Strategies to develop and strengthen human factors and ergonomics knowledge among stakeholders in Sweden

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Knowledge and application of human factors and ergonomics (HFE) has significant potential as a useful tool and solution provider in the development, design and implementation of safe, efficient and sustainable artefacts and systems. Yet, it seems that this HFE knowledge is not utilised to its full potential. In a world of competing financial and commercial priorities, HFE specialists have apparently not succeeded in selling the systems approach as a tool towards improved overall systems performance and human well-being. The present paper describes the strategic and practical work performed by the Swedish Ergonomics and Human Factors Society (EHSS) to strengthen the quality of human factors and ergonomics knowledge and practice among various stakeholders in Sweden. EHSS view human factors and ergonomics as a systems and design oriented discipline that extends across all aspects of human activity. Beyond the traditional domains of specialization within the discipline, the physical, cognitive and organisational ergonomics, EHSS has identified three focus areas; visual ergonomics, voice ergonomics and ergonomics design for all. Within these

Practitioner Summary: This paper presents the strategic and practical work performed by the Swedish Ergonomics and Human Factors Society (EHSS) in order to strengthen the quality of human factors and ergonomics knowledge and practice in Sweden. EHSS has identified three focus areas for its strategic work: visual ergonomics, voice ergonomics and ergonomics design for all.

Keywords: human factors, visual ergonomics, inclusive design, voice ergonomics, social sustainability

1. Introduction

The multi-disciplinary science and practice of human factors and ergonomics (HFE) is systems oriented and design driven and embrace all aspects of human work. It implies the design of tasks, artefacts, systems and environments to be compatible with human physical and mental needs, abilities and limitations (Chapanis, 1996). Despite the continuous technological achievements through society, humans are still present in many, if not all, systems; acting as e.g. users, operators, maintainers and designers. Even a highly automated system requires people – in any case to start, stop, monitor and occasionally perform service and maintenance on equipment within the system. Hence, it is necessary to take into account the physical, cognitive and social abilities and limitations of the humans when developing both simple and complex system solutions. The variation within the user community is large, from the population in working life, to children, elderly, people with disabilities and people from different cultures. In any given context, all these user groups should be provided with the possibility to interact with technical and other solutions correctly.

There is a large body of knowledge available on the importance of human factors and ergonomics to successful (and unsuccessful) systems and joint performance and well-being outcomes. Positive effects can be found for individuals, companies and for the society as a whole (Mossink & De Greef, 2002). This knowledge is manifested for instance in scientific literature, handbooks, guidelines and standards on how to develop and implement system solutions that are effective, safe, sustainable, and comfortable for the users. Yet, it seems that this knowledge, and the application of HFE principles and methods in practice, is not utilised to its full potential. In a world of competing financial and commercial priorities, HFE specialists have apparently not succeeded in selling the systems approach as a tool towards improved overall systems

performance and human well-being (Dul et al., 2012). Rather, there are islands of knowledge and pockets of practice that still remain to be linked.

The work presented in this paper is largely inspired by the position paper by Dul et al. (2012) that propose a joint world-wide HFE development plan and strategies at several national and international levels in order to strengthen and develop the HFE discipline and profession. The suggested main strategy for the future of HFE combines three interrelated elements into a '*HFE demand development cycle*' (Dul et al., 2012, p. 388): a stakeholder's **demand** for high-quality HFE, which can stimulate the **application** of high-quality HFE, which can raise the stakeholder's **awareness of the need**, which may in turn further increase the stakeholder's **demand** for high-quality HFE.

One attempt to meet this strategy for the future from a national perspective has been done in Sweden, where relevant stakeholders and their needs have been identified, to be able to develop strategies for communication, building partnerships and advance HFE education.

Specifically, the present paper describes the strategic and practical work performed by the Swedish Ergonomics and Human Factors Society (EHSS). The overall aim is to develop and strengthen the quality of human factors and ergonomics knowledge and practice among various stakeholders in Sweden.

2. Swedish Ergonomics and Human Factors Society

The Swedish Ergonomics and Human Factors Society (EHSS) consists of about 350 professional and student members across the nation, representing different occupations in industry, academia and public sector at governmental, regional and local level. The majority of the members have professions as engineers, physiotherapists, psychologists and designers working as practitioners, researchers, professors and designers. Together, the members cover knowledge and experience in physical, cognitive and organizational ergonomics. The application areas for education, research and design are broad; from product development and working environments to complex socio-technical systems such as health care, aviation, maritime, traffic and public transports as well as process and nuclear industry. Although the members are based in Sweden, many of them work on a global arena.

The composition of the EHSS' board mirrors the diversity of its members and consists of representatives from different disciplines and sectors; public, industry and academia and includes both scientists and practitioners. The members of the board work with ergonomics and human factors issues in their ordinary work as researchers, teachers, practitioners or designers. The strategic and practical work performed by EHSS is in many cases also performed by the board members in their daily working life.

The overall goal of EHSS is to create value for the members and form a multidisciplinary platform for collaboration across disciplines and professions. Further, EHSS aims to support and disseminate research results, methods and tools into practice, for example evaluation methods for user interaction, physical and mental work loads and risk analysis.

2.1 Stakeholder interaction and strategic focus areas

In order to develop and maintain stakeholder interaction and networking, EHSS regularly arrange breakfast meetings, after work sessions and one-day seminars for the members. EHSS also participates in scientific and trade conferences, both nationally and internationally, as well as in events related to the area such as the World Usability Day. EHSS also administers a student prize on master thesis level each year, where the winning student participates in the coming Nordic Ergonomics and Human Factors Society (NES) conference and presents the work in a Nordic competition between students. Also, EHSS carries out evaluations of ergonomic products on the market.

Beyond the traditional areas of physical, cognitive and organisational ergonomics, EHSS has identified three strategic areas, both from a research and from a societal level, to be important to focus on and learn more about. One area is visual ergonomics, the multi-disciplinary science concerned with understanding human visual processes and the interactions between humans and other elements of a system (Long et al., 2014). Another area is voice ergonomics, which is an aspect of human interaction with the working environment that has not been paid much attention to until now, as being one part of a sustainable working life. The third area is inclusive design, which deals with ergonomic design for all users in society, including

the increasing number of ageing workers in Sweden. This area is important for improvement of social sustainability in society and working life.

3. Visual ergonomics

The multi-disciplinary nature of visual ergonomics pose a challenge when wanting to obtain a comprehensive picture of all factors concerned in this field. Figure 1 presents a mind-map of how different factors can affect the eyes, muscles, headache, circadian rhythm, visual performance and productivity (Hemphälä, 2014). The mind-map shows how different visual ergonomics factors can affect each other. The blue boxes with arrows show the interventions, the green boxes show the environment and the beige boxes show the human responses. The causality for most of the factors is not known (Hemphälä, 2014). As illustrated in Figure 1, the lighting situation, the visual aids, the psychosocial and physical work environment (work tasks) can affect vision and perceived visual ability. Visual ability can affect musculoskeletal activity and may cause discomfort, but the relationship between eyestrain and musculoskeletal strain in the neck and shoulders is still unclear. If the visual system is exposed to glare or other visual disturbances it might cause headaches. Visual performance and productivity can be affected by the physical work environment, any musculoskeletal discomfort, any eyestrain, and the level of alertness (circadian rhythm).

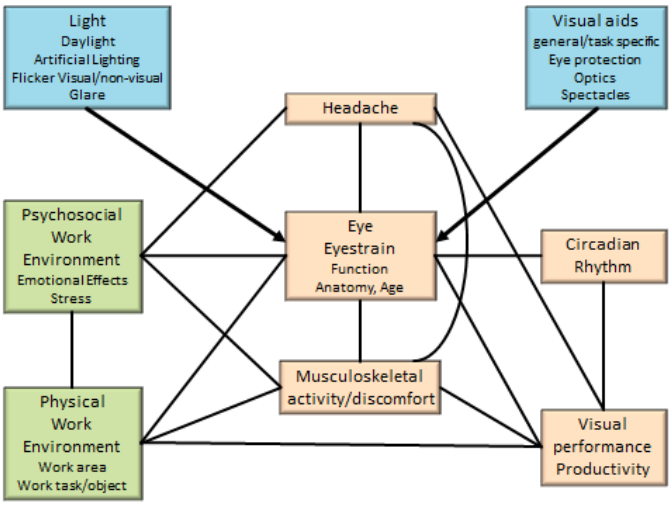


Figure 1 The chart model shows how the different visual ergonomics factors can affect each other. The blue boxes show the interventions, the green boxes the environment, and the beige boxes the human responses (Hemphälä, 2014).

Many different disciplines are needed to get a good visual environment; e.g. optometrists, occupational ergonomists, lighting designers, architects, ophthalmologists, working life inspectors. To facilitate visual ergonomic knowledge and to promote visual ergonomics as a discipline, it is important to arrange visual ergonomics workshops and lectures. The different professions that deal with the visual environment need to cooperate to facilitate learning at a higher level.

To accommodate for this need, a network for Visual Ergonomics practitioners called SNiS (Synergonomiskt Nätverk i Sverige) was setup within EHSS in 2007. Twice a year, the network arranges a day with seminars, at no cost, for all EHSS members. These seminars have contributed to increased awareness of the importance of a good visual environment.

In 2010 a visual ergonomic research network started, called ErgoVision, which include researchers from different professions in the Scandinavian countries. The focus of this network is to define what visual ergonomics is, to gather information on what type of research that was performed and to evaluate the level of knowledge within the area of visual ergonomics present in the Scandinavian countries.

The researchers in the ErgoVision network regularly give shorter lectures about visual ergonomics to increase the awareness of the visual environment as a risk factor. In addition, a book about vision and lighting at work places has also been published in Swedish (Nylén, 2012). Members of the ErgoVision network has also contributed to a report published by the Swedish Work Environment Authority about the ageing eye and the need for more light with increased age (Arbetsmiljöverket, 2012b).

The NES conferences have become a meeting ground for individuals interested within the field of visual ergonomics. A Visual Ergonomics network is in charge of Visual ergonomics sessions at the conference. The researchers within the ErgoVision also have meetings at the NES conference. Because of these annual meetings the collaboration between the researchers has increased. A tool for visual ergonomics risk analysis method is being developed by some of the Swedish researchers from the ErgoVision network (presented as a poster at the IEA conference 2015). Studies with the effect of glare or visual blur on the eyes and muscles in the neck and shoulder region are also being performed by a number of researchers within the ErgoVision network.

Since these networks have started the awareness of the importance of visual ergonomics have been higher among the members of EHSS. Longer visual ergonomic courses (5 weeks) on a regular basis are so far only given to optometrists. Shorter courses and lectures are otherwise given to other professions. The craving for more education from occupational ergonomists and working life inspectors are high. But more knowledge is needed. More research is needed. Networking and lecturing are two ways of spreading the knowledge of visual ergonomics.

4. Voice ergonomics

An aspect of human interaction with the working environment that has not received much attention within the area of ergonomics is about using the human voice as a working tool. Many people use their voices in their normal working situation, especially people in education on various levels, but also officers, call centre staff and others. This area, the so called voice ergonomics, has bearings on personal health as well as on the quality of human communication. When a worker experiences voice problems a speech therapist is sometimes consulted. A speech therapist can give good advice addressing medical aspects and individual therapy. Sweden has internationally recognized researchers and clinicians in speech therapy, but they normally have very limited experience from field work in working life.

Sweden has since several decades a great number of highly competent occupational ergonomists mainly associated with the Swedish occupational health service. These ergonomists normally have good contacts with enterprise management and are used to implement work environment changes. However, they hardly have any knowledge about speech issues and acoustics. These issues have recently been put in focus by a new updated provision on work load by the Swedish Work Environment Authority (Arbetsmiljöverket, 2012a), where voice load also is addressed.

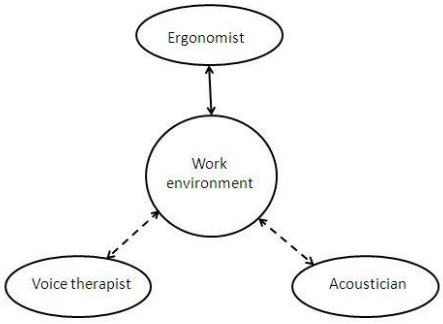
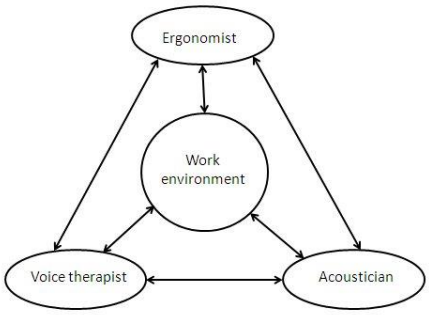


Figure 2a Model of present situation.



2b Model of the anticipated network in the future.

A prioritized goal of EHSS is to form a network for voice ergonomics, creating closer relations between practitioners in physical ergonomics, speech therapists and acoustic experts, moving from the present situation as presented in Figure 2a where the various professionals work in solitude, to the anticipated future network illustrated in figure 2b. The aim of the intended network is to increase cooperation between these professions to be able to address voice and acoustic problems with a holistic systems approach to create acoustic environments for safe and efficient work. The goal also includes appropriate educational measures for all stakeholders involved.

5. Ergonomics design for all

Ergonomic design of products and environments affects human performance in everyday systems. Often the design is done with a general thought that the user group is normal distributed adults between18-65 years (the traditional working force). However, human physical and mental prerequisites vary between people and also by age. Therefore, it is important to also accommodate the needs of small and big persons, persons living with various disabilities, expectant mothers, elderly, adolescents and children in the design. People with various disabilities can be for example wheel-chair users, blind people and people with dementia. But to include all people in society when designing is not a simple task. Then we have to deal with extraordinary ergonomics, or inclusive design, which means taking into consideration various human characteristics and focusing on ergonomics for people that generally are excluded from common design guidelines.

A framework that deals with 'Design for All' has been developed at Chalmers University of Technology in Sweden, and tested twice in a University course on master level for design engineering students. The aim of the framework is to identify what specific requirements different age groups and people with disabilities generate in various contexts and how these requirements create conflicts and challenges when trying to design for all. The framework consists of five parts:

1. A theoretical literature study of specific needs (physical and/or mental) associated with age and disability of the chosen user groups (elderly, children, physical impairment, impaired vision, impaired hearing etc.)
2. Observe the chosen everyday system (e.g. a public space or a workplace) to identify critical tasks to be performed and what contextual problems/hinder there for correct performance within the system. Perform unstructured interviews with people if appropriate.
3. Analyse the results from theory (specific needs for the different user groups) and practice (critical tasks and contextual problems) and make a list of problems followed by requirements for each user group.
4. Make a list of conflicts and contradictions between the requirements for the different user groups. Is there anything preventing a critical situation where the difficulties for all user groups can be supported?
5. Decide on the most relevant and feasible improvement areas for the system so it will be improved from a "design for all"-perspective.

This framework has been used for example to study public spaces, more specifically local public transport, self-service restaurants and grocery stores. These are examples of everyday systems that should be accessible for everyone, i.e. all inhabitants of the society should be able to access functions here. The specific user groups studied were people with visual impairment, wheel-chair users and elderly. A variety of critical tasks and contextual problems were identified within these public spaces, but also a variety of design solutions were found, some of these rather simple.

For instance, in Gothenburg today, 40 per cent of the busses and trams are not adapted to wheel-chair bounded persons at all. Where there are solutions to board wheel-chairs, the access ramps are manual (Figure 3) and an accompanying person is needed. This person needs to get a hook from the driver to fold the ramp, or the driver needs to do it. This is very time consuming and the time-schedule will be ruptured. Furthermore, there is too little space in the bus to fit an electric wheel-chair together with for example a stroller. However, the students proposed good solutions in how people in wheelchairs could included in the public transport system. They also showed how articles in grocery stores should be positioned to offer everyone a chance to reach them, and how restaurants should be furnished to avoid conflicts between user groups as wheelchair users and visually impaired people.

Figure 3 Student project in Gothenburg city testing how busses are adapted for wheel-chairs. The ramp needs to be fold manually and there is limited space for the wheel-chair inside the bus. The wheel-chair driver needs to have an assistant or get help from the driver. The loading/un-loading procedure affects the time schedule of the bus.

By using the framework, both theory and practice are used to analyse a system from a design for all perspective in a more structured way, which has been successful in student projects. A prioritized goal of EHSS is to spread the knowledge of inclusive design theory and methods among different stakeholders, in academia as well as to practitioners to increase the possibilities to develop a more social and sustainable society in Sweden.

6. Concluding remarks

EHSS has shouldered a leadership role in promoting HFE work in Sweden by identifying strategic focus areas and key stakeholders. The work includes building strategic partnerships, like the visual ergonomics network and the voice ergonomics network to further the HFE knowledge and application and ensure sustained improvements in both research and practice.

For a relatively small organization as EHSS in small country as Sweden, it is not possible to cover all areas within the vast scope of human factors and ergonomics, while maintaining high-quality. It is necessary to choose appropriate focus areas. Today, it is mainly board members driving and participating in this work but our efforts will only be successful in the long run if our individual members get increasingly involved.

The contribution of this paper is to show a strategy to develop and strengthen human factors and ergonomics knowledge among stakeholders that can be formulated in the context of an individual society within the IEA. This also opens up for other Societies to join us in our efforts and actively contribute to our key areas as well as support us in other areas where we lack resources.

The EHSS' activities are one step towards broadening the knowledge and application of HFE in the Nordic countries and to comprise new areas and domains of specialization. Specifically, this includes increased awareness of the need to design society and workplaces for wider spectra of user groups. Visual ergonomics, voice ergonomics and ergonomic design for all user groups, including children, disabled and elderly are important areas to highlight for practitioners, product developers, researchers, teachers and authorities to improve accessibility and the environment for all people, in order to increase safety, efficiency and well-being.

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