

Defining ergonomics/human factors

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1 Introduction

The focus of this encyclopedia is ergonomics and human factors. The title *International Encyclopedia of Ergonomics and Human Factors* in some respects suggests that ergonomics and human factors are possibly two separate subject areas that are being covered. The conjunctive 'and' strongly supports this interpretation. If ergonomics and human factors were synonymous, why not just use one name? Several years ago, the main professional organization of this area in the United States decided to change its name by adding the term ergonomics. They also decided to add the conjunctive 'and.' It is now called the Human Factors and Ergonomics Society (HFES). If ergonomics and human factors are the same and there evidently was a desire to keep both names in the society's name, then why not use a slash instead of the 'and' and call it Human Factors/Ergonomics Society. And for that matter why not call this encyclopedia, the *International Encyclopedia of Ergonomics/Human Factors*? In fact, there is a journal that uses the slash instead of the conjunctive, *Human Factors/Ergonomics in Manufacturing* which happens to be edited by the same main editor of this encyclopedia (Prof. W. Karwowski). It is difficult to pronounce a slash (so it's silent), but probably to persons unfamiliar with the field would find even more strange sounding, hearing a string a three words and not knowing if one or two are adjectives. If you are going to keep both ergonomics and human factors in the name --'and' sounds better together.

Many professionals consider the terms ergonomics and human factors synonymous, although others do not necessarily concur. To some, ergonomics has a traditional relationship with the physical aspects of work, while human factors has a greater relationship to cognitive involvement. Ergonomics evolved from studying the interactions between humans and their surrounding work environment (with environment defined broadly to include machines, tools, the ambient environment, tasks, etc.). Use of the term human factors tends to be a North American

phenomenon with individuals who do work (research, teaching, practicing) that is most concerned with 'above the neck' processing (perceptual and cognitive processes, etc.). The rest of the world more frequently use the term ergonomics to include 'above the neck' processing as well as 'below the neck' processing. In the latter, the areas of biomechanics and physical workplace design are emphasized. The use of the term ergonomics in the United States typically implies 'below the neck' activities.

More recently in the United States, ergonomics has been added to names having the label human factors as ergonomics became better known (through mass market public media, such as advertising for cars and chairs). Also the superordinate organization, a level over the national and culture-specific organizations of the field, is called the International Ergonomics Association. Further, all of the worldwide societies use a form of the word ergonomics, not human factors.

Since ergonomics has been more closely allied with the physical aspects of the field, to better distinguish it from the more mental/cognitive part, there has been increasingly greater use of the label "cognitive ergonomics" versus "industrial or occupational ergonomics." Indeed a technical group in HFES has been formed using this name. There is also a journal, *International Journal of Cognitive Ergonomics*. Although there is some overlap in subject matter covered in them, one could contrast its name with another journal called the *International Journal of Industrial Ergonomics*. We expect to see greater use of the term ergonomics, but we also expect to see people distinguishing between the physical and cognitive sides of the field.

There appears to be a growing consensus that human factors and ergonomics refer essentially to a common body of knowledge. Despite this confluence, we still suffer from a lack of name recognition. The lay public, business, government and academics generally do not have much of an idea what the field is all about. Most individuals have little problem understanding what established areas like physics, chemistry, mathematics, and astronomy deal with. Like

similarly recognized subjects such as history and geography, these areas form the basis of school curricula. The relatively new field of psychology, which is about 100 years old, has become such a well recognized area that many high schools now offer courses in it. HF/E has this not reached this level of exposure. In fact, exposure to the field is rather scant even for students in colleges and universities. Martin and Wogalter (1987) examined the availability of HF/E courses to college students in the US. Fifty schools were selected randomly from each of four categories of universities and colleges (research, doctoral, masters, and baccalaureate/liberal arts) from a listing of four-year colleges and universities in the United States. Only 2% (one school) of the sample of liberal arts colleges and only 10% of the master's universities had a course in HF/E. Of the doctoral institutions, 62% had not a single HFE course, and 44% of the research institutions had no HFE courses. Other than a brief mention in a back chapter of an introductory psychology text book or of an industrial/organizational psychology text book, most college students have virtually no (or at best, scant) opportunity to learn about the field.

One obvious and crucial problem lies in the two predominant names that we have talked about above. Human factors is a general but indistinct term; one cannot derive from this name the content of the knowledge domain addressed. A lay person might guess that the field deals with human beings, but they probably would not recognize that it deals with (among other things) people interfacing with technology. Rather, the lay person might expect that a human factors psychologist deals with some special form of therapy or perhaps, person-to-person interaction (and interestingly, this is one of the few domains that human factors does not address). Also, an engineer who says their area is human factors will also have problems eliciting much understanding by lay persons either.

With the term ergonomics, the problems are different. One is that unfortunately, the word ergonomics is very close to economics; the two can easily be confused by listeners and readers.

But considering this differently, this resemblance can be turned into an advantage as did Hendrick (1996a) in his influential publication entitled “Good Ergonomics is Good Economics.”

The 'ergo' of ergonomics means work. The breadth of the field could be considered constrained by this suffix. Thus, how “work” is defined is critical. Many people may limit 'work' to mean activities associated with employment. This frame of reference would not include leisure pursuits, an area certainly covered by the field's intent. Work can, however, be interpreted broadly, as in its meaning the general physical expenditure of energy to accomplish a goal. Thus, most of what humans do (and their bodily processes) could be justifiably considered work, and thereby, ergo-related.

But what besides work and the involvement of humans define the field? Whatever the actual name, it should be asked how the area is bound, what is its unique knowledge content, what are its central theses, and how do we provide a concise, succinct statement that characterizes the area? Here, we address the definition question, not simply as another exercise in polemics, but rather as a fundamental evaluation of where our area stands at the start of a new millennium and to distill a way to advance our enterprise to a higher level of societal recognition and value.

One way to examine how an area embraces its domain is to see how it is being represented in various definitions. Definitions reflect how people specify some topic or concept using available language. Terms most frequently used to describe an area's scope can be a significant source of insight. In the present work, we extracted concise phrases describing HF/E from a previous work (Wogalter et al., 1998) that involved analysis of numerous definitions.

2 Method

Previously, we took the language from a set of 134 definitions from 78 sources compiled by Licht, Polzella, and Boff (1990), and supplemented them with another 56 definitions from 35 sources of various kinds including HF/E textbooks and brochures, World Wide Web sites,

introductory psychology, industrial/organizational psychology and safety engineering textbooks (Wogalter et al., 1998). Definitions selected were intended to describe the field circumscribed by one or more of the following names: ergonomics, human factors, human factors engineering, and engineering psychology. Some were short, dictionary type definitions (e.g., “the study of work” and “human-machine interface”); other were much longer accounts giving the contents and goals of the field. Example definitions are given in table 1.

Insert table 1 about here

In the process of limiting the final list to content words most frequently mentioned, the original set of definitions was first stripped of certain elements, such as connecting words (e.g., the, and, to, which) that were unlikely to reveal meaningful interpretation. Additionally, the basic names designating the field were deleted, e.g., the term 'ergonomics' was deleted if it appeared as part of the definition. The terms 'human factors', 'human factors engineering', and 'engineering psychology' were also deleted when they co-occurred in these specific sequences, but the terms themselves were retained if they occurred in other word contexts and sequences. The remaining terms were then sorted alphabetically. Words with identical prefix roots were combined when the ending/suffix did not change the basic meaning of the word. Words with high frequencies were then used to create definitions of moderate length that express the field of HF/E.

3 Results and Discussion

A high frequency of mention of specific words across the included 134 definitions suggests that they are meaningful components describing the field. By limiting the terms to these and combining them, basic or core definitions of the field can be formed. Moderate frequency terms could be used elaborate the definitions with additional terms that include the methods, goals, and

other details. One example is: HF/E involves the application of engineering design to the study and production of safe and efficient human-machine systems. Other examples include Chapanis' (1995) and Wickens' (1992) definitions in table 1. A few additional examples of moderate length appear in Table 2. Try making your own definitions from the terms. It really is an interesting and illuminating exercise.

Insert Table 2 about here

In Table 3 we have categorized the set of terms in another way. Here there is a smaller set of categories under the headings who, what, how, when/where, and goal. A quick study of this categorization undoubtedly inspires a well-suited definition or two. The table also provides a concise set of reference terms for describing our field to others.

Insert Table 3 about here

Across the entire set of definitions, the statements reflect a diversity in detail and purpose, varying in how much is given on the field's content, methods, and goals. Sometimes it was difficult to tell whether the wording was actually a definition. We tended to be liberal in accepting wording as a definition that under different criteria would not be considered as a true definition, but rather a description of methods or goals.

A recent survey and a series of focus groups in the United States (Hendrick, 1996b) revealed that one of the primary complaints of HFES members was that untold numbers of people outside of the field know little, if anything, about our field. As we discussed at the outset, part of the problem has been our name, but also some of the problem may be that our definitions are not user-friendly. While we formed some of the word groupings and definitions ourselves (which

undoubtedly reflect some of our own personal biases), they were not produced considering the varied population groups to whom they may be proffered. Using the word lists, a different set of definitions could be formed to target different recipient groups (e.g., lay persons vs. engineering/science experts). In fact, we believe you can tailor a definition to an audience you are speaking to or working with.

Technology is a powerful single force that is shaping human behavior. Too often, technology is 'mindless' with respect to the individuals who either use it or are affected by it. A small but growing group of professionals seek to mediate between growing technical systems and their human users. As technology becomes complex, there needs to be even greater efforts in HF/E to enable synergistic relationships. Such an effort will be crucial to the path of true technological progress in the coming years. In order to play its role more effectively, the field needs a clear, concise unequivocal and usable term to describe our efforts. We suspect that the term ergonomics will take that role, along with adjectives of physical and cognitive.

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Table 1. Example Definitions.

Brown, O., and Hendrick, H. W. (1986)

. . . the relations between man and his occupation, equipment, and environment in the widest sense, including work, play, leisure, home, and travel situations.

Chapanis, A. (1995)

. . . is a body of knowledge about human abilities, human limitations and other human characteristics that are relevant to design.

Hancock, P. A. (1997)

. . . is that branch of science which seeks to turn human-machine antagonism into human-machine synergy.

Mark, L. S., and Warm, J. S.. (1987)

. . . attempts to optimize the fit between people and their environment..

Howell, W., and Dipboye, R. (1986).

Person-machine system design.

Meister, D. (1989)

. . . the application of behavioral principles to the design, development, testing and operation of equipment and systems.

Clark, T. S. and Corlett, E. N. (1984)

. . . study of human abilities and characteristics which affect the design of equipment, systems, and jobs and its aims are to improve efficiency, safety, and well being.

Sanders, M. S., and McCormick, E. G. (1993)

. . . designing for human use.

Wickens, C. D. (1992)

. . . is to apply knowledge in designing systems that work, accommodating the limits of human performance and exploiting the advantages of the human operator in the process.

Table 2. Moderate-length Definitions form from the most frequent terms.

- (a) Designing and engineering human-machine systems.
 - (b) Applying science to people performing in working environments.
 - (c) Studying man's limited capabilities related to safe job operation
 - (d) Improving knowledge on the fit between users and tasks.
 - (e) The interface between people and machines in systems.
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Table 3. *A Short List of Terms Assigned to a Simple Category Structure Describing Human Factors/Ergonomics.*

<i>Who</i>	<i>What</i>	<i>How</i>	<i>When/Where</i>	<i>Goal</i>
human	system	engineering	environment	safety
people	machine	designing	work	comfort
users	equipment	applying	life	efficiency
person	product	studying		
	technology	optimizing		
