

The Exposure of Undergraduate Students to Human Factors/Ergonomics Instruction

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ABSTRACT

The present study examined the availability of human factors/ergonomics courses to students in the U.S. Fifty schools were selected randomly from each of four categories of universities and colleges (Research I and II, Doctoral I and II, Masters I and II, and Baccalaureate/Liberal Arts I and II). Only one human factors/ergonomics (HFE) course was found in the sample of liberal arts colleges and only 10% of the master's universities had such a course. Of the doctoral institutions 62% had no HFE courses and 44% of the research institutions had no HFE courses. The possible reasons for these results are discussed as well as some possible actions that might be taken within the context of the Human Factors and Ergonomics Society's strategic plan to ameliorate this problem and expose students in higher education environments to the field, not only for the students' benefit but also for the discipline.

INTRODUCTION

In recent years the Human Factors Society changed its name to include ergonomics in part to acknowledge that the latter term has become better known than human factors (now, of course, called the Human Factors and Ergonomics Society or HFES). Indeed the field has been a relatively unknown discipline because the name human factors is not one that describes the field unambiguously. However, even with the increased use of the term ergonomics, it is not clear that the general public will become aware of the broad range of goals and activities comprising the field.

The lack of knowledge and misunderstanding of the field might, in part, be attributable to a paucity of publicity and education. People seeing furniture or automobile advertisements describing the comfort of a chair or the placement of controls on an automobile dashboard may think that ergonomics is limited to those narrow areas. That is, they may not realize the discipline's breadth. Recently, HFES has been moving forward on the development of a strategic plan that is partly a result of an extensive series of focus groups and questionnaires involving the membership (Hendrick, 1996). An overwhelming number of members emphasized the need for greater public, private sector, and government awareness of the field. One way of educating people about any field, including ergonomics, is through college courses.

Within psychology the first opportunity to expose students to human factors/ergonomics (HFE) would be in a survey-level course such as Introduction to Psychology, one of the largest enrollment courses at most universities. Unfortunately, most instructors for these courses know little

about HFE and would be encouraged to mention the topic only if their textbook dealt with HFE. In a non-random sample of 19 current introductory psychology texts (the one's we had on our shelves) we found that 10 had essentially no coverage of any applied topics. One had a two line definition of engineering psychology under a discussion of fields of psychology. Another had a two line mention of industrial/organizational (I/O) psychology in a chapter on motivation. Seven books had some form of applied psychology chapter all of which covered I/O psychology. Two of these failed to mention HFE; three of those that did, clearly identified it as a sub-field of I/O psychology although, to their credit, one gave it three pages and the another gave it six pages of coverage. The two books that identified the HFE area as a separate sub-discipline and gave it considerable coverage are by authors (Baron, 1995; Kalat, 1996) who are faculty members in departments having graduate programs in the area (Rensselaer Polytechnic Institute and North Carolina State University, respectively). These data confirm that students in the typical introduction to psychology course are likely to exit the course knowing as little about human factors as when they entered.

Some schools, of course, offer graduate education in human factors/ergonomics. Undergraduates at these schools have the good fortune of having HFE faculty who can teach an undergraduate course. However, these schools are a small fraction of the schools of higher learning in the U.S. Examination of the most current HFES (1996) directory shows that most universities and colleges in the U.S. do not have a single member in the Society. While lack of membership in HFES does not necessarily mean that there are no qualified faculty who could teach HFE, it is one indicator

that there may be no willing or properly trained faculty to teach such a course. In some cases departmental resource limitations might prevent the teaching of any specialized, non core courses outside of the mainstream of the departments.

It is possible, then, that most undergraduates in the U.S. have absolutely no academic exposure to human factors/ergonomics as a field of study. They may not know that the study of HFE exists, and therefore would not consider it a potential option for further study. Perhaps more importantly, those graduates entering other fields who might need the assistance of a human factors specialist or ergonomist might not know that such help is readily available.

The purpose of the present study was to determine the availability of courses in HFE that would allow undergraduate students more than a passing exposure to the field.

METHOD

Using the Carnegie Foundation's (1994) Classification of Institutions of Higher Education, samples of institutions of higher learning from four categories were selected. The university and college classifications include the categories: Research I and II, Doctoral I and II, Master's I and II, and Baccalaureate/Liberal Arts I and II. The assignment of colleges and universities to these categories is based on the definitions described in Table 1. For the purposes of this study, we collapsed across the I & II distinctions to form four categories: Research, Doctoral, Master's and Baccalaureate (Liberal Arts). The Carnegie Foundation categories of Associate of Arts Colleges (e.g. junior and community

colleges) and Specialized Institutions (e.g. theological seminaries, medical schools) were not examined in this study.

The institutions within each category were assigned a number and using a random number table 50 institutions were selected thereby giving an unbiased sample of all institutions contained in each category. For the selected institutions, the most current college catalog was searched using microfiche records (most college libraries purchase a subscription to this service). The catalog information was examined to determine whether there were courses listed that deal primarily with issues concerned with HFE.

Courses were examined in the departments of psychology, industrial engineering, computer science, and design (if the institution had these departments). Course titles could include some or parts of the following terms: human factors, ergonomics, human- (man)-machine systems, engineering psychology, human engineering, applied experimental psychology human performance (not in a physical education context), human technology interaction, human-centered technology, aviation psychology, human-computer interaction, user interface design, or any mix or combination of these terms. Pages of the catalogs that described these courses were photocopied (including the department, course number, and descriptive summary of the course content, if given)

RESULTS

Disregarding type of institution, approximately one fourth offer a HFE course at some level (see Table 2). In the institutions having HFE courses, the number offered varies

Table 1. *Definitions of University and College Categories from the Carnegie Foundation (1994) Classification (collapsed across I and II categories).*

The 1994 Carnegie Classification includes all colleges and universities in the United States that are degree-granting and accredited by an agency recognized by the U.S. Secretary of Education

Research Universities: These institutions offer a full range of baccalaureate programs, are committed to graduate education through the doctorate, and give high priority to research. They award 50 or more doctoral degrees each year. In addition, they receive annually \$15.5 million or more in federal support.

Doctoral Universities: These institutions offer a full range of baccalaureate programs and are committed to graduate education through the doctorate. They award annually at least ten doctoral degrees—in three or more disciplines—or 20 or more doctoral degrees in one or more disciplines.

Master's (Comprehensive) Colleges and Universities: These institutions offer a full range of baccalaureate programs and are committed to graduate education through the master's degree. They award 20 or more master's degrees annually in one or more disciplines.

Baccalaureate (Liberal Arts) Colleges: These institutions are primarily undergraduate colleges with major emphasis on baccalaureate degree programs.

Table 2. Number of institutions offering at least one course in human factors/ergonomics and the department and curriculum level. Fifty schools in each institutional category were sampled ($N = 200$).

| Institutional Category | Any Course | Undergraduate | | | Graduate | | |
|---------------------------|------------|---------------|-------------|---------------------|------------|-------------|---------------------|
| | | Psychology | Engineering | Computer Science | Psychology | Engineering | Computer Science |
| Baccalaureate | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| Masters | 5 | 2 | 1 | 1 | 0 | 1 | 2 |
| Doctoral | 19 | 10 | 7 | 3 | 6 | 6 | 2 |
| Research | 28 | 15 | 14 | 14 | 4 | 4 | 6 |
| TOTAL | 53 | 27 | 23 | 18 | 10 | 11 | 10 |

extensively (ranging from 1 to 20 courses with a median of 2). Forty-six (23%) offer at least one undergraduate course and 23 (11.5%) offer at least one graduate course. At the undergraduate level a few more psychology departments offer courses than engineering departments and a few more of these offer courses than computer science departments. At the graduate level about the same number of departments in each of these disciplines offer such courses.

At the baccalaureate (liberal arts) colleges only one course was found that could be classified as being related to HFE and judging by the description, it is a course in safety. Five of the masters institutions (10%) offer a HFE course. Of doctoral institutions 19 (38%) offer a HFE course while 28 (56%) of the research institutions offer such a course.

Using the course titles and descriptions we loosely categorized the courses as being human factors (wide coverage of topics including cognitive and physical issues), ergonomics (primary emphasis on work and biomechanics), or human-computer interaction (emphasis on human-computer hardware and software interface issues). As shown in Table 3, in psychology departments most courses cover general human factors with a few departments also offering a human-computer course. Even in engineering departments courses typically cover general human factors. Only two engineering departments at the undergraduate level and two at the graduate level offer only a more limited ergonomics course. Not surprisingly, computer science departments offer courses only in human-computer interaction.

DISCUSSION

In the vast majority of cases, undergraduate students have no opportunity to learn about the field of HFE. Only 23% of

the institutions sampled had at least one HFE course at the undergraduate level. Even in doctoral and research institutions the number of universities that do not offer a single HFE course at any level is surprisingly high (62% and 44%, respectively).

Why is HFE so poorly represented compared to an area such as I/O psychology? One possibility is that students are simply not interested in taking such a course. Our experience indicates that this possibility is unlikely. One of us teaches an introductory course in which a full lecture is devoted to the topic. Compared to most other topics more students come up after the class and remark that they find this topic particularly interesting. Engineering students, in particular, often say that they wish they had known about this area earlier in their undergraduate career because it is something that they might have wished to pursue.

A second possibility is that the area is too specialized to warrant a full course. However, this argument would seem to be equally valid for I/O psychology, a course which is much more widely available. While HFE and I/O might be considered too specialized by liberal arts colleges, at such institutions HFE could easily be included in a general course in applied psychology that includes other topics such as sport psychology, etc. Unfortunately, however, applied psychology is another course seldom taught in psychology departments.

A third possibility is that the majority of psychologists are ignorant about the existence of the HFE field. While possible, it seems unlikely that so many of our colleagues would be so ill-informed particularly in departments that have a course in I/O psychology. A fourth possibility seems most likely to us, that most departments simply do not have a

Table 3. The number of human factors/ergonomics courses at the sampled institutions categorized as general human factors, ergonomics, or human-computer interaction as a function of discipline offering the course (psychology, engineering, computer science) and curriculum level (undergraduate and graduate).

| | Undergraduate | | | Graduate | | |
|------------------|---------------|------------|----------------------------|---------------|------------|----------------------------|
| | Human Factors | Ergonomics | Human-Computer Interaction | Human Factors | Ergonomics | Human-Computer Interaction |
| Psychology | 25 | 1 | 4 | 8 | 0 | 4 |
| Engineering | 20 | 7 | 1 | 8 | 2 | 2 |
| Computer Science | 0 | 0 | 18 | 0 | 0 | 10 |

person on staff who feels capable of teaching such a course. In the I/O area even if there is not a faculty member on staff who specializes in I/O, there is often a faculty member, such as a social psychologist, who has at least had a course in the area or is familiar enough with a number of the topics (e.g. organizational psychology, motivation, leadership) to feel comfortable teaching the course. However, faculty, even those in experimental psychology, may feel that they do not know enough about HFE to teach a course, particularly given the multidisciplinary nature of some of the material. There are probably very few faculty teaching an undergraduate HFE course who do not consider themselves specialists in the area.

Given that the HFES wishes to more fully inform people about the field and that undergraduate education is one medium for doing so, what solutions are available for adding HFE to the undergraduate curriculum? At the introductory textbook level, one possibility would be to inform authors of the problem and to offer them material that would make it easy to include the topic in future editions of their books. We think it is not accidental that the two authors with the most complete coverage of this topic are associated with departments having HFE graduate programs. They understand the importance of the topic and have colleagues who can provide them with material if necessary. Perhaps the HFES could play that role for other authors.

What might be done to encourage the teaching of a HFE course in undergraduate curricula at more institutions of higher education? If the problem is, as we suspect, a shortage of trained faculty, one possibility would be to provide appropriate materials and training programs for faculty from allied areas. It might be possible, for instance, to institute a two-week summer course designed to prepare a faculty member from experimental or I/O psychology to teach a basic course in HFE. Material could be provided to serve as the basis for each class lecture (e.g. multi-media, lab demos, etc.).

A second possible way to provide courses for institutions lacking appropriately trained faculty would be for HFES to provide or subsidize some form of distance learning. For example, several standard basic undergraduate courses having different emphases could be created and sold to colleges and universities utilizing either a site license or a per student charge. Depending upon the demand and costs, the courses could range from prepackaged videotapes to interactive internet access with a live instructor. The latter type of course might even include virtual field trips to appropriate sites that illustrate HFE principles and solutions.

In short, we are proposing that the HFES needs to think about ways to encourage an expanded coverage of HFE in the undergraduate curriculum of institutions of higher education nationally. Unless institutions expand their coverage we feel that the general populace will not understand the importance of what we do, and our field will suffer the consequences.

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