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## HUMAN FACTORS AND ERGONOMICS

Terms associated with "human factors" include "human characteristics," "human factors engineering," "ergonomics," "human engineering," and "the human element."

### **"Human Factors" Viewed as "Human Characteristics"**

The phrase "human factors" is often used to mean "human characteristics." Various human factors in this sense generally fall into one of three groups of human characteristics: (1) physical characteristics, (2) physiological characteristics, and (3) psychological or behavioral characteristics. These groups of human factors are not necessarily mutually exclusive. Here human factors defines the nature of our "humanness," that is, the characteristics of "being human."

Physical human factors include physical attributes of the human body such as height, weight, arm reach, center of gravity, etc. Physiological human factors include such things as muscle strength and endurance in different body positions, visual acuity, tolerance to extremes of temperature, frequency range of human hearing, etc. Psychological or behavioral human factors include things such as mental reaction time to various stimuli, various acquired meanings associated with certain colors (red often means "danger"), the capabilities and limitations of short term memory, "expectancy" as an element of perception, etc. In addition, there are cultural norms that must also be taken into account. For example, in the U.S. cultural environments, electrical switches go "up" to turn on and "down" to turn off; hot water valves are on the left of the faucet outlet and cold water valves are on the right; electrical dials turn clockwise to increase flow, but a fluid valve turned clockwise will decrease flow, etc.

As a scientist, the human factors specialist or engineer does not attempt to judge human factors as right or wrong, correct or incorrect. Rather, the human factors scientist merely attempts to

understand and define these factors, or human characteristics, so that their strengths and weaknesses, and their capabilities and limitations might be taken into account when designing systems where persons are to be an essential component, in the same way that a mechanical engineer must understand, define, and take into account the characteristics of physical materials included in a structural design.

### **Human Factors Engineering**

Human factors engineering is the discipline dedicated to optimizing the relationship between technology (system hardware and software) and the human operator of various systems. Any man-machine system can and should be the target of human factors engineering. Anywhere you find technology and people interacting, there is a need for human factors engineering. (Kantowitz, 1983, paraphrased)

During the design stage of system, product, and facility development, for the purposes of optimizing efficiency and safety, the human factors engineer is trained to take into account certain relevant human characteristics of the people who will operate or use such things, and then design such systems to be compatible with those characteristics. That is, a human factors engineer designs things to provide the "best match" between system user capabilities and limitations and the relevant system hardware components that impose physical, physiological, and/or psychological demands on such users.

A competent mechanical or civil engineer will design a structure to take advantage of the particular strength characteristics of the material being used for construction. A competent mechanical or civil engineer would not design a structure outside the strengths and limitations of the materials being used, as this would pose a foreseeable and unacceptable risk of structural collapse. In like fashion, a human factors engineer, or any engineer using human

factors engineering design principles, when designing a system that will contain a human component (such as a human operator), will design the system to "fit" or take advantage of the strongest and most effective human characteristics related to system requirements, and will not design a system that makes demands on human performance that are near or outside the areas of human strengths or the most effective human capabilities.

### **Ergonomics**

The terms ergonomics and human factors are often used synonymously. Both describe the interaction between the operator and task demands, and both are concerned with trying to reduce unnecessary stress and resulting injury to persons engaged in a certain activity or operating certain equipment. The term ergonomics originated as a European term while human factors is more often used in the United States.

Ergonomics has traditionally focused on how work affects people, while the emphasis in human factors (engineering) is on the design of systems that reduce the potential for system operation errors and prevent injury. Ergonomics may involve studies of physiological response to physically demanding work; environmental stressors such as heat, noise, and illumination; the performance of complex psychomotor tasks; and activity involving elements of visual-monitoring. The emphasis in ergonomics has been on ways to reduce fatigue by designing tasks within people's work capabilities. The goal of an ergonomics work program is to achieve the optimal match between persons doing work and the overall work environment.

### **Human Engineering**

Human engineering has been defined (similar to the term "human factors engineering") as a discipline concerned with designing man-made systems so that people can use them effectively and safely, and the creation of environments suitable for human living and work (Huchingson, 1981).

Human engineering is often used interchangeably with "human factors," or "human factors engineering." Unfortunately, it is a term that begs to be misinterpreted and should be avoided in light of better available terms such as "human factors" and "human factors engineering." The words and order of words used in this term can imply to the uninformed that it is the human that is to be "engineered," or "changed," rather than the system.

### **"Human Factors" Viewed as "The Human Element"**

The term "the human element," or "the human factor" is often heard in conversations of persons having little or no true knowledge of "human factors" or "human factors engineering." It is often used by persons to express their personal bias or prejudice concerning the behavior of certain people related to a specific event being examined. When something goes wrong, the term "the human element" is typically used as follows: "Well, what do you expect when you're dealing with 'the human element'?" In this sense, it is an attempt to blindly judge or blame people as being "idiots," or "stupid," or worse. It is also a term that typically is arrogantly intended to apply to everyone except the speaker. As such, it is a term that should not be used by human factors professionals.

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