

Knowledge Gaps and Research Challenges in the Contemporary Ergonomics

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Introduction

Ergonomic community has developed and documented a substantial body of knowledge and skills regarding interactions between humans and their environments, and methodologies for analysing and designing systems over the past 50 years [1]. The benefits of Ergonomics can appear in many different forms such as productivity and quality, safety and health, reliability, job satisfaction, and personal development. One of the basic aims of Ergonomics is to seek efficiency in purposeful effectiveness in the widest sense of achieving desired results without wasteful input, error, and damage to the person involved or to others. It is not useful to expand unnecessary energy or time because insufficient consideration is given to the design of work, workspace, working environment and conditions.

Ergonomics focuses on systems in which humans interact with their environments. The environments are complex and consist of physical, organisational, and social issues [2-4]. The system can be a work system where the human is a worker and the environment is the working environment or a product/service system where the human is a product user or a person who receives a service and the environment is the environment where the product is used or where the service is received [5]. In view of these complexities, the best possible solutions would be to provide flexible situations where the human operator can optimize a specifically appropriate way of doing things. Unfortunately, such an approach is sometimes impracticable because a more efficient way is often not obvious, with the result that a worker can go on doing something a wrong way or in wrong conditions for years. Thus, it is necessary to adopt systematic approaches such as starting from a sound theory, setting measurable objectives, and checking success against these objectives [6].

Ergonomics also searches to ensure that the working environment is in harmony with activities of the worker. This goal is self-evidently valid but, attaining it is far from easy for a variety of reasons. The human operator is flexible and adaptable and there is continuous learning, but there are quite large differences amongst individuals. Some differences such as physical size and strength are obvious, but other factors such as cultural differences and differences in style and in level of skill are less easy to identify. Hence, ergonomic research requires developing wide-based skills that include strong technical and research competencies. It also necessitates developing good communication skills and recognitions that they are an agent of change working within a team with multiple stakeholders [7].

Strategies for Future Ergonomic Research

Dul et al. suggests that the current ergonomic research has three fundamental characteristics: systems approach, design driven, joint performance and well-being outcomes [1]. This combination is unique in comparison to other disciplines. However, the developed systems

are changing and will continue to change in the future. Ergonomics can help to design systems that fit people so that well-being and performance outcomes are achieved in future systems.

Recent research also reports that Ergonomics currently serves the main stakeholder group of system actors relatively well with well-being outcomes, but it needs to better serve the main other stakeholder groups such as system experts and system decision makers with high-quality Ergonomics [1]. These stakeholder groups are more influential in system design than system actors and have a strong interest in performance. At the same, they may have only a limited view about what Ergonomics could offer. Therefore, Ergonomics should expand its reach to system experts and system decision makers, with greater emphasis on the performance goal, and on the diversity of application areas. To strengthen the demand for and the application of high-quality Ergonomics for all stakeholders, the following two main strategies for the future research of Ergonomics are proposed [1]:

1. Strengthening the demand for high-quality Ergonomics by enhancing the awareness of stakeholders' need for high-quality Ergonomics (in particular, for system experts and system decision makers, emphasising performance) and
2. Strengthening the application of high-quality Ergonomics.

The above two strategic elements are interrelated. Higher demand for high-quality Ergonomics can lead to more high-quality Ergonomics provided (pull), and more availability of high quality Ergonomics can stimulate demand for high-quality Ergonomics (push) [1]. The Ergonomics community can take an active role in boosting this cycle by focusing on both the pull and push approaches. It can enhance the stakeholders' awareness of their need for high-quality Ergonomics. This can be done by communicating with stakeholders, building partnerships with stakeholders, and educating stakeholders [8].

Modern technology has greatly improved the well-being and quality of people's life including older ones and many studies indicate that older people are receptive to using new technologies. However, older people often encounter difficulties because they receive inappropriate training or designers of the technology have not taken into consideration the needs of older people. User testing and user-centred design are critical to the success of technical systems. Despite of the importance of such issue, we currently very little know about the efficacy of design aids and supporting tools for the older adults in particular. We also need more information on the best way to train the older adults to use new technologies such as online training programs and multimedia formats [9].

In the workplace, research on how technology impacts employment opportunities and work performance of the older workers would be extremely helpful. Not much research also has been done on tele-work as it relates to the older workers or the factors that influence

technology adoption, especially for minority elderly workers and people who are not highly educated or well off economically. Large portions of these issues could be addressed, or partly addressed through technological solutions. However, we will firstly need a systematic effort to understand their needs and incorporate them into the design of products for the marketplace.

Conclusions

Ergonomics has significantly contributed to the design improvements for all kinds of systems with people, work systems, and product/service systems and will continue to demonstrate its value more successfully to the industry stakeholders. Contemporary ergonomic discipline also has showed rapidly expanding application areas, continuing improvements in research methodologies and increased contributions to fundamental knowledge as well as important applications to the needs of our aging society in general.

Developments in technology and socio-economic dilemmas of the 21st century also have posed significant challenges for the ergonomic discipline and profession. According to the report on 'Sustainable workplaces of the future - European research challenges for occupational safety and health' published by the Partnership for European Research in Occupational Safety and Health [10], the following seven research topics will be main challenges for the next decade:

1. Sustainable employability to prolong working life
2. Disability prevention and reintegration
3. Psychosocial well-being in a sustainable working organisation
4. Multifactorial genesis of work-related musculoskeletal disorders (MSDs)
5. New technologies as a field of action for OSH
6. Occupational risks related to engineered nanomaterials (ENMs)
7. Safety culture to prevent occupational accidents

The above issues will affect the forthcoming directions in the developments of ergonomic discipline across science, engineering, design, technology and management of human-compatible systems. The future challenges for Ergonomics and ergonomists will require

development of wide-based skills that will include strong technical and research competencies. It is also considered what's needed to succeed in Ergonomics is education, credentials, experience, professional certifications, affiliation with professional groups, and continued training and development [11]. The requirements and opportunities for filling our knowledge gaps for further research are expected to be amongst the more important challenges to the Ergonomics community for the immediate future. This would require holistic approaches to achieve successful outcomes to the benefit of all the stakeholders [11].

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