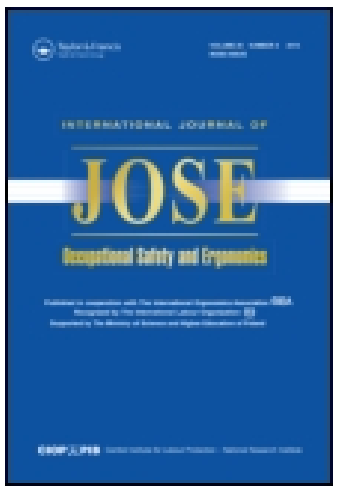

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Company Strategies and Program for Implementing Ergonomics

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Three periods of work environmental activity in the company will be presented: (a) A period without a work environmental organization and an environmental budget, covered approximately 1 year; (b) A period when an environmental organization with a separate work environmental budget was established. This period covered 15 years; (c) A period when the company was divided in 3 companies without a separate work environmental budget, but still an environmental organization, covering the last 12 years.

ergonomic program strategies execution project

1. PRE-WORK ENVIRONMENTAL PROGRAM AND ORGANIZATION

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

- economic resources,
- personnel resources.

The first step to create a program was to establish 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 inquiries,

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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 were at that time, there was no money 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 environmental projects was both work-intensive and time consuming and at times almost created conflicts (Aarås & Westgaard, 1980).

It was clear that the company needed a defined system with guidelines for cooperation between the environmental organization (including the Environmental Group) and the production departments as well as a separate environmental budget.

2. ESTABLISHMENT OF THE WORK ENVIRONMENTAL ORGANIZATION, ENVIRONMENTAL PROGRAM, AND ENVIRONMENTAL BUDGET AT THE COMPANY

The experience from the first year of the environmental work led the company to formulate the important factors, which should be included in our environmental program, that is, how we should establish a work environmental organization and execute work environmental projects.

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 form a widely based working group.
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 organization 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 projects 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 aforementioned points with the appropriate departmental management and the trade unions.
8. The departmental management must stimulate the aforementioned cooperation by active participation and by showing a positive interest in environmental surveys, planning of solutions, and the execution of projects.

The environmental organization and lines of communication between the different subcommittees (i.e., special groups) handling environmental matters that require special knowledge, are shown in Figure 1.

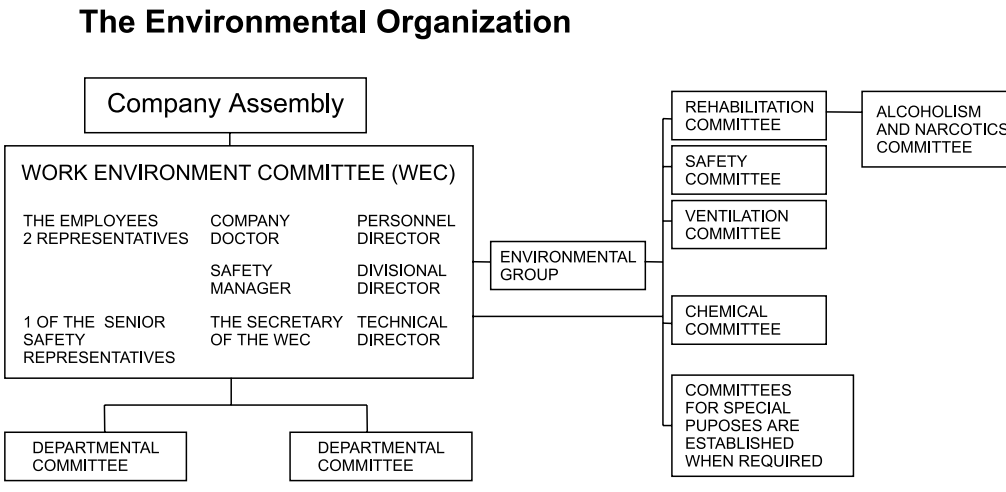

Figure 1. The environmental organization at Alcatel.

These subcommittees report on their activities and problems to the Work Environment Committee (WEC), which coordinates their activities according to their program and guidelines. The WEC is the governing and deciding body in the environmental organization at the company. The main responsibility of the WEC is to organize 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.

On the basis of the annual surveys of the Environmental Group, the WEC prepares and updates an environmental action program with the main emphasis on the financing of this program. 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. Overall 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 organization has a close working relationship with other organizational systems within the company. One important rule is that environmental problems are solved at the lowest possible organizational level in the company. Larger and particularly important environmental matter are submitted to the Company Assembly, which consists of representatives from the company management as well as representatives of the employees' organizations.

Other subcommittees are

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

- The Alcoholism and Narcotics Committee (ANC) has to acknowledge 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, labeling, and storage, is compiled for each chemical.
- Departmental Committees represent employees' representatives, management, and safety representative for that department. Personnel, employment, and productivity matters are dealt with in these joint committees. They are also concerned with environmental standards with their departments and can obtain advice from any environmental subcommittee. It is desirable that environmental problems are solved within the departments, as this increases the local interest and activity, and reduces the load on the environmental organization. The close cooperation between the environmental organization, the company management, and the trade unions ensures a wide, democratic consideration of the environmental problems and actively involves the employees in the solution of their own problems.

3. BASIC PRINCIPLES FOR THE WORK ENVIRONMENTAL ORGANIZATION

According to several years of experience with our environmental organization, the following basic principles for the work environmental organizations are recommended. Five important aspects are particularly focused on.

3.1. Responsibility

1. The environmental organization, with its subcommittees, is responsible for establishing a systematic environmental effort within the company. The environmental organization must therefore develop an action program, which includes the identification and 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 organization.

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.

3.2. 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.

3.3. Information

The environmental work demands a continuous, detailed exchange of information between the environmental organization, 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 organization ensures an early identification of problems. Information from the environmental organization is necessary for a common coordinated environmental activity.

3.4. Integration

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

3.5. Work Division

1. Minor environmental problems are solved within the departments as far as possible.
2. Subcommittees are established to be responsible for environmental aspects that require special knowledge (e.g., the ANC, the Chemicals Committee).

3. The environmental efforts are co-coordinated by a central group, the WEC, which has overall 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.

4. WORK ENVIRONMENTAL BUDGET CANCELLED—NEED FOR DOCUMENTATION OF HEALTH EFFECT AND FOR MODIFICATION OF THE WORK ENVIRONMENTAL PROGRAM

Work environmental budget was cancelled when the company was divided into three companies in 1990. This increased the need for having scientific documentation of necessity to implement the project from a health point of view. From 1990 more than 90% of the employees worked mainly on tasks that were connected with personal computers (PC). Therefore, focus was directed to work conditions for visual display unit (VDU) operators. Visual discomfort and musculoskeletal illness were the main problems reported by these VDU operators. Due to the complexity of these work environmental problems, a multidisciplinary team was established. In order to study the visual problems, professor H.-H. Bjørset as a lighting engineer and professor G. Horgen as an optometrist participated in the teamwork. Regarding musculoskeletal discomfort an experienced occupational ergonomist and medical doctor, A. Aarås, joined the team as medical director for the company.

Laboratory studies were necessary to carry out in order to convince the management to spend money to improve the visual condition and reduce musculoskeletal discomfort among VDU workers. Further, laboratory studies were the first step in order to find optimal solutions regarding quality criteria of the luminaires and their placement related to the PC (Bjørset, 1987). Bjørset found that the best lighting system was to apply suspended luminaires with a light distribution about 20% upward and 80% downward, through an effective, semi-diffuse reflector-louvre system.

The luminaires were positioned at each side of the VDU workplace, giving an average illuminance of relevant work areas of more than 600 lx with a satisfying luminance distribution.

Figure 2. The workplace with the new table/chair and the new luminaires.

Further, in optometry, different lenses were tested as regards to work posture and muscle load. The lowest muscle load in the neck and shoulder region was found when wearing single-vision lenses compared with progressive lenses (Horgen, Aarås, Fagerthun, & Larsen, 1989, 1995).

After implementing the new luminaires and giving optometric corrections to those who required them, a significant reduction of visual discomfort was reported by two intervention groups of VDU operators whereas the control group did not report any significant changes (Aarås, Horgen, Bjørset, Ro, & Thoresen, 1998).

Postural load during VDU work was also studied in the laboratory. A comparison between various work postures was done in order to find which posture created the lowest static muscle load. This study showed that there was a significant lower static load for the sitting position with support of the forearms on the table top compared with sitting and standing without such support (see Figure 3; Aarås, Fostervold, Ro, Thoresen, & Larsen, 1997).

The results from the laboratory study were tested in a prospective field study to find out if the results were valid in a complex work environmental condition. Two years after intervention, a significant reduction of shoulder pain was reported in two intervention groups in parallel with a significant

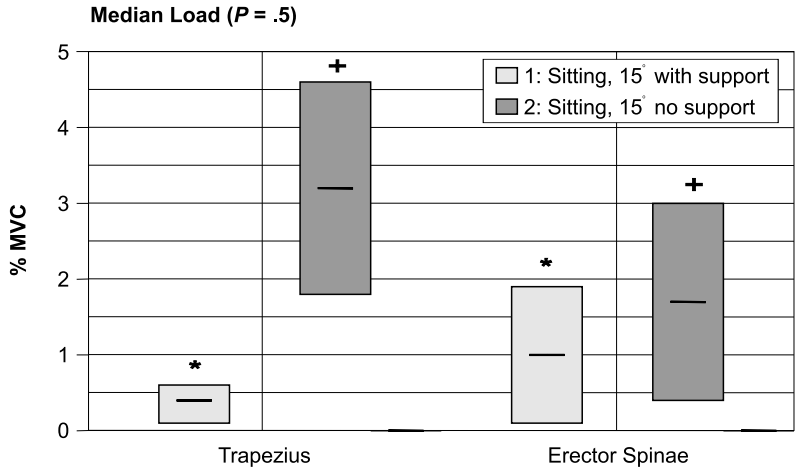

Figure 3. Group median values with 95% confidence interval for the two postures. Twenty participants took part in the study. An asterisk (*) indicates a significant difference when comparing with the column containing a plus sign (+).

reduction in static trapezius load whereas no such reduction was found in the control group (Aarås et al., 1998). The same study showed that supporting of the forearms in a pronated position when using keyboard and mouse did not seem to be effective in reducing the forearm/hand pain. No effect was observed regarding forearm/hand pain in any of the three groups. The total time the operator used the mouse was found to be related to the pain level in the forearm/hand. Therefore, workload when using a mouse as an input device was examined in a laboratory study. Two positions of the forearm were compared. One mouse gave an almost neutral position, vertical mouse (Anir), whereas the traditional mouse required a pronated position (Aarås & Ro, 1997).

The aim of this laboratory study was to compare the load on the musculoskeletal system when operating a mouse with a more neutral position of the forearm, with a traditional mouse requiring a more pronated forearm position. The study had a parallel randomized block design. The work consisted of "painting" small squares on the screen by using Paintbrush. The participants worked for approximately 30 min, after a 10-min break they continued for another period of approximately 30 min with the other mouse. They worked in the sitting position with the hands at elbow height and supported almost the whole forearm on the tabletop. This was true when using both mice. Electromyography (EMG) was used to assess the muscle load. The load is given as percentage of maximum voluntary

contraction (MVC). The muscle load of the forearm was significantly less when using an almost neutral position of the forearm compared with a pronated one. This was true for extensor digitorum communis regarding the static 4.5 (2.1–7.0) MVC versus 10.8 (7.2–13.5) MVC, $p = .0005$ and median 10.3 (5.1–15.0)MVC versus 17.0 (11.6–22.5) MVC, $p = .001$ as group median values with 95% confidence intervals of the amplitude distribution function (ADF; Figure 4; Aarås & Ro, 1997). Gustafsson and Hagberg (2000) found similar results when comparing a neutral and a pronated position of the forearm when operating the mouse. These results indicate the need for reducing the pronation of the forearm when working with a mouse.

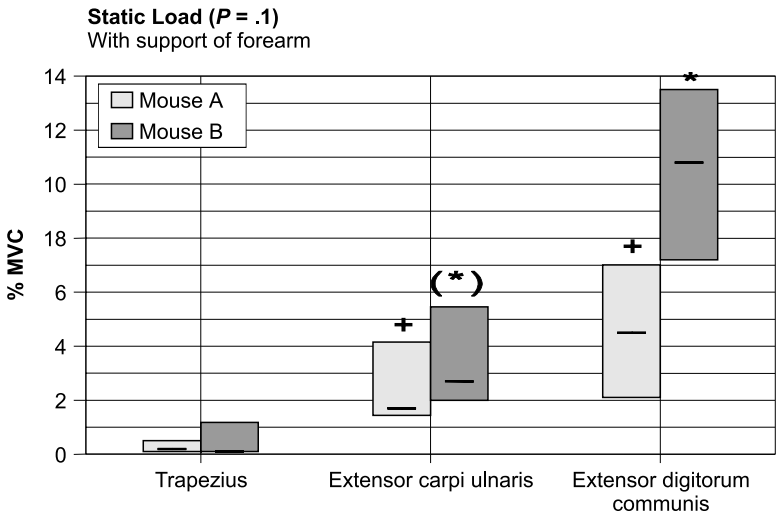

Figure 4. Static muscle load for trapezius, extensor carpi ulnaris, and extensor digitorum communis as median group values with 95% confidence interval for the group using Anir mouse (dark columns), and a traditional mouse (dark columns). An asterisk (*) indicates a significant difference when comparing with the column containing a plus (+); $p = .06$.

The laboratory study was followed up by a prospective field study where the vertical mouse was compared with a traditional mouse using a more pronated forearm. The study was set up with a parallel group design with two groups of VDU workers with pain in the forearm/hand and shoulder. The group of 67 participants with an intensity of pain in the forearm and shoulder of approximately 50 mm on a 100-mm visual analog scale (VAS) was randomly divided into one intervention group and one control group (Aarås, Dainoff, Ro, & Thoresen, 2001). The aim of the study

was to examine if participants having pain in the forearm/hand and shoulder experience a change in the development of musculoskeletal pain in the upper part of the body, when starting to use the vertical mouse compared to use a traditional mouse. After using the vertical mouse for 6 months, a significant reduction in pain intensity and frequency was reported for wrist/hand, forearm, shoulder, and neck ($p < .009$). The control group using the traditional mouse reported only small changes in the pain level ($p > .24$; Aarås et al., in press). Figure 5 shows the forearm pain in the last 6 months.

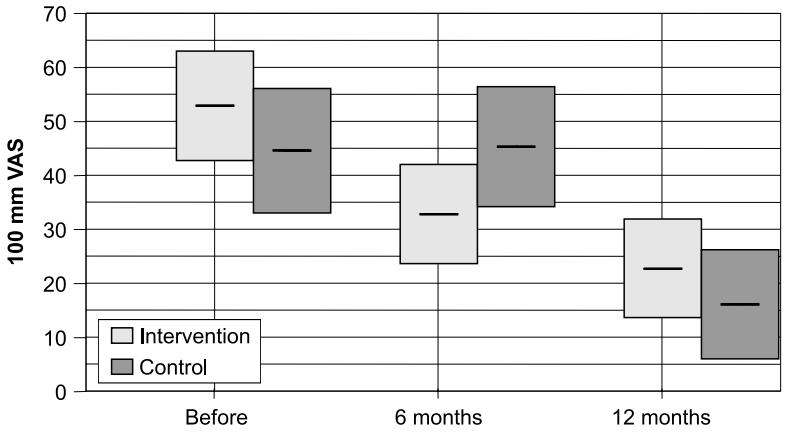

Figure 5. The reduction in forearm pain after using the Anir mouse. The intensity of pain in the last 6 months. The values are given as group mean with 95% confidence interval.

Before intervention, there was no significant difference between the two groups regarding forearm pain. After 6 months, a significant reduction of intensity of forearm pain was reported in the intervention group, 52.9 (42.7–63.0) to 32.8 (23.6–42.0), whereas no such reduction was observed in the control group, 44.6 (33.0–56.1) to 45.3 (34.4–56.4) as mean value with 95% confidence interval (Aarås et al., 2001). After 6 months there is a significant difference between the groups ($p = .02$), after correction is made in the statistical analysis for the initial difference between the groups. Similar results were found for the neck, shoulder, and wrist/hand pain. After 6 months from the start of the study, the former control group got the vertical mouse. After 6 months they reported a significant reduction of forearm pain 45.6 (30.8–60.4) to 15.6 (5.5–25.7). The group who got the initial intervention did not report any significant changes in the forearm pain from 6 to 12 months of the study period, that is, the reduction in pain level was maintained.

5. CONCLUSION

In occupational medicine, it is of utmost importance that the company has a strategy and program for implementing ergonomics. Without a separate environmental budget in the company, it is of great importance to carry out laboratory studies to get evidence of potential ergonomic improvements for the workers. This procedure has been absolute necessary to convince the management to accept the cost to implement ergonomic improvements.

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