On the Description and Definition of Human Factors/Ergonomics

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ABSTRACT

This work examines the terms most frequently used to describe our field, which has variously been named Ergonomics, Human Factors, Human Factors Engineering, and Engineering Psychology. A large number of definitions were collected, including those assembled in an earlier technical report by Licht, Polzella, and Boff (1990). First, the definitions were stripped of connector words. Second, the prefix root terms that had the same meaning were combined and third, the words were tabulated and sorted to reveal the content terms most frequently employed. These data may be used to develop core, concise definitions or longer more expository descriptions of the field. The list of terms could also be used as a starting point for the development of definitions oriented for different target audiences (e.g., lay persons vs. other engineering/science experts) as a method of disseminating information concerning what we do.

INTRODUCTION

At the mid-point of our century, one of the more interesting academic texts was Oakley's (1949) "Man the Tool-maker." Oakley's proposition was that tool use was a defining characteristic of human beings. Even the partial acceptance of this interesting postulate makes it clear that a comprehensive understanding of ourselves must include a detailed evaluation of tools, technology, and the way these artifacts affect the people we are now and will be in the future. At about this same time, scientific societies were being founded in Europe and the United States devoted to this understanding, and today one of the collective strengths of the field is a growing consensus that the different labels such as "Human Factors" and "Ergonomics" refer essentially to a common body of knowledge. Despite this scientific progress, at a general societal level we still suffer from a lack of name recognition. Today, academicians and lay-public alike have little problem understanding what established subjects like physics, chemistry, mathematics, and astronomy deal with. Indeed, alongside similarly recognized subjects such as history and geography, these areas form the basis of many curricula in high school and even grade school. It may well be the imprimatur of acceptance that a subject is taught at these levels. For example, psychology is a well recognized subject that today one can take high school courses in, a subject that in its experimental form is barely one hundred years old. Neither Human Factors or Ergonomics has this level of exposure.

One crucial problem with our area lies in the two predominant names. Human factors is general but indistinct; one cannot derive from this name the content of the knowledge domain addressed. Although one could claim the same thing for say physics itself, the name has been established to such an extent and for such a time that the latter problem essentially does not arise. With ergonomics, the problems are different. Unfortunately, the word ergonomics is so close to economics that the two can easily be confused, especially in the lay mind. Of course, this similarity might be used to an advantage such as in Hendrick's (1996a) linkage entitled "Good Ergonomics is Good Economics." If ergonomics concerns the laws of work, how "work" is defined is critical. While work can interpreted broadly (e.g., the expenditure of energy to accomplish a goal), many people limit it to dealing with their employment. This frame of reference would not include people's interactions with technology in leisure pursuits, an area certainly covered by our field's intent. It should be noted that ergonomics evolved as a discipline in both Europe and the United States from studying the interactions between humans and their surrounding work environment (with environment defined broadly to include machines, tools, ambient environment, tasks, etc.). Many of the analysis and methodological techniques we use today were developed from the early study of manual work.

Underlying each of these concerns is the fundamental question of definition. 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 which 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.

One way to examine how an area embraces its domain is to see how it is being explicated in definitions. The definitions reflect how people specify some topic or concept using available language. Terms most frequently used to describe the area's scope can be a significant source of insight. In the present study we used a large number of definitions and tabulated the content words and foundational data.

METHOD

Language was taken from a set of 134 definitions from 78 sources compiled by Licht, Polzella, and Boff (1990) in an unpublished technical report. This list was supplemented by another set of 56 definitions collected by the present authors. These were taken 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. 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.

The set of definitions was stripped of certain elements, such as connecting words, in the process of limiting the final list to content words most frequently mentioned. First, the names designating the field (cited above) were deleted from the definition text, 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 definitions were also stripped of terms unlikely to reveal meaningful interpretation from their content or meaning. Most of these are common connector type words. The words were then sorted. Similar words were combined that had an identical prefix root and where the ending/suffix did not change the basic meaning of the word.

RESULTS AND DISCUSSION

Table 2 shows the content words rank ordered according to their frequency of occurrence in the set of definitions. Ending/suffix components are shown in parentheses. As the table indicates, certain words, e.g., human, design, system, machine, work, engineering, and applied are the most

Table 1. Example Definitions.

Chapanis, A. (1995)

. . . uses knowledge of human abilities and limitations to the design of systems, organizations, jobs, machines, tools, and consumer products for safe, efficient, and comfortable human use.

Hancock, P. A. (1997)

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

Helander, M. G. (1997)

. . . is the scientific discipline concerned with the interaction between humans and artifacts and design of systems where people participate. It deals with design of systems that people use at work and in leisure, tools that are used and procedures and practices. The purpose of the design activities is to match systems, jobs, products and environments to the physical and mental abilities and limitations of people.

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

Person-machine system design.

Meister, D. (1989)

. . . is the study of how humans accomplish work-related tasks in the context of human-machine system operation and how behavioral and nonbehavior variables affect that accomplishment.

The New Encyclopedia Britannica (1986)

...application of information on physical and psychological characteristics to the design of devices and systems for human use. Its data and principles apply to activities of the home, the workplace, and recreation." (p. 136)

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

. . . has two major objectives. The first is to enhance the effectiveness and efficiency with which work and other activities are carried out. Included here would be such things as increased convenience of use, reduced errors, and increased productivity. The second objective is to enhance certain desirable human values, including improved safety, reduced fatigue and stress, increased comfort, greater user acceptance, increased job satisfaction, and improved quality of life.

. . . designing for human use.

. . . discovers and applies information about human behavior, abilities, limitations, and other characteristics to the design of tools, machines, systems, task, jobs, and environments for productive, safe, comfortable, and effective human use.

Table 2. Words from Definitions Ordered by Frequency (frequency > 2).

human	180	beings	8	designer(s)	4
design(ing)(s)	114	branch	8	device(s)	4
system(s)	104	control(s)(ling)	8	effect(s)	4
machine(s)(ry)	69	focus(es)(ing)	8	ensure	4
work(ing)	68	integrat(es)(ed)(ion)	8	exploit(ed)(ing)	4
engineering	64	measure(d)(ing)(ment)	8	inten(t)(ded)	4
environment(al)(s)	58	minim(ize)(izing)(um)	8	interdisciplin(e)(ary)(arian)	4
appl(ied)(ly)(ies)(ying)(ications)	57	new(er)	8	match(ed)(ing)	4
equipment	55	problem(s)	8	maximiz(e)(ing)	4
us(e)(ing)(es)	52	sense(s)	8	only	4
perform(ed)(ing)(ance)	48	specif(y)(ied)(ing)(ic)(ication)	8	place(s)	4
scien(ce)(ces)(tific)	48	theory(ies)(ized)	8	play	4
people('s)(s')	45	things	8	psychosocial	4
job(s)	37	variables	8	service(s)	4
limit(ed)(s)(ations)	34	aim(ed)(s)	7	support(ive)	4
man('s)	32	broad(er)	7	synonymous	4
operat(ed)(ion(s))(ional)(ionally)	32	enhanc(e)(ing)	7	systematic	4
safe(r)(ly)(ty)	32	error(s)	7	understand(ing)	4
capa(bilities)(cities)	31	experimental(ation)	7	aids	3
stud(y)(ies)(ing)	31	facilities	7	based	3
efficien(tly)(cy)	30	group(s)	7	being	3
characteristics	29	individual(s)	7	biomedical	3
discipline(s)	28	medic(al)(ine)	7	complex(ity)	3
optim(al)(um)(ize)(izing)(ization)	27	methods	7	consumer	3
effective(ly)(ness)	25	particular(ly)	7	contribut(ing)(ions)	3
product(s)	25	person(s)	7	describe(s)	3
psycholog(y)(ical)	25	relate(s)(d)	7	desir(ed)(able)	3
relation(s)(ships)	25	satisf(ying)(action)	7	determin(e)(ing)(ations)	3
behavior(al)(s)	24	stress	7	discover(s)(ing)	3
fit(ting)	23	used	7	draw(n)(s)	3
task(s)	23	worker(s)('s)(s')	7	elements	3
user(s)('s)(s')	23	adap(ing)(tion)	6	eliminat(e)(ing)	3
know(n)(ledge)	22	anthropolog(y)(ists)	6	facts	3
improv(e)(ed)(ment)(ing)	20	aspects	6	fatigue	3
physical	20	body	6	framework	3
physiolog(y)(ical)(ically)	18	emphas(is)(es)(ized)	6	general	3
li(fe)(ve)(ving)	17	help(s)	6	great(er)	3
principle(s)	17	organization(s)	6	home	3
consider(ed)(ations)	16	reduce(d)	6	important(ly)	3
function(al)(ing)(s)	16	result(s)(ing)(ant)	6	include(s)(d)	3
research	16	suit(ed)(able)(ability)	6	interface	3
data	15	take(n)(s)(ing)	6	involve(ment)(s)	3
tool(s)	15	accept(able)(ance)(ability)	5	itself	3
information	14	accommodat(e)(ing)	5	leisure	3
man-machine	14	accomplish(ment)	5	lighting	3
comfort(able)(ly)	13	accura(cy)(tely)	5	manufacture(d)(ing)	3
goal	13	analy(sis)(ze)	5	means	3
technology(ical)	13	better, best	5	method(ology)(ologies)	3
develop(ed)(ing)(ment)	12	component(s)	5	model(s)	3
evaluation	12	conditions	5	multidisciplinary	3
field	12	follow(s)(ing)	5	order	3
interact(ion)(s)	12	health(-care)	5	output	3
proce(dures)(sses)	12	out	5	practical(ity)	3
abilit(y)(ies)	11	part(s)(ial)	5	predict(ion)	3
activ(ely)(ity)	11	possible	5	proper	3
biolog(y)(ical)	11	practice(s)	5	psychologist(s)	3
engineer(s)	11	purpose	5	quality	3
factors	11	role(s)	5	situation(s)	3
operator(s)	11	seek(s)	5	skill(s)	3
personnel	11	select(ed)(ing)(ion)	5	solution(s)	3
productive(ity)(iveness)	11	speed	5	spatial	3
workplace	11	various(ly)	5	techniques	3
increase(d)(s)(ing)	10	advantage(s)	4	tolerance(s)	3
maintain(ing)(s), maintenance	10	approach	4	total	3
objective(s)	10	attempts	4	traditional(ly)	3
industrial	9	bas(is)(es)	4	turn(s)	3
profession(al)(s)	9	cognitive	4	validly	3
requir(ed)(es)(ments)	9	combin(es)(ation)	4	varie(d)(ty)	3
training	9	cover(ing)	4	well-being	3
anatom(y)(ical)(ists)	8	creat(ing)(ion)	4		
area	8	dealing	4		

frequently-used terms in the definitions. These terms capture the essence of the field. Their meaning also points out the field's broad scope. Terms can be pulled from this list to form new definitions. High frequency terms could be used to form basic or core definition, perhaps limited to a few words. Moderate frequency terms could be used fill out the definitions with goals, methods, and examples.

A few points regarding this descriptive analysis deserve mention. The definitions reflect the opinions of numerous experts on what the area is about. Nevertheless, their ideas undoubtedly reflect some individual biases. However, truly peculiar definitions and the language they contain would be washed out because they contain terms less frequently mentioned by others. Additionally, some definitions had nearly identical wording. This could be partly due to some authors using other authors' definitions as the basis of forming their own. Alternatively, and perhaps more likely, the highly frequent terms actually do reflect core aspects of the field. Given the authoritative, expert nature of the list of authors who wrote the definitions and the inherent reliability of this kind of frequency analysis, we believe that the collated results have considerable validity.

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 some criteria would not be considered as a true definition, but rather a description of methods or goals.

The words in Table 2 could be combined further. Some combinations could be made without disagreement (e.g., "person" with "human"). However, others (e.g., "physical" with "physiological") would not receive unanimous agreement, revealing the process's subjective nature. An analysis of synonyms would be useful in making further combinations. At this point it would seem appropriate to allow readers to combine sets of terms as they deem fit.

A recent survey and a series of focus groups (Hendrick, 1996b) revealed that one of the primary complaints of members of the Human Factors and Ergonomics Society (HFES) was that many people outside of the field know little, if anything, about our field. The membership provided feedback directing the Society to use more of its resources to educate and publicize the field to relevant target audiences (e.g., industry and government). As we discussed at the outset, part of the problem has been our name, but also some of the problem might be that our definitions are not user-friendly. Using Table 2's word list, alternative definitions could be formed that are targeted to different recipient groups (e.g., lay persons vs. engineering/science experts). Usability testing of the definitions themselves could assist in the production of targeted definitions that would facilitate understanding of our field by others. Certainly, the tools and techniques of our field should be applied to the process of communicating information about ourselves.

As we have said earlier, the terms could be used to from core definitions. For example, using the four most frequent terms in Table 2 produces 'designing human-machine systems' or 'human-machine systems design.' More elaboratively, our pursuit includes the 'application of engineering design to the study and production of safe and efficient human-machine systems.' We strongly encourage others to pursue structured evaluation of these terms for the development of our discipline and our vocation.

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