests with the new cut oil
o changed cleaning turn of the machinery
o counselling
o special skin protection plan

Results
o substantial decrease of health complaints
o reduction of absenteeism rate to 4,2 %

Health Service

o And last but not least: The health quota has been increasing for 10 years. Last year we had a health standard of ninety-six percent.



Summary

A company such as VOLKSWAGEN, which wants to remain successful as a global player in international competition, needs capable and motivated employees. Health management is a way to protect and promote the health of the workforce and to improve economic efficiency.

Health management must not be reduced to raising the health quota and simply reducing costs. The protection and promotion of the employees' health are at VOLKSWAGEN above all a humanitarian and social obligation.

The motto of our health management is: **If you expect performance from the employees, you have to protect and promote their health.**

Integrating prevention of musculoskeletal disorders (MSD) in design ergonomics
Feed-back experiences in 1999

Margaret Moreau, Doctor of Industrial Medicine, Automobiles Peugeot Sochaux, 25218 Montbéliard cedex, France, (email jchris.moreau@wanadoo.fr)

Introduction

Initiated in 1992, the project consisted in opening the designer's eyes to health problems occurring in workers who are building the cars of today and tomorrow (5). More aware of those problems, they would then try and facilitate car mountability. To reach that aim, Medical doctors and Plant Management of Sochaux increased the number of interventions, thus generating a cascade of productive actions taking into account and definitely improving working conditions of work stations, where multiple peri-articular solicitations prevailed. *Medical problems*, in Trim and Final Plants, are essentially visible through an increase of annual occurrence of musculoskeletal disorders, enhanced by the phenomenon of age of personnel. This generates difficulty in improving workstations or reinserting workers, whose medical restrictions are mainly due to muscular strength deficiency and sensorial disorders. Eventually, resistance to effort and dexterity are diminished.

Protocol of action

Developing tools aimed at measuring or assessing manual operations or work situations and following up data which are simple, easy to understand, reconductible and most of all, adapted to automotive industry and local culture.

Following up those data over a length of time, in order to create progress assessments, and insure valid returns of experience for designers.

Following pathological or physiological indicators

* Age pyramid: denser around 45/50 years of age.
* Peri-articular disorders annual new cases.
* Increase of occupational diseases connected to those disorders.

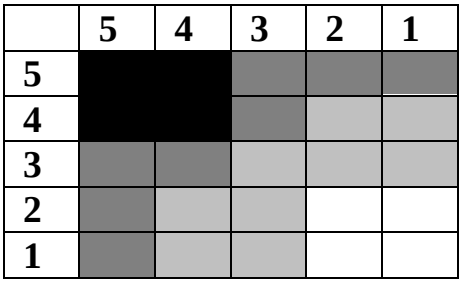
Developing technical indicators

a) A work-station assessment grid, created on the initiative of the Personnel Management of Sochaux, and used on a large scale in the local Plant, enabled us to classify 4561 work stations according to the force applied, the weights handled (physical requirements = P) and the postures (statical requirements = S), specific to the work shops (fig 1). Requirements are marked from 1 (low) to 5 (high). 60 technicians are in charge of assessing workstations and updating data. Each assessment takes about 15 minutes.

This method, called DACORS (1), enables us to make a quick scan of Trim and Final shops workstations, and to emphasise the most damaging situations. It gives an idea of the general requirement levels, thanks to the annual follow up of four types of work-stations, selected by the combination of Physical and Statical requirements (figure 1).

1) heavy
2) high average
3) low average
4) light

This principle allows the medical staff and personnel Management to follow the evolution of the heavy workstation, which has to be eliminated, and the light one to be preserved and developed.



P: Physical requirements; S: Statical requirements

	Heavy profit
	High average profit
	Low average profit
	Light profit

Figure 1. Work-station assessment grid called DACORS. Requirements are marked from 1 (low) to 5 (high). Four types of work-stations are defined with different profit.

b) Another grid, elaborated by the Methods Management of Peugeot-Citroen, assesses every single gesture and movement in mounting each part on the vehicle. Even though we do not assess parts adaptation, there remain about 700 operations per vehicle, which can be evaluated through that method called ECM (2). Medical doctors of Sochaux have added to that grid, questions aimed at quickly assessing physical and statical requirements, as well as safety hazards (figure 2). The final assessment gives an idea of global mounting feasibility.

7	**Physical requirements recommended by the medical staff**	
7/1	Part weight or effort required to place or fix it is : <6 DaN with one hand, or <10 DaN with two hands **yes** ☐ **no** ☐	
7/2	Effort applied by finger tips is: < **2DaN** ☐ (clips, stapling) > **2DaN** ☐	
7/3	Posture is :	
7/3-1	Sitting normally, standing straight, slightly bending **<30°** ☐	
7/3-2	Bending (forward, backward, sideways) **>= 30°**, rotation of upper body **>45°,** arms extended upwards, body supported by only one leg, crouching, kneeling, lying ☐	
7/4	Body totally or partially used as a tool **yes** ☐ **no** ☐ Eg: hitting with a hand, grasping with finger tips, pressing strongly with thumb, holding with thigh, knee or shoulder	

Figure 2. Extract from ECM-evaluation of requirements, which contains 37 questions.

Both methods allow an industrial assessment of the level and characteristics of the requirements in a specific shop. At the same time medical or ergonomic specialists may conduct a finer analysis of particular gestures or specific workstations.

It is important to emphasise the fact that those tools are simple and not specialised, because they need to be understood by different specialists in the company.

Educational efforts:

- Reminder of MSD risk factors film sampled in shops (film: SOS Mains (3))
- Originating from Medical staff, manual efforts standards, applied to parts, mounting work stations and extracted from French norms, were issued to designers (4).
- Company doctors were integrated into working groups, modifying some operational processes, designing heavy apparatus manipulations or working conditions in a new shop.

Results

In 1996, the above-mentioned task forces obtained concrete results on the launching of a new model:

- Reducing by 50% the effort needed to fix a gear-lever cap or electrical connections through modifications of the process. Of course, such examples remain specific, but every acceptable result is repeated thousands of times by the operators, and other new vehicles have already profited from such improvements of the process. In this case, there is an amplification of the ergonomic effects.
- Choosing seat manipulators, that were validated by operators in a pilot shop, and then in pre-production, before being finally installed.
- Creating a new engine trim shop in which, the priority was to reduce biomechanical factors such as extreme strength and excessive angulations using a few elementary ergonomic rules.

- Placing work benches at an acceptable height, suspension of heavy tools, increasing the number of heavy charge manipulators and taking care of parts conditioning contribute a lot to improving working conditions on the production line.

New cases of MSD in 1996 were lower in that shop with 154 workers, than in an older shop of assembly tasks. These results were also due to a partial replacement of old by younger labour as well as to rotation of persons on different stations, thus soliciting different sets of muscles.

In the future, new ambitious objectives are imposed in the development chart of new vehicles:

- to obtain an average ECM mark >= 14 / 20
- only 2% of these marks can be <= 8 / 20
- if the ECM = 0 / 20, then the process must be remodelled

In 1999, new vehicles will leave the assembly line in a new Trim and Final Plant. This new plant has already benefited since 1997 from a precocious ergonomics program, which draws on feedback experiences. Some promising broad out-lines are emerging, which need to be validated at the start up of production.

Parallel to the technical progress, the evolution of MSD has remained low in the workshop called GAV (Under Bonnet engine assembly), which was directly concerned by this approach. We can also observe a similar tendency in an older workshop for the final assembly of vehicles.

The comparison of the marks, attributed by the DACORS´s method, between 1996 and 1998, showed that there was not a degradation of the ergonomic state in the GAV shop.

These new work conditions facilitated the professional reintegration of a number of people handicapped by their disabilities.

Conclusion

These results are precarious, and cannot only be explained by ergonomic achievements. Never the less, they are encouraging. Feed-back experiences will be numerous and enriching, if we react according to the update of our indicators, the preservation of the tool's pertinence and the capacity to gather the indicators (personnel competence to evaluate workstations and to manage the data).

Other limits of this approach are also given by using simplified criteria, considering only three biomechanical factors, such as Force, Angulation and Trauma in a cyclical context. And moreover, medical data and professional items are not directly linked together (multiple risk factors)

The variability of the physiological, technical, organisational parameters, cause the risk control to fluctuate and remain incomplete. So, the two grids DACORS and ECM can be considered as essentially an alarm signal.

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5. Moreau, M. Integrating prevention of Musculoskeletal Disorders (MSD) in vehicle conception at Peugeot Sochaux. *IEA Congress 1997*, Tampere, Finland, 1997 (Abstract).

The journey to ergonomic self reliance

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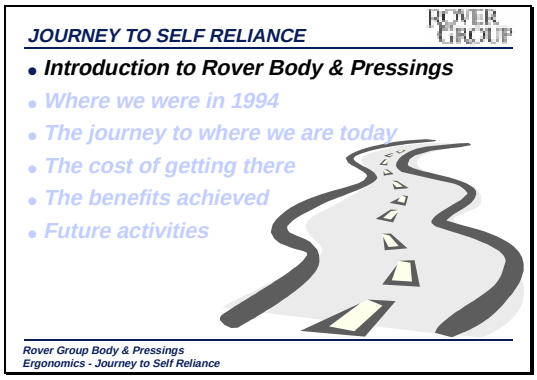
Picture 1



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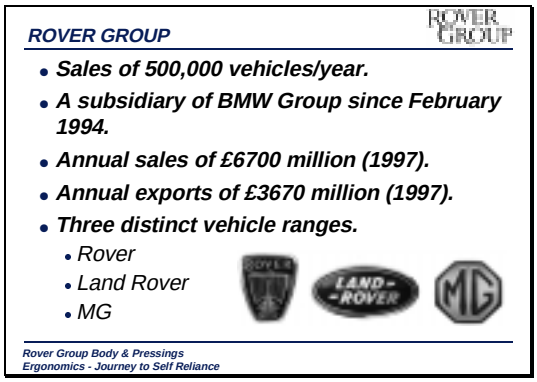

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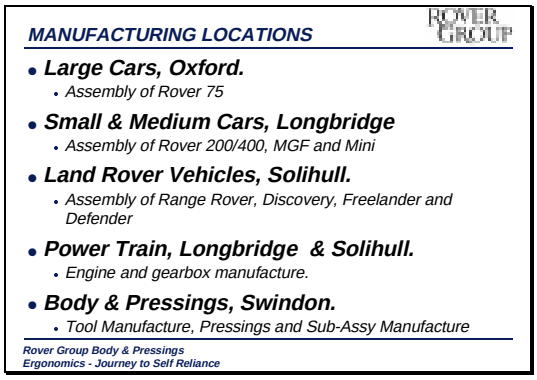

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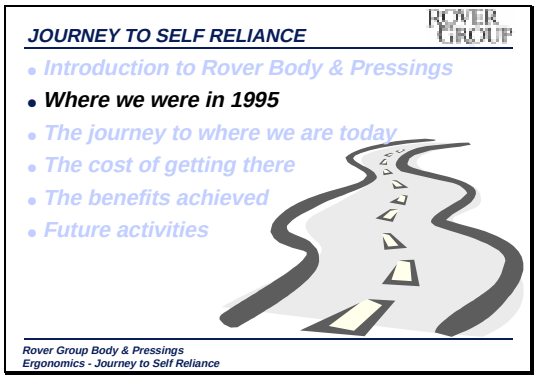

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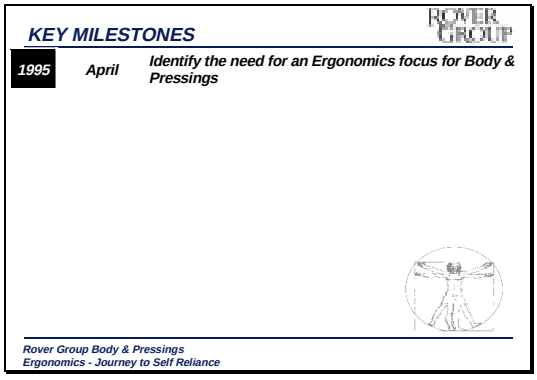

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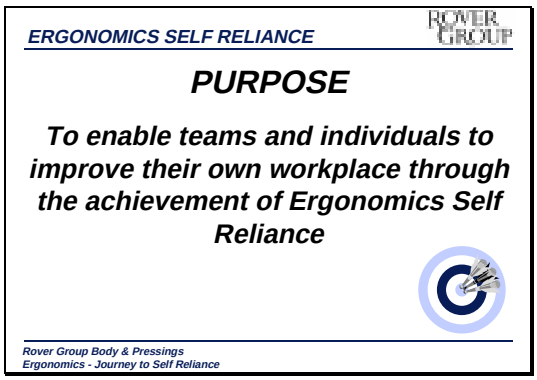

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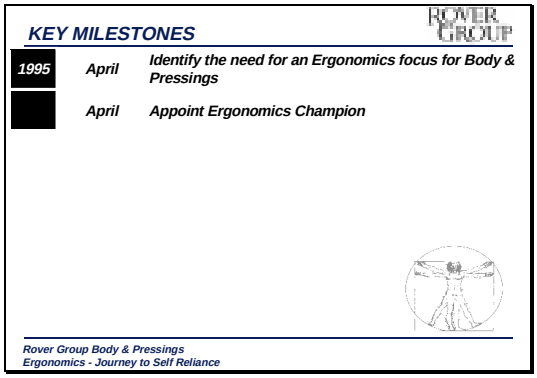

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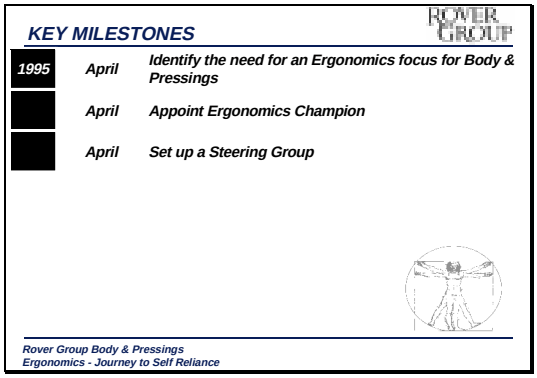

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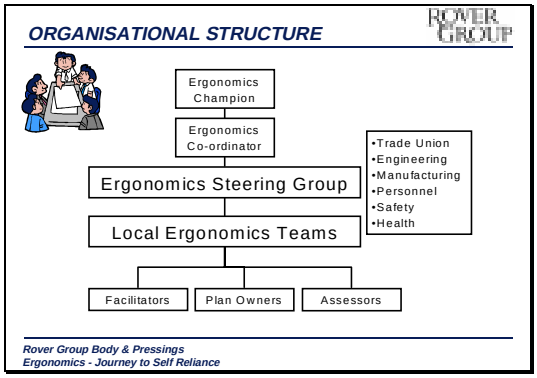

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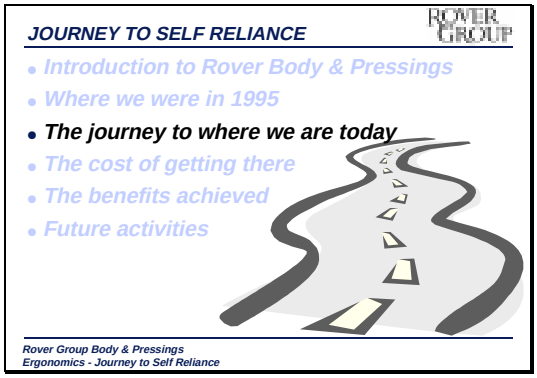

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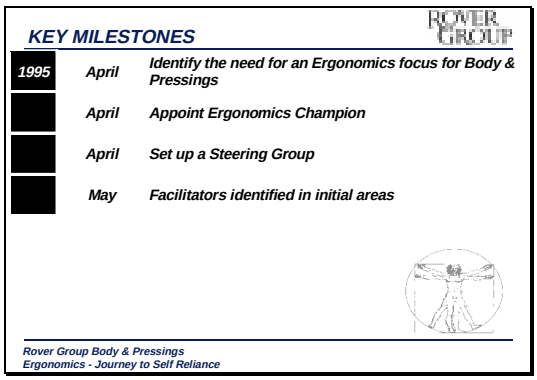

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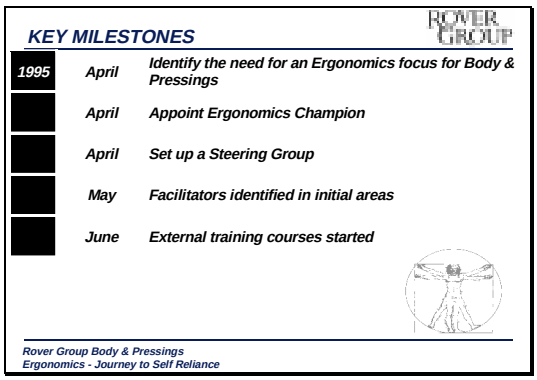


Picture 13

TRAINING STRUCTURE

- ***Principles and application of ergonomics***
- ***Anatomy***
- ***Anthropometrics***
- ***Bio-Mechanics***
- ***Manual Handling***
- ***Video Analysis***

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 14

KEY MILESTONES

1995	April	Identify the need for an Ergonomics focus for Body & Pressings
	April	Appoint Ergonomics Champion
	April	Set up a Steering Group
	May	Facilitators identified in initial areas
	June	External training courses started
	June	Trade Union support identified for Ergonomics

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 15

KEY MILESTONES

1995	April	Identify the need for an Ergonomics focus for Body & Pressings
	April	Appoint Ergonomics Champion
	April	Set up a Steering Group
	May	Facilitators identified in initial areas
	June	External training courses started
	June	Trade Union support identified for Ergonomics
	October	Pilot projects in place in two areas

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 16

KEY MILESTONES

1996	January	Associate Job Assessment (ABA) system introduced

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 17

ABA ASSESSMENT

- ***Associate Job Analysis***
- ***Developed from BMW experience***
- ***Ergonomic data collection tool***
  - *Ergonomics*
  - *Environment*
  - *Personal Protective Equipment*
- ***Two days training provided before use***

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 18

KEY MILESTONES

1996	January	Associate Job Assessment (ABA) system introduced
	January	Activities Monitor introduced

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 19

KEY MILESTONES

1996	January	Associate Job Assessment (ABA) system introduced
	January	Activities Monitor introduced
	February	Contact made with Loughborough University Department of Human Sciences

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 20

LINKS WITH LOUGHBOROUGH UNIV

Human Sciences Department:

- Strong links with Senior Lecturers at Loughborough University
- MSc Student final year project (Thesis) (Four completed to date)
- Rover provided presentations to Students at the University
- Visits to Swindon by students
- RGBP Ergonomic Consultant on day release at Loughborough University

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 21

KEY MILESTONES

1996	January	Associate Job Assessment (ABA) system introduced
	January	Activities Monitor introduced
	February	Contact made with Loughborough University Department of Human Sciences
	March	Initial Procedures developed

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 22

ERGONOMICS SELF RELIANCE

POLICY

- A strategy exists which supports Rover Group milestones for Associate Care
- A measurement process exists ……..
- A cross functional steering group develops the strategy for ergonomics and a support structure is in place ……..
- Areas have trained facilitators who are the focal point ……
- A mechanism exists to ensure that all problems highlighted are resolved ……..
- All work areas are formally assessed using a standard system ……..
- Best practice is recorded and a feedback loop exists ……..

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 23

ERGONOMICS SELF RELIANCE

CRITICAL SUCCESS FACTORS

- The vision is supported by all management leaders
- Appropriate Associates are trained and have knowledge of ergonomic principles
- A standard assessment procedure is applied to all work areas
- All Associates are involved in improving the workplace
- Relevant learning is taken from Best Practice and implemented in future processes

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 24

ERGONOMICS SELF RELIANCE

OUTCOMES

- Risk of injury from working processes is eliminated
- Injuries, absenteeism and claims against the company arising from poor ergonomics are reduced
- Productivity is increased
- Quality is improved

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 25

KEY MILESTONES

1996	January	Associate Job Assessment (ABA) system introduced
	January	Activities Monitor introduced
	February	Contact made with Loughborough University Department of Human Sciences
	March	Initial Procedures developed
	April	Ergonomics reviews introduced into engineering design phase for new model program

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 26

KEY MILESTONES

1996	January	Associate Job Assessment (ABA) system introduced
	January	Activities Monitor introduced
	February	Contact made with Loughborough University Department of Human Sciences
	March	Initial Procedures developed
	April	Ergonomics reviews introduced into engineering design phase for new model program
	May	Two Loughborough students join for four months

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 27

SUBJECTS OF STUDENT PROJECTS

- **Systems Ergonomics**
  - Establish a strategy & process for self reliance
  - Develop a high level infrastructure
  - Introduced facilitators' group
- **Best practice in Engineering**
  - Introduce ergonomic assessments into Engineering design reviews
  - Introduce electronic document storage for Ergonomics information

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 28

KEY MILESTONES

1996	January	Associate Job Assessment (ABA) system introduced
	January	Activities Monitor introduced
	February	Contact made with Loughborough University Department of Human Sciences
	March	Initial Procedures developed
	April	Ergonomics reviews introduced into engineering design phase for new model program
	May	Two Loughborough students join for four months
	May	Body & Pressings Health & Safety awareness day

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 29

KEY MILESTONES

1996	May	First Rover Group Ergonomics workshop

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

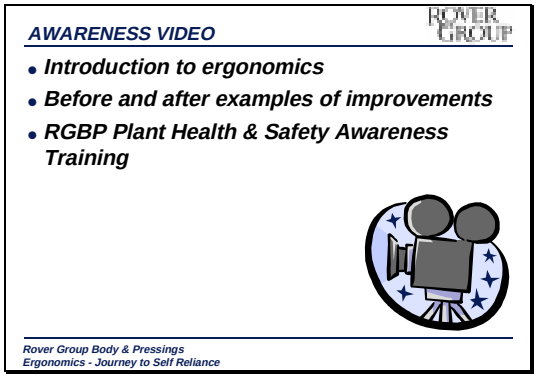
Picture 30

KEY MILESTONES

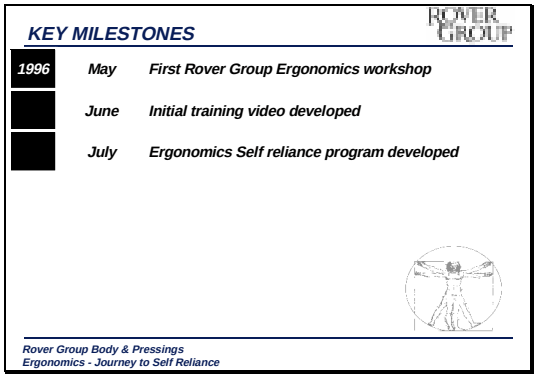
1996	May	First Rover Group Ergonomics workshop
	June	Initial training video developed

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 31



Picture 32



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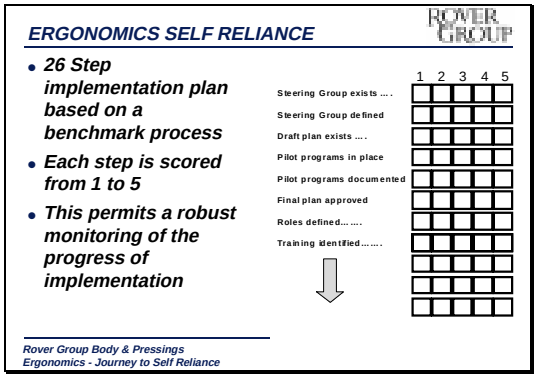

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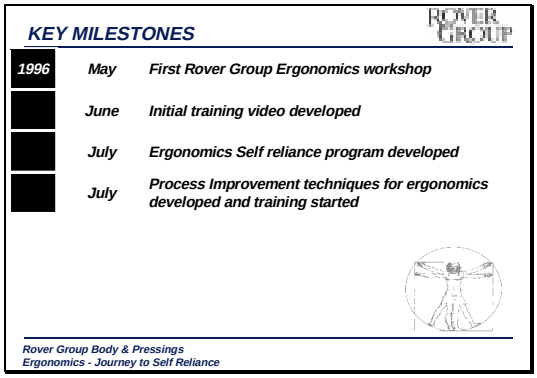

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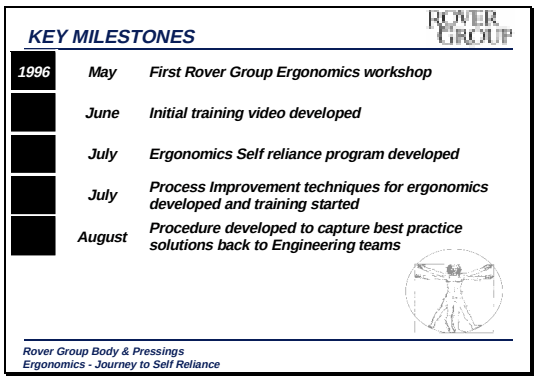

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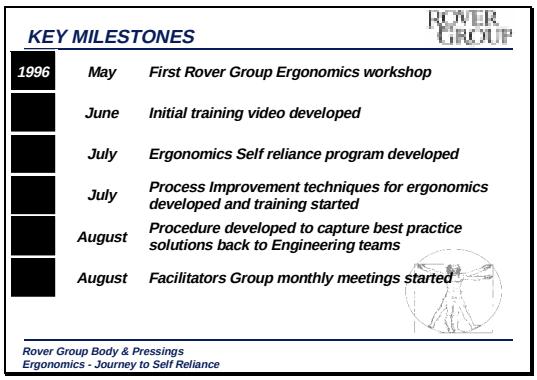


Picture 37

ERGONOMIC FACILITATORS GROUP

Objectives

- To provide a forum for communication
- To create an environment of mutual understanding
- To enable the facilitators to feel comfortable in their role
- To share best practice
- To commonise approaches
- To provide mutual support
- To provide a forum for recognition for leading or supporting ergonomics activity

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 38

KEY MILESTONES

1996	May	First Rover Group Ergonomics workshop
	June	Initial training video developed
	July	Ergonomics Self reliance program developed
	July	Process Improvement techniques for ergonomics developed and training started
	August	Procedure developed to capture best practice solutions back to Engineering teams
	August	Facilitators Group monthly meetings started
	September	60 Associates trained to date

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 39

KEY MILESTONES

1996	September	First video library set up

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 40

KEY MILESTONES

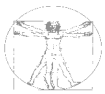
1996	September	First video library set up
	October	Simulation techniques used in first application

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 41

KEY MILESTONES

1996	September	First video library set up
	October	Simulation techniques used in first application
	December	Procedures finalised and issued across Rover Group



Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

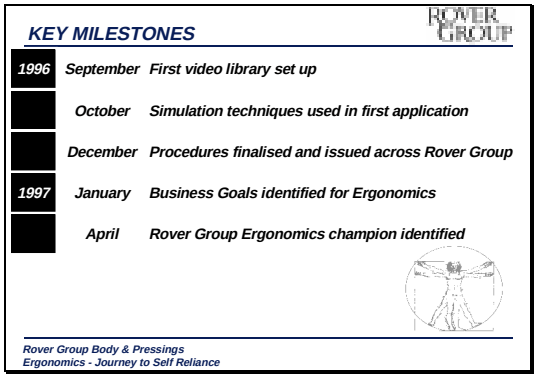
Picture 42

KEY MILESTONES

1996	September	First video library set up
	October	Simulation techniques used in first application
	December	Procedures finalised and issued across Rover Group
1997	January	Business Goals identified for Ergonomics

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 43



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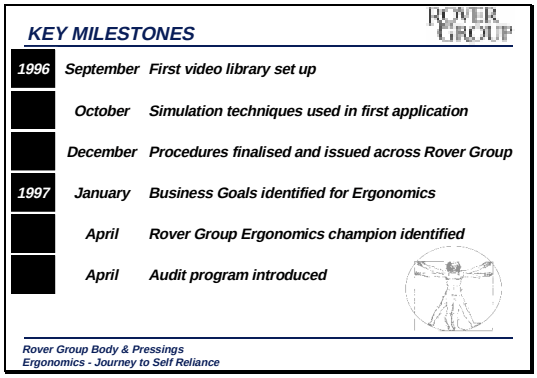

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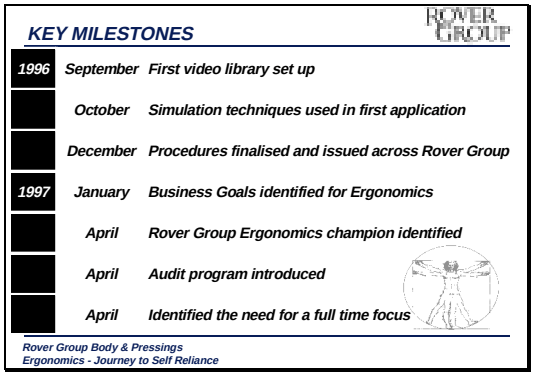

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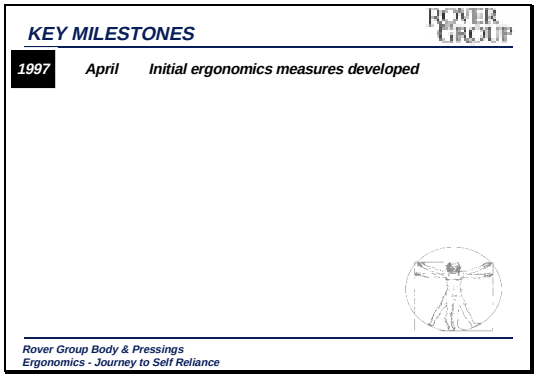

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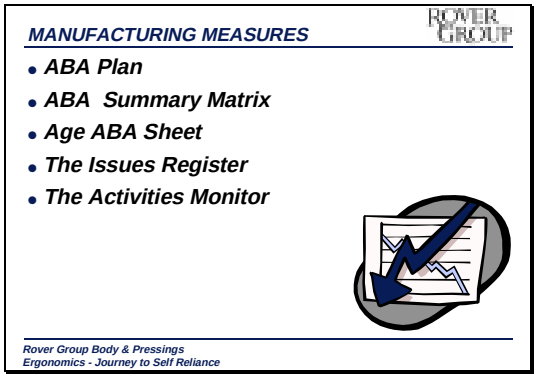

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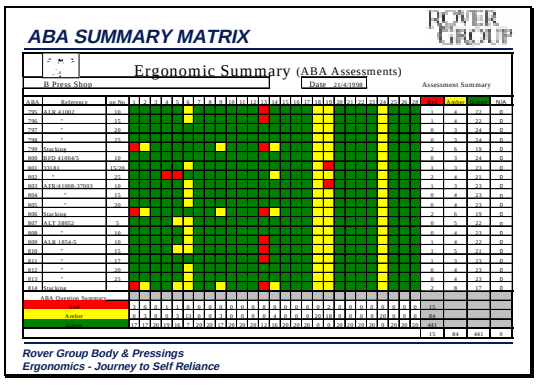

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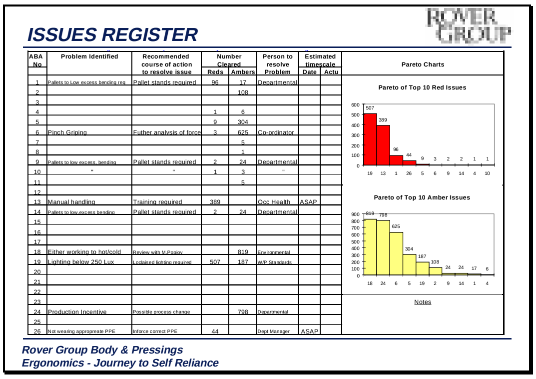
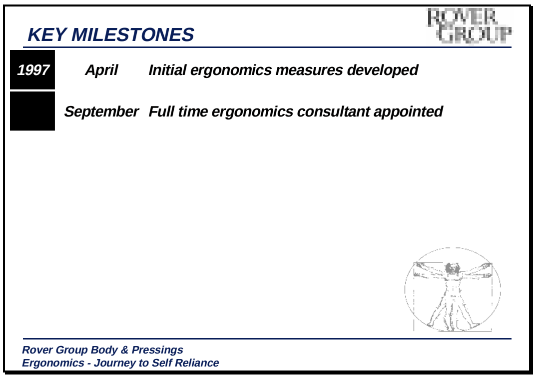


ISSUES REGISTER

ABA No	Problem Identified	Recommended course of action to resolve issue	Number Cleared Reds	Number Cleared Ambers	Person to resolve Problem	Estimated timescale Date	Estimated timescale Actu
1	Pallets to Low excess bending req	Pallet stands required	96	17	Departmental		
2				108			
3							
4			1	6			
5			9	304			
6	Pinch Griping	Futher analysis of force	3	625	Co-ordinator		
7				5			
8				1			
9	Pallets to low excess, bending	Pallet stands required	2	24	Departmental		
10	"	"	1	3	"		
11				5			
12							
13	Manual handling	Training required	389		Occ Health	ASAP	
14	Pallets to low excess bending	Pallet stands required	2	24	Departmental		
15							
16							
17							
18	Either working to hot/cold	Review with M.Popiov		819	Environmental		
19	Lighting below 250 Lux	Loclaised lighting required	507	187	W/P Standards		
20							
21							
22							
23							
24	Production Incentive	Possible process change		798	Departmental		
25							
26	Not wearing appropreate PPE	Inforce correct PPE	44		Dept Manager	ASAP	

ROVER GROUP
Pareto Charts
Pareto of Top 10 Red Issues
600 500 400 300 200 100 0
507 389 96 44 9 3 2 2 1 1
19 13 1 26 5 6 9 14 4 10
Pareto of Top 10 Amber Issues
900 800 700 600 500 400 300 200 100 0
819 798 625 304 187 108 24 24 17 6
18 24 6 5 19 2 9 14 1 4
Notes
Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 50



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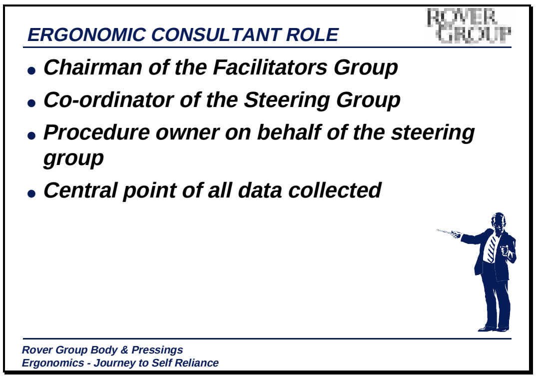
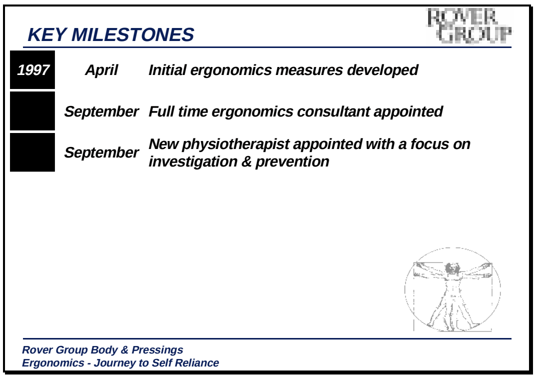


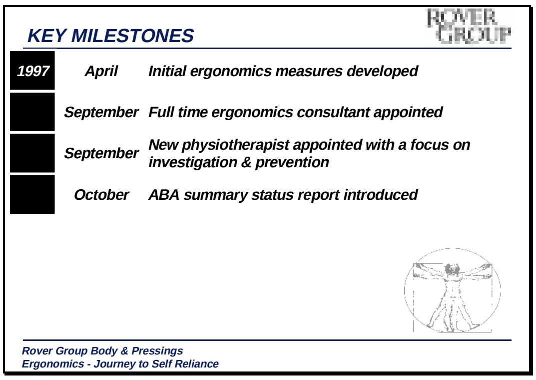
ERGONOMIC CONSULTANT ROLE
ROVER GROUP
• Chairman of the Facilitators Group
• Co-ordinator of the Steering Group
• Procedure owner on behalf of the steering group
• Central point of all data collected
Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 52



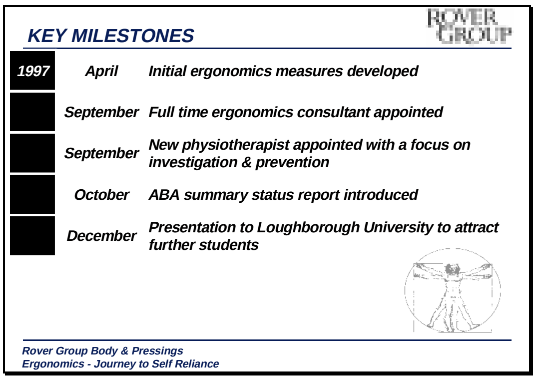
KEY MILESTONES
ROVER GROUP
1997
April
Initial ergonomics measures developed
September
Full time ergonomics consultant appointed
September
New physiotherapist appointed with a focus on investigation & prevention
Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 53



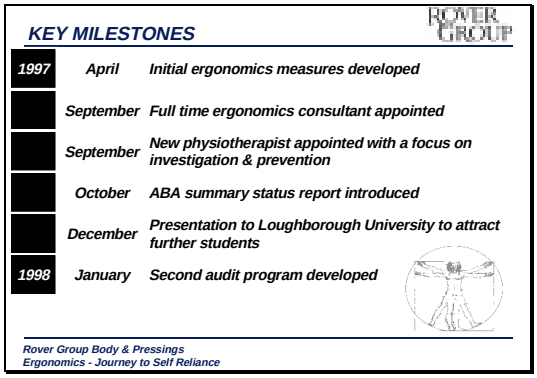
KEY MILESTONES
ROVER GROUP
1997
April
Initial ergonomics measures developed
September
Full time ergonomics consultant appointed
September
New physiotherapist appointed with a focus on investigation & prevention
October
ABA summary status report introduced
Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 54



KEY MILESTONES
ROVER GROUP
1997
April
Initial ergonomics measures developed
September
Full time ergonomics consultant appointed
September
New physiotherapist appointed with a focus on investigation & prevention
October
ABA summary status report introduced
December
Presentation to Loughborough University to attract further students
Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 55



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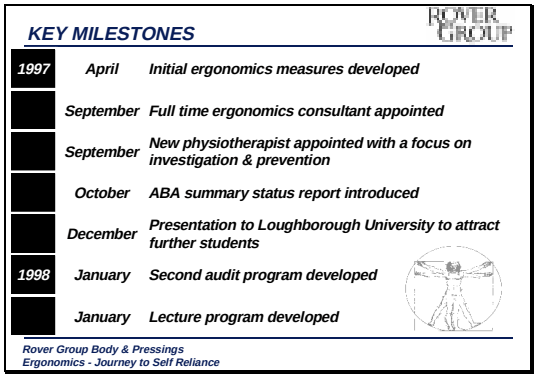

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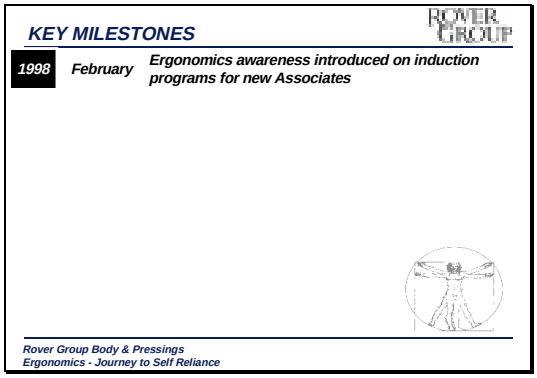

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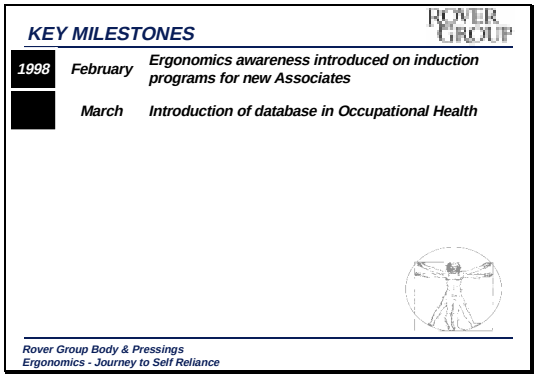

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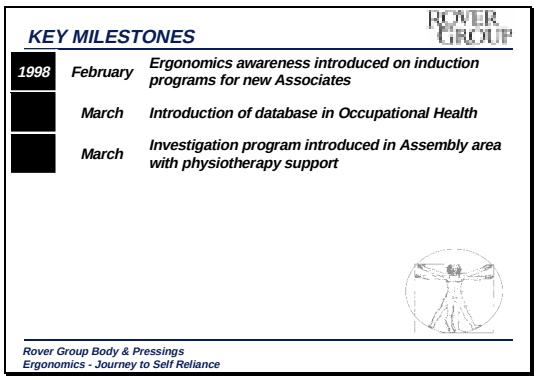
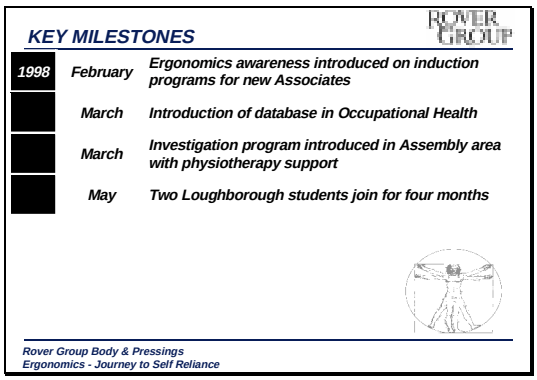
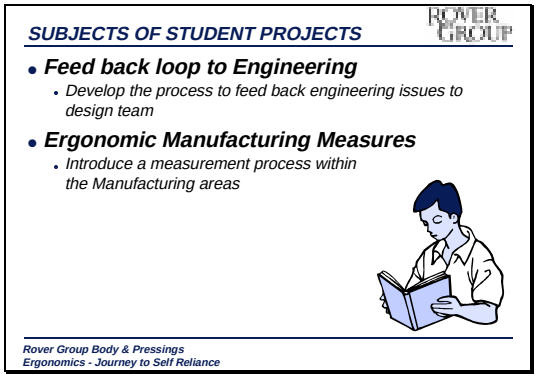


Picture 60



Picture 61



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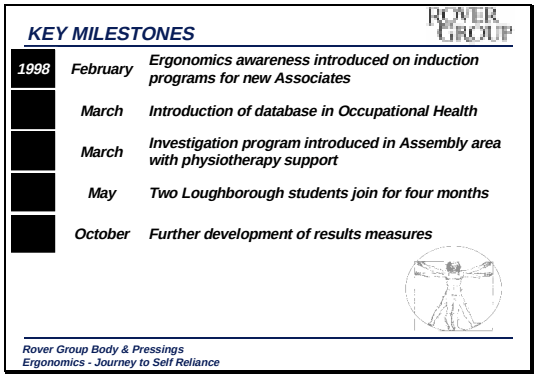

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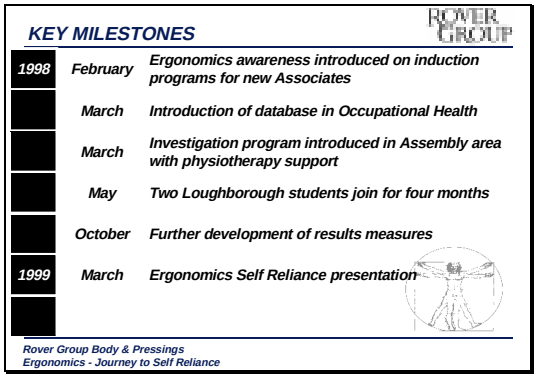

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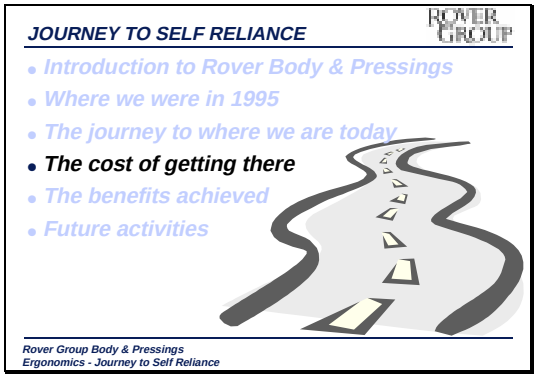

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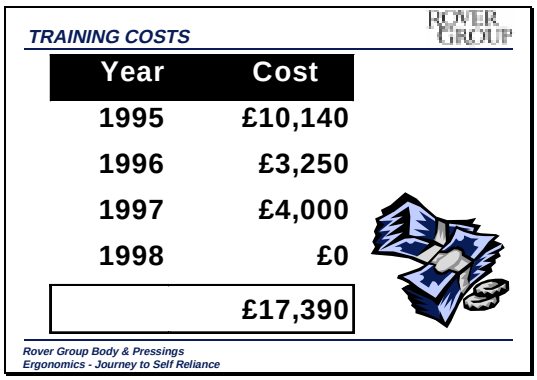

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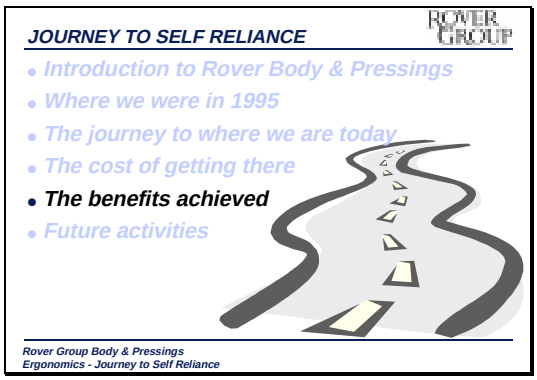

Picture 67

THE BENEFITS ACHEIVED

- Ergonomics awareness introduced at all levels within the Business
- Ergonomics reviews introduced to design processes
- Ergonomics improvement programs in place at the worksite
- Ergonomics measures introduced

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 68

JOURNEY TO SELF RELIANCE

- Introduction to Rover Body & Pressings
- Where we were in 1995
- The journey to where we are today
- The cost of getting there
- The benefits achieved
- Future activities

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Picture 69

FUTURE ACTIVITIES

- Develop the next step business goal objectives
- The Development of an Occupational Health Database
- Develop the Measures process
- Review role and responsibilities
- Share fair of all departmental ergonomic activities

Rover Group Body & Pressings
Ergonomics - Journey to Self Reliance

Experience from co-operation in ergonomics during a 25 years period

Arne Aarås, MD, PhD, Alcatel STK ASA, P.O. Box 60 Økern, 0508 Oslo, Norway, (email arne.aaraas@alcatel.no)

Introduction

Three periods of work environmental activity in the company will be presented. The total period covers 25 years.
1) A period without a work environmental organisation and an environmental budget covered approximately one year.
2) The period when an environmental organisation with a separate work environmental budget was established. This period covered 15 years.
3) A period when the company was divided in three companies without a separate work environmental budget, covering the last 10 years.

Pre work environmental program and organisation

In order to have efficient work environmental activities, two essential resources must be available to be able to improve or execute environmental projects:

- *Economic resources*
- *Personnel resources*

For many years a close co-operation has been established between the company's management and the employees which contributed to create a common cause, where the results of environmental work are considered important, necessary and advantageous for the company.

The first step to create a program was establishing of an *Environmental Group* with the objective of identifying and assessing environmental problems. This group consisted of the Company Doctor, the company Safety Manager and a representative from the employees' major trade union. The Environmental group should, on its own initiative, and in response to inquires, both advise and assist the company in environmental and safety matters. Further, duties were to make annual surveys of the physical working environment in all the company departments. The intention of the Environmental group was to activate as many as possible of those concerned in the execution of a project. However, the strong involvement of the Environmental Group was interpreted in such a way that it seemed to be taking control and responsibility away from departmental management with the risk of having the responsibility for execution of the projects.

Other main problems at that time were that no money was assigned to a department for environmental projects. The proposed investment had to be re-allocated from other financial resources, bringing with it the danger of other projects being made to suffer.

It is evident that handling of environmental projects was both work-intensive and time consuming and at times almost created conflicts.

It was clear that the company needed a defined system with guidelines for co-operation between the environmental Organisation (included the Environmental Group) and the production departments as well as a separate environmental budget. To achieve these aims, we considered the following factors:

1) Adequate information must be conveyed from the department concerned or from the Environmental Group, to ensure an appropriate priority for the intended environmental activity and to enable integration with other activities of that department.
2) Participation by the production engineers, foreman, safety representative or shop steward of a department - together with the Environmental Group. When required, a representative from the Industrial Engineering Department should be present.
3) The working procedure was felt to be important in terms of accurate, written reports, describing the present situation and the intended solutions should be prepared. These reports are information and working documents for the environmental organisation and the project managers.
4) The financing of the environmental projects must be arranged at the beginning of each year, to ensure that the physical execution of project is not delayed for financial reasons.
5) The environmental projects must be integrated with the other activities of the department, so that there are adequate resources available for completing the project. One person is appointed project manager and has responsibility for the execution.
6) The department has responsibility for the control and surveillance of the project.
7) The Environmental Group must cooperate on all of the above points with the appropriate departmental management and the trade unions.
8) The departmental management must stimulate the above mentioned co-operation by active participation and by showing a positive interest in environmental surveys, planning of solutions, and the execution of projects. These factors were build into our program how we should establish an environmental organisation and how to execute work environmental projects.

The work environmental organisation at the company

The environmental organisation and lines of communication between the different sub-committees (i.e. special groups) handle environmental matters which require special knowledge, is shown in figure 1.

These sub-committees report on their activities and problems to the *Work Environment Committee (the WEC)* which co-ordinates their activities according to their programme and guidelines. The Work Environment Committee (WEC) is the governing and deciding body in the environmental organisation at STK. The main responsibility of the WEC is to organise a systematic effort to improve the working environment according to the company guidelines and the existing environmental laws. Three of the senior management were represented in the WEC. In addition, the Environmental Group and the representatives from the major trade union participated.

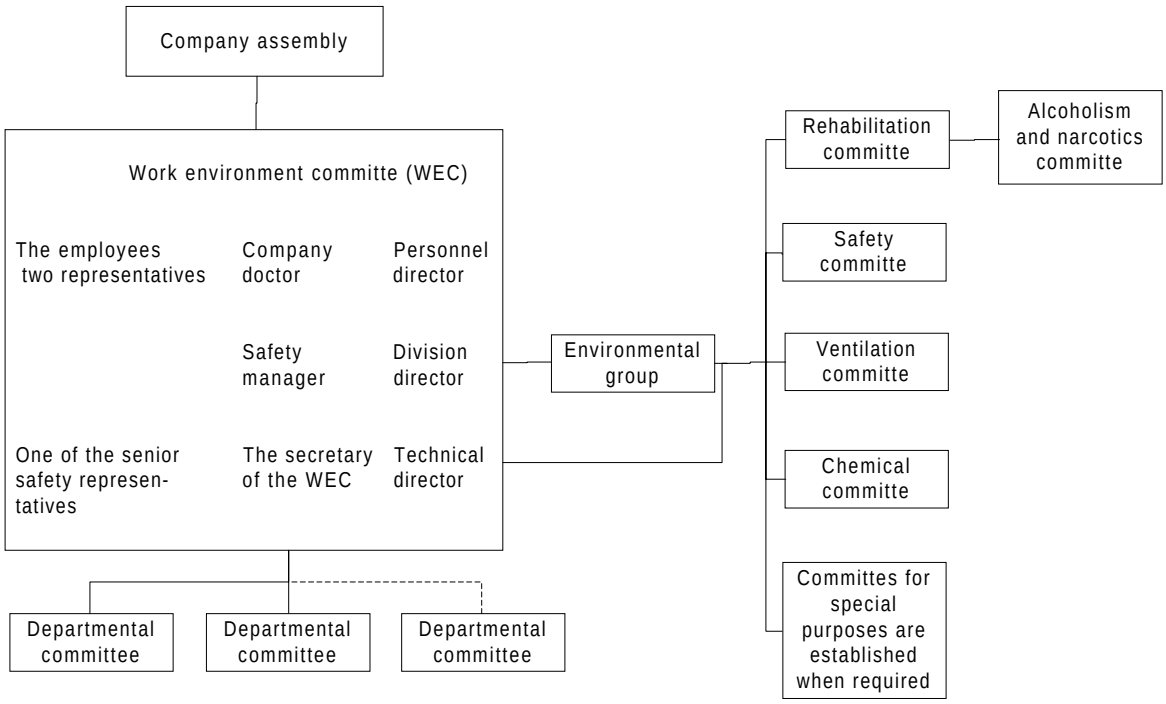

Figure 1. The environmental organisation at Alcatel STK.

On the basis of the annual surveys of the Environmental Group, the WEC prepares and updates an environmental action programme with the main emphasis on the financing of this programme. Other important duties are:

1) Participation in planning alterations of the physical work environment as well as planning of new production facilities;
2) Preparing a final list of priorities for environmental projects;
3) Co-ordination and management of the activities of environmental subcommittees and any project groups;
4) Ensuring that the safety representatives and Departmental Committees are actively involved in the environmental work;
5) Ensuring that adequate information and training in environmental matters is provided for all employees and, in particular, those recently employed;
6) Over-all responsibility for surveillance of all environmental work within the company.

It is understood that the environmental projects are incorporated with and given the same priority as other company projects. It is therefore important that the environmental organisation has a close working relationship with other organisational systems within the company. One important rule is that environmental problems are solved at the lowest possible organisational level in the company. Larger and particularly important environmental matters are submitted to the *Company Assembly*, which consists of representatives from the company management as well as representatives of the employees' organisations.

Other sub-committees are:

The Rehabilitation Committee which have to organise a work situation for any employee who, due to an accident, age, illness, or for social reasons, is not able to continue in her/his normal work, so that she/he has the opportunity to work and to have a satisfactory social situation within the company.

The Alcoholism and Narcotics Committee have to acknowledging the problems arising at work due to misuse of alcohol and narcotics.

The Safety Committee deals with problems concerning the physical safety of employees.

The Chemicals Committee deals with a systematic control of all chemicals. Further, a file with information on composition, health hazard, preventive measures, first aid, labelling, and storage, is compiled for each chemical.

Departmental Committees represent employees' representatives, management and safety representative for that department.

Basic principles for the work environmental organisation

Five important aspects were particularly focused:

Responsibility
1) The environmental organisation, with its sub-committees, is responsible for establishing a systematic environmental effort within the company. The environmental organisation must therefore develop an action programme, which includes the identification, establishment of economic resources, and control of the execution, of environmental projects.

2) The company/departmental management is responsible for the physical execution of environmental projects in an active co-operation with the employees through the Departmental Committees and the environmental organisation.

3) The company management is responsible for ensuring that physical and psychological factors in the work environment are considered at the planning stage of new production facilities.

Democracy
The employees or their representatives on the joint committees must be involved in the identification and solution of their own problems, and participate in the control and the inspection of environmental projects.

Information
The environmental work demands a continuous, detailed exchange of information between the environmental organisation, company/departmental management and the employees. Information from the company/departmental management is necessary to ensure that the employees have opportunities for inspection and control. Information

from the employees to their supervisors and to the environmental organisation ensures an early identification of problems. Information from the environmental organisation is necessary for a common co-ordinated environmental activity.

Integration
The environmental organisation must be closely associated with the company's other organisational systems. This is achieved by ensuring that senior representatives from management and the trade unions participate in the environmental organisation and the other joint committees.

Work division
1) Minor environmental problems are solved within the departments as far as possible.

2) Sub-committees are established to be responsible for environmental aspects, which require special knowledge (e.g. the ANC, the Chemicals Committee).

3) The environmental efforts are co-ordinated by a central group, the WEC, which has over-all responsibility.

4) A small, independent group (the Environmental Group) is established to identify and assess environmental problems in different departments.

5) The Departmental Committees function as local WECs, by establishing the priorities for their environmental project and controlling their execution in their own department.

Modification of the work environmental program - need for documentation of health effects

The work environmental budget was cancelled when the company was divided in three companies in 1990. This increased the need for having scientific documentation of necessity to implement the project from a health point of view (1, 2, 3, 4, 5, 6, 7). From 1990 more than 90% of the employees worked mainly on tasks which were connected to a PC. Therefore, focus was directed to work conditions for Visual Display Units (VDU). Visual discomfort and musculoskeletal illness were the main problems reported by the VDU operators.

Due to the complexity of these work environmental problems, a multidisciplinary team was established. In order to study the visual problems, professor Bjørset as a lighting engineer and professor Horgen as an optometrist participated in the teamwork. Regarding musculoskeletal discomfort an experienced occupational ergonomist and medical doctor jointed the team.

Laboratory studies were the first step in order to find optimal solutions regarding quality criteria of the luminaries and their placement related to the PC. Further in optometry, different lenses were tested as regards to work posture and muscle load. Postural load during VDU work was studied. A comparison between various work postures was done in order to find which posture created the lowest static muscle load.

All the results from the laboratory studies were tested in prospective field studies to find out if the results were valid in a complex work environmental condition. This procedure has been absolute necessary to convince the management to implement ergonomic improvements all over the three companies.

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Maturation and devolvement of the ergonomics process within a large, multinational corporation

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Executive summary

The ergonomics program at 3M is an evolving process that has achieved significant reduction of occupationally related musculoskeletal disorders (MSDs) during the past ten years. These successes have occurred in both manufacturing and office environments. Quantification of the number of MSDs, estimates of the total cost of MSD cases, a demonstrated ability to control MSDs in the workplace and favorable cost-benefit studies facilitated implementation of the ergonomics program. A strategy of the ergonomics process has been to spread knowledge of ergonomics widely across the organization. Subsequently business people and designers have begun to enhance the design of products with the addition of ergonomic features, or produce new products designed *ab initio* as products for unmet ergonomic needs.

Introduction

In 1989, Minnesota Mining and Manufacturing Company (3M) implemented a computerized, corporate-wide system for recording injuries and illnesses in the workplace. This replaced the previous paper-based reporting system, and integrated the data for more than 50,000 employees working in more than 100 different facilities within the contiguous United States.

This computerized database made it possible to analyze, almost at a glance, the types of incidents occurring in our facilities. While we long had an appreciation of the existence of musculoskeletal disorders (MSDs) in our facilities, we were surprised to find that they comprised nearly one-half of all the incidents which were required to be reported to the national Occupational Safety and Health Administration (OSHA). These “ergonomic” cases also accounted for more than one-half of the number of cases with associated lost-work days.

At the same time, we were able to identify an objective estimate of the cost of these lost-time cases. Under the United States’ system of workers’ compensation, an employer is required to pay the costs associated with a work-related injury or illness through an insurance program. Typically, these expenses include the cost of medical treatment, wage replacement during the time off work and any associated legal costs. As most employers insure against such costs, actuaries acting for the insurer compute the expected, or average, cost of such cases in order to predict losses and calculate premiums. This cost will vary by company and state; however, based on workers’ compensation insurance industry estimates, the average cost of a compensable case is

approximately US$13,000, with a standard deviation of approximately US$150,000 (2). Statistically it is clear that the costs are not normally distributed.

Knowledge of the number of cases and the costs of each lost-time case gave us a reliable estimate of the cost of musculoskeletal cases to the company. While the core ergonomics group was convinced that this cost was conservative in that it did not reflect productivity effects and other cost savings that would result from establishing good ergonomics practices, it established a cost-avoidance basis for arguments for intervention. It only remained to demonstrate that there were effective control measures that would reduce the cost of the musculoskeletal injuries and illnesses.

As you might suspect, these MSD cases were occurring in both manufacturing and office environments. We were confident that we had answers for both. We began to deploy these solutions in a systematic fashion at a few of our manufacturing plants. The results were very encouraging. The incidence rate (number of cases per 100 employees per year worked) decreased at the selected plants while it remained constant or increased slightly at the remaining plants.

This gave us a compelling story to bring to our manufacturing executive management and resulted in a corporate wide emphasis on controlling exposure to "ergonomic" hazards. Since the program was implemented early in this decade, we have seen, based on the index year of 1993, a 70% decrease in the number of lost-time MSD cases within our manufacturing operations.

We have also been able to demonstrate similar results within our office ergonomics program. At the time the program started, there were approximately 30,000 computer workstations within 3M, most of which are located within our office centers in the states of Minnesota and Texas. While we have not documented prevalence of discomfort as high as the 30% levels reported elsewhere (3), many of the individuals using these computers have reported concerns about comfort and workstation arrangements, and the needs for ergonomic guidance are manifest.

Unfortunately, due to the large number of workers involved, individual evaluations of each workstation were infeasible. Consequently, a decision was made to provide levels of service. The first, and most general, was training in good working techniques utilizing various media such as group training sessions, special publications, and newsletters. A part of this training directs individuals who are concerned about physical symptoms to report those symptoms to their supervisor or the occupational medical service. Secondly, we provided a limited number of individual workstation evaluations. Finally, an ergonomics clinic was established within the occupational medical group to assist individuals who were, or thought that they were experiencing symptoms.

We also coordinated with other concerned individuals such as facilities management, and purchasing agents. We formed a multi-disciplinary team to first develop criteria for ergonomic office furniture and accessories and then to select and specify products that met those criteria for general use within the company.

We recently published a review of 30 months experience with regard to 1000 individuals who reported physical or visual discomfort to the ergo clinic (1). An appointment was scheduled with a nurse trained in office ergonomics for that individual. During the appointment, the nurse determined whether referral for further medical treatment was advisable and provided training in computer working techniques. She

also used a demonstration workstation to make an assessment of issues related to the individual's workstation, and wrote a list of recommendations that was given to the user. These recommendations were primarily related to adjusting the workstation to fit the individual worker, e.g. working with neutral wrist posture, selecting an appropriate keyboard or monitor height, but also included items such as recommendations for new eyeglasses, adding anti-glare filters.

A follow up contact and survey was made with the symptomatic individual approximately one month later to assess the effectiveness of implementing the recommendations. Implementation of the recommendations was found to be very effective in reducing reported discomfort. Four hundred forty nine of the individuals contacted had implemented the recommended changes in their workstation at the time of the survey, 89% of these individuals reported that their symptoms were completely resolved or greatly improved as a result.

More recently a web-based "self-help" software program and office ergonomic solution centers have been made available to computer users within 3M. The self-help site is available at the individual user's own work site through either intranet or internet. The software uses a series of questions to guide the user through an evaluation of their own workstation. Recommendations are provided to address any issues identified, e.g. correct positioning of monitors, keyboards, etc. Separate sections provide information on stretching exercises, general guidelines for the physical arrangement of computer workstations, suggestions for actions to be taken if the user is experiencing physical or visual discomfort, and specified products.

The solution centers are also used to demonstrate the specified office ergonomic products and as to provide a focal point for general information about office ergonomics. The solution centers are generally open during working hours. This is supplemented at regularly scheduled hours by resource individuals such as an ergonomist or facility manager to answer questions.

Productivity and cost savings benefits from office ergonomics programs

Implementation of the office ergonomics program has given us an opportunity to study the cost-benefit relationship of good ergonomics practices. It should be noted that it is often difficult to generalize from one situation to another, as existing equipment, e.g., chairs, adjustable height keyboard surfaces, etc. may vary widely.
The method of analysis used is payback period, which is defined as the amount of time necessary for the amount of savings to equal the costs of the investment.

Cost benefit study of a secretarial group

This case study was conducted on 78 workstations where highly similar secretarial work was performed. In the two years immediately preceding the study, there had been a total of three compensable MSD cases. Using the US national average cost for a compensable case, the expected annual cost of these MSD cases was $US 19,500.

All of the 78 workstations were evaluated by one ergonomist within a two-week period and the recommended changes to the workstations were compiled into a single report. The total cost of all the recommended changes was US$10,890, or an average

cost per workstation of US$139.60. During the one-year period following the implementation of the recommended changes, no new lost-time MSD cases were reported.

This calculation of the payback period is straightforward. There is an avoided cost of US$19,500 per year and a one-time investment of US$10,890. Dividing the avoided annual cost by the investment cost and multiplying by twelve months tells us that it requires approximately 7 months to recover the cost of the investment.

Cultural change

During implementation of the ergonomics program, interesting things began to occur within the culture of the company. Basic ergonomics training was added to the training curriculum for designers and engineers. Teams implementing projects to address musculoskeletal issues found that they were also able to accomplish significant cost savings due to gains in efficiency. An "aha" effect occurred that was summarized by a senior project engineer after examining a production line with regard to both its manufacturing and ergonomic shortcomings. His insight was that "the chokepoints are the same."

Ergonomics began to be perceived as a tool to enhance the quality of the workplace. It was not a difficult step to begin to apply ergonomics to product design.

Ergonomics perceived as a business opportunity

While engineers and designers began to appreciate the benefits resulting from including good ergonomic design into production equipment, business people and designers investigating market trends began to see the opportunity of adding value to their products through sound ergonomic features.

While this interest in incorporating good ergonomics into products has generally focused on single items such as hand tools, the most developed instance of this occurred in the area of office ergonomic products.

Evaluation of large numbers of workstations and analysis of how existing products performed gave a good appreciation of where unmet needs existed with regard to ergonomic products for computer workstations. A team charged with developing new office-related products perceived this as an opportunity to develop an entirely new product line around these unmet needs and introduced it globally in 1996. The result is a clear linkage between successfully implementing ergonomics within 3M and development of a new product line that offers significant ergonomic benefits.

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Future office ergonomics

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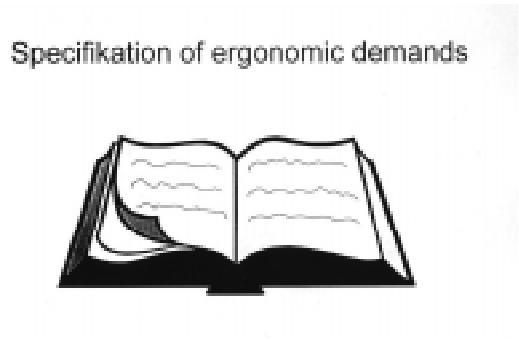
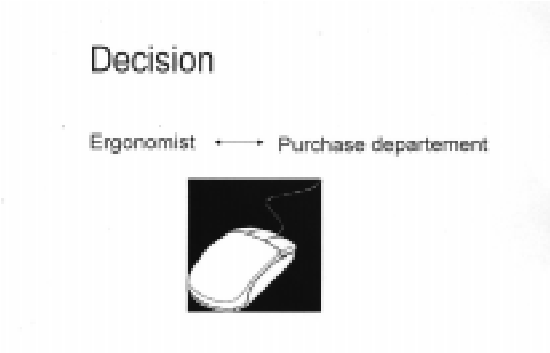
Background

Working as a an ergonomist in a big multinational company for 12 years has given me some experience of how to deal with ergonomic questions inside a big organisation. This lecture is an attempt to show one possible way of integrating the ergonomic questions into the core business of the company, and by doing so lifting these issues to a higher level than they are today. My aim with this lecture is to point out the importance of having a close co-operation with the line organisation so that the occupational health services is becoming an integrated part of the company. This could be a way of increasing the importance of these so-called "soft questions".



Comments on picture 1
Step one in the procedure is to sit down with "users" and talk about *what* sort of work is going to be done and *how* the work is going to be done (sitting position, standing position, leaning forward position etc). Next step is to create a specification of ergonomic demands, that suite the actual work. This specification is made in co-operation between the ergonomist, the users and head of the department.

Comments on picture 2
The list of the specification demands is taken over by the purchase department, and is a document among others, sent over to potential suppliers. Negotiations are taken place with suppliers, in these negotiations the purchase department choose 2-3 possible suppliers.



Comments on picture 3
The ergonomist and the purchase department together make the final decision on what product and supplier to choose. In this way the ergonomic questions are taken into consideration in an earlier stage, and the chance of preventing future ergonomic problems are much bigger.

Future ergonomic problems

Stress diseases due to:
- Overtime work
- Short project schedules
- Work organisation
- High working demands
- Difficulty to find an acceptable balance between work and leisure
- New technique introduced

The big challenge for the ergonomist in the next century is to deal with these questions, and maybe find a way of doing a "demand specification" where these questions are taken into consideration.

Let's go home and give it a try!!!

Organize for production and health in forestry work

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First I will try to give you a short history of the development in the forestry in Sweden. Forestry work before 1945 was almost completely manual and a winter season job. From the middle of the 1950's the hand held power saws were introduced in Swedish logging operations.

In the beginning of the 1960's the first agricultural tractor was introduced in the forestry and then in the middle of the 60's the first skidders and forwarder machines (tractors which transport timber out from the forest to a forest road).

In the 1970's more technically developed forestry machines were introduced such as feller bunchers and some time later processors and more specialised forwarder machines.

The forestry become more and more mechanised and the drivers more specialised. We also got the multifunction machines (harvesters) in the 1980's (machines which are felling, delimbing and cutting whole trees).

The logging process today is almost 100% mechanised in the professional forestry.

Unhealth in the forestry

Until 1970's the dominant ergonomic problems were injuries in the back and knees and of course accidents caused by falling trees and by chain saws.

From 1970's until today we can see different types of unhealth and also how the working conditions have strong influence on the health situation.

The “new” health problem was load injuries in the neck and shoulders, caused by the specialisation of the drivers. The work included long shifts, too little variation and also too high speed. More than 50% of the drivers had this type of health problem.

A lot of drivers had to get early retirement pension, which caused large costs for the state, but also for the companies. Another problem was that the reputation of the forestry sector and the possibility to recruit new workers became more difficult.

Researchers, the National Board of Occupational Safety and Health, industry health services, employers and workers organisations etc. know a lot about the health problems and together we started new projects trying to solve the problem.

In the 1980's a project was started in three of the biggest forest companies. The goal was to reduce the neck and shoulder problems and to increase the productivity by creating an invulnerable work organisation. Create working groups with two machines (harvester and forwarder), broader competence, possibility for worker to make decisions and to take responsibility for the forest operations, were some of the most important parts of the measures.

With experience from that and other projects we have continued both the employers and the workers organisations and of course directly in the companies, to find ways to develop the forest work. After all projects concerning neck and shoulder disorders, we also found that many forest workers had psychological health problems.

About three years ago the forest companies and the Forest Workers Trade Union started a project: Developed working environment and production, called “AndOi Project”. The project tried to take care of both the production and the working environment.

The most successful forest district in the biggest Forest Company in Sweden Assi Domän is Laxå. The result from this district is extremely good.

The forest workers work together in production groups. In Laxå, the group members (4-6 persons) have full responsibility for everything around the logging process. They make an agreement with the District Ranger about the budget and how much they will produce for one year and after that the group takes the whole responsibility for everything. They have also the full possibility to make decisions so that they can fulfil the budget. The Forest Ranger is now a contact person for all teams in the district.

We mean that this Forest Ranger (Bengt Karlsson) is quite unique because he has the power to show the forest workers confidence. In his district there are only employed persons and no contractors and everyone have very high competence. Everybody has got education and training in the different operations. That means that all can drive both types of machines and also can do the other different work as planning, economy, reparation, etc. Together with organisation of work, trust each other, etc, there have also been a technical developing, e.g. the hanging cabins, vegetable hydraulic and chain oils.

The health situation has been so good in the district that there are no problems with neck and shoulder disorders and/or psychological unhealth.

For those of us who have followed the people and the result in the Laxå district, we hope that all forest companies will take part of what has happened and start to travel in the same direction.

Common sense at GTI

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Introduction

Working at GTI is nice but often also hard - physically hard – according to the risk inventories carried out in the company's various branches. Virtually every branch scores high on physical risks; uncomfortable positions, working in the same position for long periods, carrying heavy loads manually or repeating the same movements for long periods of time. This results in physical complaints, frustration and absenteeism. Back, neck, arm and leg problems occur most frequently. Not only engineers and installers but office employees too suffer from these.

Unhealthy postures and movements can be prevented. For example by using devices, which help to prevent physical stress. The introduction of these will make work lighter and thus less taxing.

A campaign called “Common Sense at GTI” has been launched at GTI in order to encourage employees to actively improve their own working conditions.

The presentation also looks at how this subject is communicated within GTI. It also encompasses the structuring of ideas for useful devices in so-called product sheets, a competition for inventors amongst the employees and general means of communicating the importance of promoting good working conditions. The preparations for the theme campaign have been made by a working group consisting of representatives from the company.

How to develop a campaign for these types of activities? At GTI this sort of campaign follows a fixed systematic approach. The approach used by GTI is set out below:

DEVELOPING AN OCCUPATIONAL HEALTH AND SAFETY CAMPAIGN

by Desiree Schelle, group communication co-ordinator at GTI Holding

Put together a multifaceted working group

The occupational health and safety representative is generally well-informed about the work process in your company and the statutory legislation that applies to it. However, make sure that you also appoint someone in your working group to look after occupational health and safety from the employee’s point of view. This person does not have to know very much about occupational health and safety but should be well-informed about your company culture. This person might be a personnel officer or a member of the communication staff. This objective look prevents your campaign from becoming too 'technically correct', which could result in the powers of persuasion missing the mark. After all, how you put the message across is at least as important as the message itself!

An external advisor can also provide a fresh look at things. But remember that he will not know your company as well as you does. He cannot therefore play a leading role in the process.

Make the campaign recognisable or 'relating to the company'

There are of course a whole lot of resources on the market that put across a message about occupational health and safety and working safely. A wide range of videos, posters and information booklets on various useful subjects. However, by choosing standard solutions you will be making it that much easier for your employees to ignore the message. 'That's got nothing to do with my work...' and 'We do things differently here...' are the frequently heard responses to standard material.

By using our own photographic material and logo as much as possible, the GTI common sense campaign was recognised and acknowledged by employees. Recognising colleagues and work situations considerably increased the attention value. Furthermore, GTI employees took the campaign more seriously because it was obvious that work and time had been invested by their own management.

An additional benefit: Your customers also recognise that the information resources originate from your company.

Base the entire campaign on a central theme

When working out the first theme the working group realised that there would have to be a leitmotiv running through the matter if GTI wanted to obtain satisfaction from their efforts in the area of occupational health and safety in the coming years. Each time you have to attract attention back to something it uses up too much energy and produces too few results.

In addition to the title “Common Sense at GTI”, two cartoon characters were developed who appealed to the GTI public and their supporters because of their comings and goings and their sense of humour. The appearance of these two cartoon figures in staff publications etc. is currently sufficient to get the GTI employees thinking about occupational health and safety.

Bring the company culture visibly back into the campaign

GTI employees have a good measure of pride in the company and certainly just as much self-mockery. And without exception they are also slightly cocky. These three characteristics were of great importance when choosing the design of the means of communication. A strict, domineering tone in the campaign would have had a counter-productive effect at GTI. So you should always bear this in mind and check it out in practice where possible.

Work out each component of the campaign according to a fixed structure

When working out components of the campaign it is best to adhere to a fixed step-by-step schedule. Some core questions are of interest here:

** Target group(s): who are we addressing with this component?*

Establish to who this information is of interest according to the subject. When doing so, look at the order of importance and composition of the various target groups. But

look in particular at the extent to which a target group is in a position to really change something in respect of the problem; their so-called role in the situation.

Thus the first GTI theme, 'safety rules', was primarily of interest to employees and managers in the assembly department, whilst we aimed the second theme, 'physical stress', first and foremost at management and the board of directors. Although they are not the ones who experience the physical stress, they are most certainly the ones who can take the decision to buy better aids!

** Goals and message for each target group: What do you want to achieve with the target groups and what are you going to tell them?*

Establish beforehand what you want the theme to achieve with each group so that you will subsequently be in a better position to test whether you have achieved the goal you have set. Thus in the first theme the working group at GTI wanted to change the employees' attitude towards occupational health and safety; occupational health and safety had to become a daily topic of conversation, and not something that 'only sissies talk about!'

** Selecting resources: Which means of communication are you going to deploy for each target group?*

Take the behaviour and the interests of the target group into account when selecting resources. The development of a comic book on safety regulations worked well with GTI's assembly employees. They have little time and inclination to study thick tomes on the subject. In this way they were also able to show their families the sort of situations they faced every day. Occupational health and safety also became a topic of conversation at home. A manual with useful tips on things ranging from toolboxes to the skills needed to make convincing presentations was put together for occupational health and safety officers who were more at home with this material. Choose a resource that meets each target group's need for information.

Test, test and test again!

Although you try to achieve proper representation of the company when the working group is put together, this working group does not have a monopoly on wisdom. You also do not want to hear afterwards that the money would have been better spent on something else. You should therefore test your ideas on your target group(s) as much as possible. This does not always have to be done with an elaborate questionnaire in a representative group.

Discussing the idea with as many people as possible or allowing drafts to be briefly looked at for an initial reaction often helps you form your own picture. While it was working on the comic book and posters for the first theme, the working group gauged the reactions of engineers, office employees, and management several times. This provided some extremely useful comments, which were used in the next stage of development. Once the first theme had been completed a written survey was undertaken to find out whether the route chosen was the right one. The positive results provided management with the reason to continue the activities.

The above tips may seem on paper to be a whole lot of extra work for a somewhat abstract result. Because even if your absenteeism figures are falling you will probably never be able to demonstrate that this is the result of all the efforts made by your company in respect of information. It may therefore be better if you were to take a look at the motivating aspects of information on occupational health and safety. Your work in this area will have a positive effect on many people around you.

- The occupational health and safety officer and the project manager will feel that they are being supported by their own management in their daily battle against unsafe work situations and accidents;

- The employees see all the attention being paid to occupational health and safety as confirmation of the fact that management is concerned with their health;

- And your customers will view your occupational health and safety activities as an indication that they are dealing with a professional company and a responsible employer.

Can you think of any better reasons to pay attention to information on occupational health and safety in a structured manner?

The Scottish & Newcastle experience of ergonomics

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Summary

Partly as a result of impending EU Legislation in 1992 (*six pack)* an Ergonomics Adviser was employed by the Occupational Health & Safety Services within Scottish & Newcastle to assist with the ergonomic considerations inherent within these Regulations. Although employed initially to address the manual handling issues within the beer delivery operations, the role of the Ergonomist has evolved to provide support and advice in many of the corporate programs aimed at improving employee health and safety. This paper describes three such programs; namely those of manual handling, display screen equipment and occupational stress. In addition to describing the systems involved with each of the programs, information is also supplied with respect to the cost-benefits of each.

Introduction

Scottish & Newcastle (S & N) is one of the leading companies in the brewing, leisure and retail industries in the UK and Europe. Although perhaps most widely recognised as the UK's leading brewer, S&N's largest concern lies within its Retail sector which employs over 26,850 people and manages 2,600 pubs and pub restaurants. The Leisure sector comprises of Center Parcs and Pontins. In total S&N employs over 45,000 people.

The Occupational Health and Safety Services (OHSS) is one of a number of group wide service departments supporting the various operating companies. Since its inception in 1982, employing only three members of staff, the department has experienced rapid growth and now has a contingent of 25 full-time and 13 part-time staff. The range of services on offer include Occupational Health, Safety, Environmental Health, Environment and Ergonomics. The department is run by the Director of Medical Services who reports directly to the Executive Board, thus ensuring that OHSS enjoy strategic status within the organisation.

Although the need for a full-time Ergonomist had been realised for some time it was by virtue of the publication of the 1992 '*six pack*' European Legislation, and in particular the Manual Handling (MH) Legislation, that a business argument for such an appointment was developed. In 1993 S&N established itself as the first, and to-date only, major UK Brewer with an in-house Ergonomics Adviser. Since that time several corporate initiatives involving ergonomics expertise have been established. The aim of today's presentation and this paper is to illustrate a few of the ergonomic programs which S&N have adopted within their corporate strategy.

Manual Handling Program

Although the requirement to examine manual handling activities was triggered by the pending EU Legislation, there was already a heightened awareness within S&N of significant problems with regard to manual handling injuries, primarily within the beer delivery operations. A survey of retirement data over the years 1990-92 indicated that whilst the average age for retirement, throughout the company, was 51.35, this figure dropped to 45.95 for the beer delivery personnel (the draymen).

The chronic effects of dray work are well known. With few exceptions, draymen rarely achieve the normal retirement age of 60. A subsequent investigation into probable causes for this trend highlighted two primary job related factors, namely service record and job demands. Firstly it became apparent that the majority of draymen had been employed in their jobs since their 20's. Having experienced twenty plus years of heavy manual handling duties, the majority of draymen required early retirement due to musculoskeletal strain. The second factor, job demands, related to the overall loads required to be moved per day by each drayman. Over the years as S&N has acquired and merged with other brewing establishments' redundancies have inevitably resulted. One direct result of this has been that, in simple terms, a fewer number of people are now expected to complete the tasks relating to dray work. For the draymen this shrinkage has lead to the daily tonnage to be moved per person having increased appreciably.

An earlier study, aimed at discovering the primary causes for lost-time, (the results of which are shown below in table 1), pointed towards backpain/strain as being by far the highest reported musculo-skeletal injury.

Table 1. Lost-time Musculoskeletal Incidents (Jan '90 – Oct '91).

Musculoskeletal Incidents	**Number**	**Further Analysis**	
Neck Pain / Strain	6		
Chest Pain / Strain	5		
Shoulder Pain / Strain	5		
Rupture (Hernia)	1		
Groin Strain	4		
Back Pain / Strain	139	Warehouse RTS Other Draymen	4 9 6 120
		Total	*139*

In late 1991 a Manual Handling Co-ordinating Committee (MHCC) was formed to examine both the implications of the EU Legislation and how to reduce the cost of manual handling to the employees and the company. An Operations Director who was also responsible for communicating progress to his fellow Directors and the Board chaired the Committee. Another strategic member of the group, the Group Safety Manager, was responsible for ensuring all proposed actions of the MHCC complied with both current and proposed legislation in the area. A later secondment to

the group, the Ergonomics Adviser, was tasked with identifying ergonomic factors in current and proposed practice in the delivery manual handling tasks. Training related aspects were assigned to the Transport Training Manager who was ultimately responsible for implementing the delivery of the resulting training package. Fundamental to the success of the project however was the need for participation from the 'owners' of the project, i.e. the distribution personnel whose jobs involve the actual elements of manual handling. For this reason experienced Operations Managers from each of the operating companies were also involved with the committee.

The starting point for the work involved conducting generic task assessments on all manual-handling tasks carried out in beer deliveries. This was principally conducted by using the practical experience of the relevant members of the MHCC. In addition, all related aspects were also analysed as part of this process including the product (kegs and crates), delivery vehicle, hoists, ropes, barrows and dropping pads. A depot site within each of the operating companies was nominated for inclusion in the study and data collection techniques such as video, photos, direct observation and interviews with delivery crews used to provide analysis material. Upon completion of this analysis, tasks were broadly categorised as either 'ergonomically unsound / unsafe' or 'ergonomically sound / safe'. Each stage of the analysis was reported to the MHCC and ratified.

Another team, mainly selected from the Safety Representatives and delivery supervisors, conducted cellar assessments to tackle any physical changes, which may have been required to assist in providing improved delivery at premises. This two pronged approach worked very successfully with many of the problems being either engineered or designed out of the equation.

On the basis of the results from the two assessment programmes a substantial training pack was developed which identified that every employee carrying out beer deliveries would require 3 days basic training. Due to the size of the group to be trained (n = 1297) training personnel were nominated from each site as Manual Handling Training Instructors. These personnel were then responsible for cascading the training to their own site employees.

Costs: The costs of the corporate program have been based on the following aspects: (a) Management time from formation of MHCC, (b) Provision of training packs to instructors, (c) Travel and accommodation costs of transport training staff and (d) Wage costs of trainees, instructors and operators. The total sum has been conservatively estimated at (Sterling) £200,000.00.

Benefits: Although the benefits of such programs can typically only be realised after several years, attempts to audit the impact of the program have meet with huge success. Rather than analyse any one trend in terms of impact, two fundamental indicators have been investigated, namely insurance claims and accident data trends.

Although there are a number of variable factors connected with insurance claims such as insurer reserve estimates and the general claims culture at any given time, figures for Manual Handling claims against S&N highlight the impact of the MHCC activities. Prior to the EU Legislation and any significant preventative measures from S&N MH (1989-90) claims cost the company just under £39,000.00. At the 'height' of the MH claims culture (1992-93) and prior to the roll-out of the S&N MH training package, claims against the company had risen by >95%. Since that time, even

though litigation has become almost commonplace, current figures indicate a decrease of 88.5%.

Manual Handling Accident rates in delivery personnel decreased by 57% in the years 1991 to '96. Using cost figures based on insured costs (i.e. liability), in 1991 Health and Safety Executive (HSE) reportable Injury rates cost the company £198,000.00. In 1996 this cost had dropped significantly to £84,000.00 and is continuing to do so. In reality however these costs should be multiplied by a magnitude of 4 or 5, if taking into account the uninsured costs (e.g. loss of expertise/experience, overtime working, investigation time, and product damage). If these costs are extrapolated to take these uninsured costs into account, the savings from 1991 to 1996 can be calculated at £570,000.00.

The reductions in both insurance claims and accident statistics cannot be solely attributable to the actions of the MHCC. Various interventions such as automation and risk assessments all played a role in reducing the injury rates. What is clear however is that the multi-disciplinary approach to addressing the situation, i.e. strategic management, safety, ergonomics and shop floor employees all combine to provide a strong team in the prevention of injury.

Display Screen Equipment Programme

Over the last five years the level of Display Screen Equipment (DSE) use, and especially that of Laptops, has increased significantly throughout the various operating companies. Again, due to the needs of both the Legislative bodies and the health and safety requirements of the company, a steering group was formed to address the issue. The Ergonomics Adviser chaired the group and was ultimately responsible for formation of the company package. Other members of the group included the Director of Medical Services who was responsible for writing and communicating the DSE company policy and the Group Health Services Manager. At an early stage, it was obvious that the Ergonomics adviser could not attempt to support and train all company assessors (n=250) and users (n=5000) in the DSE programme. As a result, the training and information role was assigned to the regional occupational health advisers who were able to offer the DSE service as part of their other health related services to company Managers. By managing the package in this way, the Ergonomics Adviser is detached from the daily running of the programme and is able to operate at a more strategic level ensuring continual compliance and advising the company on necessary changes, when and if required.

The current DSE management package includes: (a) A management and administration manual, (b) User guide booklet entitled 'Working with display screens', (c) An information poster displaying the correct principles for DSE use, (d) A one day training package for DSE Assessors and (e) A 2 hour training package for all DSE users. Information specifically addressing the issues relating to both Laptop and Homeworkers is provided within the information and training elements of the package. Although the primary target group for this package is ultimately the company as a whole, some of the operating companies, such as the various Head Offices and Customer Sales departments by virtue of their number of DSE users utilise the program more than others.

Costs: Based upon (a) Formation of package, (b) Wage costs of trainees, assessors and users, (c) Wage costs for OHAs. The total cost for the package estimated at £80,000.00.

Benefits: To-date there has been only one claim made against the company based on DSE grounds and this was settled for little over £1,500.00.

Occupational Stress Programme

Although still widely recognised as an extremely nebulous area, and as yet removed from any stringent legislation, S&N first tackled this issue as far back as 1986. Company statistics suggested that stress was affecting specific sectors and levels within the company. As a result of these concerns, and a need to ascertain the true picture of S&N stress, OHSS contracted Cary Cooper of the University of Manchester Institute of Science and Technology (UMIST) to conduct a stress audit in all S&N Companies. In one of the first studies of its kind, findings indicated that stress was not, as traditionally indicated, a 'white collar' affliction. The results, which confounded the OHSS hypothesis of perceived higher stress levels in 'Blue collar workers', highlighted similar stress levels for both blue and white-collar workers across all sectors and levels. In addition, the study summarised that S&N had in fact an 'institutional stress problem'.

The outcome of this research prompted OHSS to conduct stress awareness training for employees aimed at learning about stress and its effects. Between the years 1993/95, and based on the findings of the Stress Audit, the regional OHAs conducted Stress Awareness sessions to individual operating companies within the group. With 8 people trained per session and 3,400 people in total to train, the awareness exercise was a huge undertaking by OHSS.

More recently however there was concern raised about the apparent lack of refresher training and the forthcoming Approved Code of Practice (ACOP) from the UK legislators. In late 1998, several members of OHSS conducted a stress needs analysis survey on Managers throughout the company. The semi-structured interviews were aimed at ascertaining the Managers needs in respect of occupational stress and how they should and could manage this area of risk. The results of this survey assisted OHSS in the preparation of a guidance manual and training seminar to be delivered by the OHAs.

Due to its current 'roll-out', no attempt has yet been made to establish potential cost-benefit data.

The future of Ergonomics at S&N

Although initially the Ergonomics Adviser was employed solely to address certain legislative duties, the benefits of using ergonomic principles as key business components have been realised over the last six years. Whereas historically ergonomics has had to justify its very existence, the proven track record of cost savings and reduced injury rates, amidst others, ensure a very long and healthy future for the discipline within S&N.

The ergonomics programme at BCM Airdrie

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Company Background

Boots Contract Manufacturing (BCM) is the largest contract manufacturing company of its field in Europe, developing and producing a wide range of cosmetics, toiletries and healthcare products. BCM has eight factories and one major development laboratory. These are located on the company's main site in Nottingham (England) and in Airdrie (Scotland), Vitré and Flers (France), Dietzenbach (Germany) and Tarragona (Spain).

This report focuses on the ergonomics activities at the BCM Airdrie site in Scotland where we produce cosmetics, suncare, bath/shower and baby products for Boots the Chemists and other third party retailers in the United Kingdom, Europe and overseas. The site currently employs 900 permanent members of staff with 380 packing operatives and 85 product manufacturers. The scope for applying ergonomics in the Airdrie factory is vast when you consider that we develop more than 1000 new products and produce more than 130,000,000 single items every year.

Following the employment of a temporary ergonomist in 1995, and the involvement of an external consultancy in 1996, BCM Airdrie appointed a full-time Ergonomist in June 1997. This document summarises the structure of the ergonomics programme that has since developed.

Management Commitment

Many of the processes in the Airdrie factory, ranging from manual loading of liquids and powders into manufacturing vessels to high repetition packing line tasks, have classically been linked to workplace musculoskeletal health problems. It is therefore important to mention that the instigation of ergonomics activities in the factory was not as a result of any litigation claims against the company. With the general increase of awareness about these issues, BCM Airdrie are instead committed to proactively tackling any musculoskeletal health risks. We also encourage early reporting and efficient treatment for anyone who does develop any musculoskeletal symptoms, and the Occupational Health Department have designed and enforced a detailed procedure to manage and monitor any reporting of upper-limb disorder symptoms. Since the implementation in August 1997, this procedure has been extremely effective with most employees being able to return to their usual duties after a short period

Full support is given to the ergonomics programme by the Factory Managers who attend an Ergonomics Steering Committee meeting once every two months and communicate any developments with the programme to the Managing Director of BCM

and other members of the Company Executive based at the Group Headquarters at Beeston in Nottingham.

The Role of the Factory Ergonomist

The role of the Factory Ergonomist at BCM Airdrie is *to prevent musculoskeletal disorders in BCM Airdrie by designing, coordinating and facilitating an ergonomics programme that deals proactively with ergonomics issues in the design of workplace equipment and processes.*

To achieve this successfully, the scope of the ergonomists' involvement has grown considerably to involve and affect almost every job function on site, so employee awareness and an effective communication structure is essential to the programme. A monthly newsletter is published and circulated to all departments of the factory to summarise the current status of the ergonomics activities in all areas of the factory to ensure that everyone is aware of work ongoing in other areas as well as their own.

A number of changes are currently being made to the ergonomics structure to improve the systems that were originally implemented, involving the development of basic training courses for the groups involved and new documentation to support the system. The key departments and job functions involved in this programme structure are Project Engineering, Shop-floor Personnel and Process Development, and the basic structure used to involve these groups will now be described (see figure one for a summary of the procedural links and responsibilities).

The Ergonomics Programme Structure

The ergonomics programme at BCM Airdrie focuses on the prevention of work-related musculoskeletal disorders via five main approaches:

i. Ensuring ergonomics factors are considered at the design stage of all new equipment and processes

We are currently implementing systems to ensure that we reduce the potential for musculoskeletal problems by ergonomically optimising the factory processes at the design stage. This primarily involves two departments (Project Engineering and Technical Development) and the links with these departments are currently being formalised via a short training workshop (designed specifically for this factory) which is supported with an ergonomics checklist (designed specifically to meet the needs of each department) and a detailed reference manual for future use. This checklist will soon be completed for every project in the factory to ensure that ergonomic consideration has been given to the design of all new equipment, products and work processes.

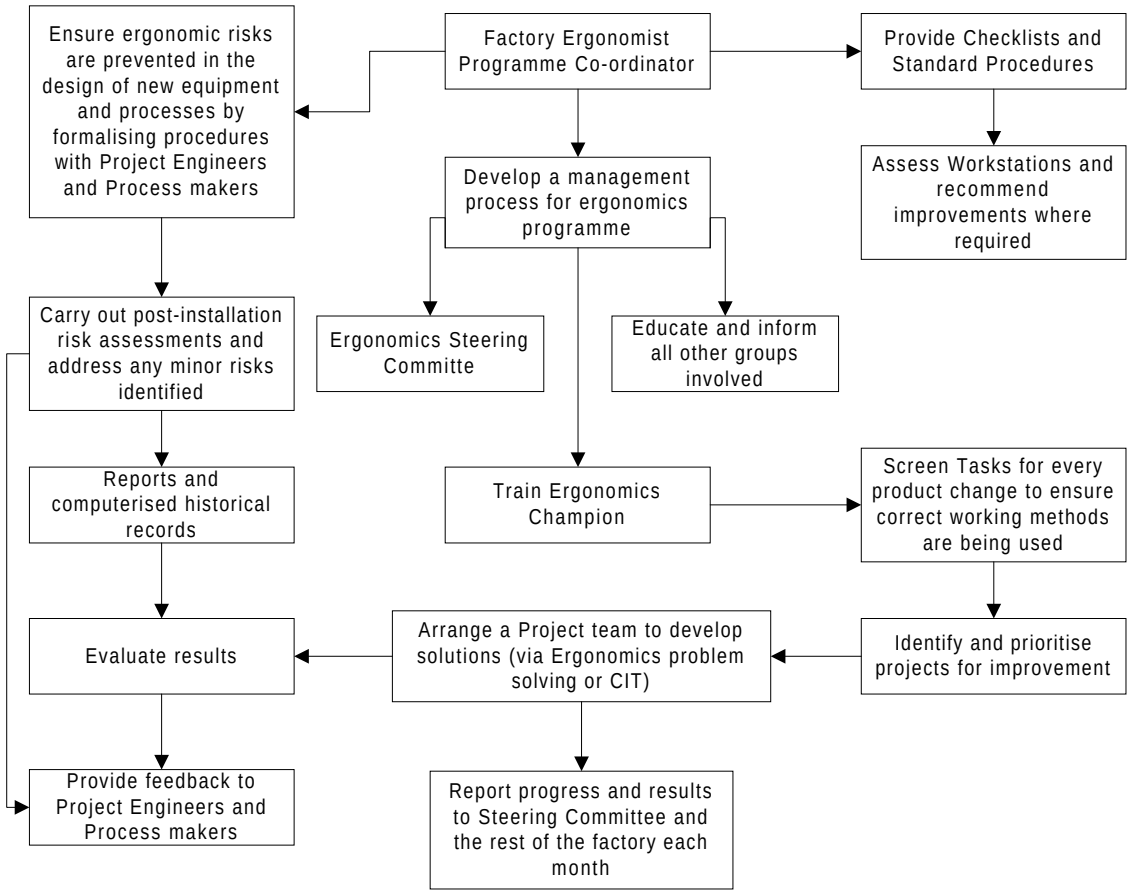

Figure 1. The ergonomics procedure for new and existing equipment and processes.

ii. Involving factory floor personnel when addressing issues with existing equipment and processes

The structured involvement of operators from the factory floor is considered essential in any aspect of the equipment and workplace design, so a representative from each packing line and manufacturing department has been nominated to act as 'Ergonomics Champion'. Each Ergonomics Champion attends a two-day ergonomics training course, which involves basic workplace ergonomics training on the first day with the second day devoted to practising ergonomics risk assessment and problem solving techniques.

Projects for improvement to existing work equipment and processes are selected on the basis of risk assessment. The Ergonomics Champions from the packing lines or departments affected are then asked to be part of the project team (consisting of approximately six people) to design a solution. Technicians and Engineers are also asked to join the project teams, and meetings are held with each group for one hour each week until a solution has been implemented. The Ergonomics Champions are responsible to communicating progress to their Teams and for arranging involvement from other Team Members when required (e.g. user trials).

iii. Implementing a system to continually monitor the packing lines for ergonomics risks following every product change

The Ergonomics Champions are also tasked to complete a 'change control' checklist for every product change on the packing lines. This assessment highlights any problems with the jobs on the packing line at an early stage of production before anyone has been exposed to the risk for any period of time. This ensures early reporting and intervention, which greatly reduces the risk of personnel exposure to potential musculoskeletal risks. The checklists provide a comprehensive and auditable ergonomics risk assessment record of all activities on every packing line in the factory.

iv. Conducting a workplace health surveillance questionnaire survey every two years

The Occupational Health Doctor for the Airdrie site recently completed a plant-wide musculoskeletal health surveillance questionnaire survey. The results of this survey were analysed in conjunction with a RULA workstation assessment of every job in the factory to detect any 'clusters' of reported symptoms which could possibly be attributed to the workplace design (1).

This was an extremely valuable exercise for the site and we plan to reassess the workforce using a similar questionnaire in approximately two years time to measure the benefits of ergonomics intervention in the factory and to prioritise areas where further work is required.

v. Improved training and education about correct working techniques for all employees

Whilst we were carrying out the RULA assessments on the production lines, we observed a huge variation in individual working methods and techniques and have identified a need for ergonomics instruction for anyone new to the company. A training package is currently being developed to provide individual training and advice, supported with a booklet that the person will retain for future reference, so that we can ensure that everyone is using the most comfortable and appropriate working technique, therefore reducing the risk of musculoskeletal problems developing. This material will also be presented to existing employees to ensure that they are also aware of this information.

Conclusion

The final stages of the programme, which has just been described, are still being implemented, so it is difficult to quantify at this stage exactly how successful the programme has been. However, the Occupational Health Department have reported a gradual reduction in the number of upper limb symptoms being experienced in the factory and they are also finding that, when symptoms are reported, this is at a very early stage of their development and are therefore very easy to treat and rehabilitate. This alone is an encouraging indicator that the programme has so far been successful and is fulfilling its aim.

As a company, BCM firmly believe that their reputation for producing high quality products depends on both the quality of the workforce and the quality of the working environment. We take both aspects seriously and are confident that using ergonomics to help develop a well trained, motivated and well informed workforce will contribute to the company's overall business goals.

Reference

1. McAtamney L, Corlett EN. RULA: a survey method for the investigation of work-related upper limb disorders. Applied Ergonomics, 1993, 24(2), 91-99.

Summary

Bengt-Olov Wikström, Göran Hägg (eds). International seminar on corporate initiatives in ergonomics, Stockholm, 19-20 March 1999. Arbete och Hälsa 1999:10.

The idea of setting up special action programs for ergonomics is rather new in our country. The institute had no expertise experience in the field when we started to plan the seminar. It showed that it was quite hard to find any programs at all in Sweden. We only found two of any larger impact, at Volvo Car Corporation and Saab Automobile. In other countries the situation seems to be about the same. However, some companies have a substantial experience and some of these were invited to the seminar.

The aim of the seminar was to bring together interested management, health and safety personnel to discuss the design and experience of ergonomic action programs within companies and organisations. Presentations were performed by invited representatives from 13 companies with experience of programs from Scandinavia, Western Europe, and USA. In addition to this, a number of researchers gave review presentations of the general state of the art of ergonomics as well as economic and quality aspects of ergonomic measures.

Starting with this seminar we hope to find ways of implementing new ergonomic action programs in companies and organisations.

Sammanfattning

Bengt-Olov Wikström, Göran Hägg (eds). Internationellt seminarium om ergonomiska handlingsprogram för företag, Stockholm, 19-20 mars 1999. Arbete och Hälsa 1999:10.

Idén att sätta upp speciella ergonomiska handlingsprogram är relativt ny i vårt land. Institutet hade ingen specialkompetens på området när vi påbörjade förberedelserna med seminariet. Det visade sig att det var svårt att hitta några program överhuvudtaget i Sverige. Vi fann bara två med någon större tyngd, vid Volvo Car Company och Saab Automobile. I andra länder tycks situationen vara densamma. Emellertid har några företag skaffat sig avsevärd erfarenhet på området och några av dessa bjöds in till seminariet.

Syftet med seminariet var att föra samman intresserade personer från management och företagshälsovård för att diskutera designen och erfarenheten av ergonomiska handlingsprogram. Presentationer gjordes av inbjudna representanter från 13 företag med erfarenheter av program från Skandinavien, Västeuropa och USA. Dessutom, gav ett antal forskare presentationer av forskningsläget inom ergonomiområdet, t.ex. i samband mellan ergonomi och ekonomi samt ergonomi och kvalitet.

Med detta seminarium hoppas vi finna sätt att påbörja arbetet med att implementera nya ergonomiska handlingsprogram i företag och organisationer.