

10. Human factors and ergonomics

Human factors and ergonomics (HF&E) is a multidisciplinary field incorporating contributions from psychology, engineering, biomechanics, mechanobiology, industrial design, graphic design, statistics, operations research and anthropometry. In essence it is the study of designing equipment and devices that fit the human body and its cognitive abilities. The two terms "human factors" and "ergonomics" are essentially synonymous.

10.1 The International Ergonomics Association defines ergonomics or human factors as follows:

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.

HF&E is employed to fulfill the goals of health and safety and productivity. It is relevant in the design of such things as safe furniture and easy-to-use interfaces to machines and equipment. Proper ergonomic design is necessary to prevent repetitive strain injuries and other musculoskeletal disorders, which can develop over time and can lead to long-term disability.

Human factors and ergonomics is concerned with the "fit" between the user, equipment and their environments. It takes account of the user's capabilities and limitations in seeking to ensure that tasks, functions, information and the environment suit each user.

To assess the fit between a person and the used technology, human factors specialists or ergonomists consider the job (activity) being done and the demands on the user; the equipment used (its size, shape, and how appropriate it is for the task), and the information used (how it is presented, accessed, and changed). Ergonomics draws on many disciplines in its study of humans and their environments, including anthropometry, biomechanics, mechanical engineering, industrial engineering, industrial design, information design, kinesiology, physiology, and psychology.

10.2 HF&E organizations

Formed in 1946 in the UK, the oldest professional body for human factors specialists and ergonomists is The Institute of Ergonomics and Human Factors, formally known as The Ergonomics Society.

The Human Factors and Ergonomics Society (HFES) was founded in 1957. The Society's mission is to promote the discovery and exchange of knowledge concerning the characteristics of human beings that are applicable to the design of systems and devices of all kinds.

The International Ergonomics Association (IEA) is a federation of ergonomics and human factors societies from around the world. The mission of the IEA is to elaborate and advance ergonomics science and practice, and to improve the quality of life by expanding its scope of application and contribution to society. As of September 2008, the International Ergonomics Association has 46 federated societies and 2 affiliated societies.

10.3 Related organizations

The Institute of Occupational Medicine (IOM) was founded by the coal industry in 1969, from the outset the IOM employed ergonomics staff to apply ergonomics principles to the design of mining machinery and environments. To this day, the IOM continues ergonomics activities, especially in the fields of musculoskeletal disorders; heat stress and the ergonomics of personal protective equipment (PPE). Like many in occupational ergonomics, the demands and requirements of an ageing UK workforce are a growing concern and interest to IOM ergonomists.

The International Society of Automotive Engineers (SAE) is a professional organization for mobility engineering professionals in the aerospace, automotive, and commercial vehicle industries. The Society is a standards development organization for the engineering of powered vehicles of all kinds, including cars, trucks, boats, aircraft, and others. The Society of Automotive Engineers has established a number of standards used in the automotive industry and elsewhere. It encourages the design of vehicles in accordance with established Human Factors principles. It is one of the most influential organizations with respect to

Ergonomics work in automotive design. This society regularly holds conferences which address topics spanning all aspects of Human Factors/Ergonomics.

10.4 Specializations

Specializations within this field include visual ergonomics, cognitive ergonomics, usability, human–computer interaction, and user experience engineering. New terms are being generated all the time. For instance, “user trial engineer” may refer to a human factors professional who specializes in user trials. Although the names change, human factors professionals apply an understanding of human factors to the design of equipment, systems and working methods in order to improve comfort, health, safety, and productivity.

According to the International Ergonomics Association within the discipline of ergonomics there exist domains of specialization:

Physical ergonomics is concerned with human anatomy, and some of the anthropometric, physiological and bio mechanical characteristics as they relate to physical activity.

Cognitive ergonomics is concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system. (Relevant topics include mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress and training as these may relate to human-system and Human-Computer Interaction design.)

Organizational ergonomics is concerned with the optimization of socio-technical systems, including their organizational structures, policies, and processes. (Relevant topics include communication, crew resource management, work design, work systems, design of working times, teamwork, participatory design, community ergonomics, cooperative work, new work programs, virtual organizations, telework, and quality management.)

Environmental ergonomics is concerned with human interaction with the environment. The physical environment is characterized by climate, temperature, pressure, vibration, light.

There are more than twenty technical subgroups within the Human Factors and Ergonomics Society (HFES), which indicates the range of applications for ergonomics.

10.5 Applications

Human factors issues arise in simple systems and consumer products as well. Some examples include cellular telephones and other hand held devices that continue to shrink yet grow more complex (a phenomenon referred to as "creeping featurism"), millions of VCRs blinking "12:00" across the world because very few people can figure out how to program them, or alarm clocks that allow sleepy users to inadvertently turn off the alarm when they mean to hit 'snooze'. A user-centered design (UCD) or the usability engineering life cycle aims to improve the user-system. Ergonomic principles have been widely used in the design of both consumer and industrial products. Past examples include screwdriver handles made with serrations to improve finger grip, and use of soft thermoplastic elastomers to increase friction between the skin of the hand and the handle surface.

HF&E continues to be successfully applied in the fields of aerospace, aging, health care, IT, product design, transportation, training, nuclear and virtual environments, among others. Physical ergonomics is important in the medical field, particularly to those diagnosed with physiological ailments or disorders such as arthritis (both chronic and temporary) or carpal tunnel syndrome. Pressure that is insignificant or imperceptible to those unaffected by these disorders may be very painful, or render a device unusable, for those who are. Many ergonomically designed products are also used or recommended to treat or prevent such disorders, and to treat pressure-related chronic pain.

One of the most prevalent types of work-related injuries are musculoskeletal disorders. Work-related musculoskeletal disorders (WRMDs) result in persistent pain, loss of functional capacity and work disability, but their initial diagnosis is difficult because they are mainly based on complaints of pain and other symptoms. Every year 1.8 million U.S. workers experience WRMDs and nearly 600,000 of the injuries are serious enough to cause workers to miss work. Certain jobs or work conditions cause a higher rate worker complaints of undue strain, localized fatigue,

discomfort, or pain that does not go away after overnight rest. These types of jobs are often those involving activities such as repetitive and forceful exertions; frequent, heavy, or overhead lifts; awkward work positions; or use of vibrating equipment. The Occupational Safety and Health Administration (OSHA) has found substantial evidence that ergonomics programs can cut workers' compensation costs, increase productivity and decrease employee turnover. Therefore, it is important to gather data to identify jobs or work conditions that are most problematic, using sources such as injury and illness logs, medical records, and job analyses.

The emerging field of human factors in highway safety uses human factor principles to understand the actions and capabilities of road users - car and truck drivers, pedestrians, bicyclists, etc. - and use this knowledge to design roads and streets to reduce traffic collisions. Driver error is listed as a contributing factor in 44% of fatal collisions in the United States, so a topic of particular interest is how road users gather and process information about the road and its environment, and how to assist them to make the appropriate decision.

10.6 Practitioners

Human factors practitioners come from a variety of backgrounds, though predominantly they are psychologists (from the various subfields of engineering psychology, cognitive psychology, perceptual psychology, applied psychology, and experimental psychology) and physiologists. Designers (industrial, interaction, and graphic), anthropologists, technical communication scholars and computer scientists also contribute. Typically, an ergonomist will have an undergraduate degree in psychology, engineering, design or health sciences, and usually a masters degree or doctoral degree in a related discipline. Though some practitioners enter the field of human factors from other disciplines, both M.S. and PhD degrees in Human Factors Engineering are available from several universities worldwide. The Human Factors Research Group (HFRG) at the University of Nottingham provides human factors courses at both at MSc and PhD level including a distance learning course in Applied Ergonomics. Other Universities to offer postgraduate courses in human factors in the UK include Loughborough University, Cranfield University and the University of Oxford.

10.7 Weaknesses of HF&E methods

Problems in how usability measures are employed include the fact that measures of learning and retention of how to use an interface are rarely employed during methods and some studies treat measures of how users interact with interfaces as synonymous with quality-in-use, despite an unclear relation.

Although field methods can be extremely useful because they are conducted in the users natural environment, they have some major limitations to consider. The limitations include:

1. Usually take more time and resources than other methods
2. Very high effort in planning, recruiting, and executing than other methods
3. Much longer study periods and therefore requires much goodwill among the participants
4. Studies are longitudinal in nature, therefore, attrition can become a problem.