Human Factors Specialists'Education and Utilization: Results of a Survey

Harold P. Van Cott and Beverly Messick Huey, Editors; Panel on Human Factors Specialists'Education and Utilization, National Research Council

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Panel on Human Factors Specialists' Education and Utilization
Robert C. Williges, Chair
Committee on Human Factors
Commission on Behavioral and Social Sciences and Education
National Research Council

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PANEL ON HUMAN FACTORS SPECIALISTS' EDUCATION AND UTILIZATION

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COMMITTEE ON HUMAN FACTORS

Foreword

The Committee on Human Factors was established in October 1980 by the Commission on Behavioral and Social Sciences and Education of the National Research Council. The committee is sponsored by the Office of Naval Research, the Air Force Office of Scientific Research, the Army Research Institute for the Behavioral and Social Sciences, the National Aeronautics and Space Administration, the National Science Foundation, the Air Force Armstrong Aerospace Medical Research Laboratory, the Army Advanced Systems Research Office, the Army Human Engineering Laboratory, the Federal Aviation Administration, and the Nuclear Regulatory Commission. The principal objectives of the committee are to provide new perspectives on theoretical and methodological issues, to identify basic research needed to expand and strengthen the scientific basis of human factors, and to attract scientists both inside and outside the field for interactive communication and needed research.

Human factors issues arise in every domain in which humans interact with the products of a technological society. To perform its role effectively, the committee draws on experts from a wide range of scientific and engineering disciplines. Members of the committee include specialists in such fields as psychology, engineering, biomechanics, physiology, medicine, cognitive sciences, machine intelligence, computer sciences, sociology, education, and human factors engineering. Other disciplines are represented in the working groups, workshops, and symposia organized by the committee. Each of these disciplines contributes to the basic data, theory, and methods required to improve the scientific basis of human factors.

Acknowledgments

The activities of the panel and the preparation of this report are a special achievement, in light of the circumstances under which they occurred. The panel was established with Oscar Grusky and myself as cochairs. Just prior to the initiation of our work, I was involved in a serious automobile accident. My extensive hospitalization and rehabilitation precluded my participation in most of the panel deliberations. Oscar Grusky graciously accepted all the responsibilities of chairing the panel throughout my recovery. Unfortunately, personal responsibilities required that he resign from the panel shortly after my return to professional activities.

In addition to the effort and contributions of each member of the panel, six resource people participated in meetings addressing questionnaire development. These people included Earl Alluisi, assistant for training and personnel technology at the Pentagon; Thomas McCloy, associate professor and deputy for human factors at the United States Air Force Academy; John O'Brien, of the Human Factors Research Division, Electric Power Research Institute; Judith Olson, associate professor in the Graduate School of Business Administration, University of Michigan; Brian Peacock, human factors head at General Motors Corporation; and Ben Schneiderman, professor in the Department of Computer Science, University of Maryland. Their contribution is gratefully acknowledged.

This report is unusual in that its conclusions are based on the results of a survey of human factors specialists that was conducted for the study panel by the Survey Research Laboratory of the University of Illinois at Urbana-Champaign. Seymour Sudman directed all the survey activities, provided an initial summary of results, and was extremely responsive to additional information requests of the panel members. Staff member Beverly Huey diligently conducted subsequent analyses of the survey data as needed by the panel and provided documentation for the statistical command files. The Close Combat (Light and Heavy) Division of the Human Engineering Laboratory, Aberdeen Proving Ground, Maryland, provided access to their facilities for the follow-up analyses. Three panel members, Douglas Harris, Mark Sanders, and Richard Pew, accepted the major responsibility for summarizing and interpreting the survey results for the panel. Their summaries are presented in Chapters 3, 4, and 5, respectively, of this report.

The diversity of authorship and the integration of survey results and analyses required a major editing responsibility. Beverly Huey and Harold Van Cott expertly provided the necessary technical editing.

As chair of this study panel, I gratefully acknowledge the unselfish efforts of each of these individuals as well as the thoughtful deliberations and contributions of all our panel members. Without such a coordinated effort, we would not have been able to complete our study panel activities.

Robert C. Williges
Chair, Panel on Human Factors Specialists'Education and Utilization

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Human Factors Specialists' Education and Utilization

Summary

This report is concerned with human factors specialists: the men and women who do human factors research and apply human factors data and principles to design. It asks: What do these specialists do? Where and how do they do it? How are they educated and trained, and what is the quality of these experiences? Do the education and training obtained meet the needs of employers? Will the supply of human factors specialists match expected demand? What needs to be done to improve the training and use of human factors specialists?

To answer these questions the Panel on Human Factors Specialists' Education and Utilization designed and commissioned two surveys. One, a mail-in questionnaire, was sent to the directors of the 65 university graduate programs in human factors in the United States and Canada asking them to describe their programs. The other, a computer-assisted telephone interview, queried human factors specialists and supervisors about their professional and job-related activities and education.

The panel gave careful attention to the design and pretesting of the questions in both surveys and, in the case of the specialists survey, to the sampling frame because it defined a human factors specialist and determined who was eligible to be interviewed.

The response rates to both surveys were higher than typically encountered. Of those invited to participate in the telephone interview, only about 10 percent declined; and 75 percent of the graduate programs supplied the program information requested in the mail-in survey.

SELECTED FINDINGS

Characteristics and Use of Human Factors Specialists

Type of Employer

Except for specialists who are psychologists, most human factors specialists (76%) work for private business; the rest work for government (15%) and education institutions (10%). Most psychologists in human factors are employed by government (41%) or private business (47%).

Focus of Work

The majority (60%) of human factors specialists work in just three areas: computers, aerospace, and industrial processes. Other areas—health and safety, communications, transportation, energy, consumer products, and office products —account for an additional 27 percent, with no other area accounting for more than 0.5 percent of the sample. A large amount of human factors work is performed for military purposes, with military aerospace, computer, communications, and transportation human factors work accounting for at least half of the work performed by 30 percent of the specialists sampled. Much of this military work was done under one of the new Department of Defense programs (for example, MANPRINT) that emphasizes human-centered design.

Work History

Most human factors specialists (70%) have held their present position for five years or less and 39% of them for two years or less. This pattern is consistent across types of employers, areas of work, extent of military work, and gender. The previous position of most of the specialists sampled (63%) was primarily concerned with human factors and was with the same employer (44%).

Salary Received

Nonsupervisory human factors specialists had a median salary of $46,000 and supervisors a median of $57,000. Salary levels are relatively uniform across employers, areas of work, and the extent of military work done. As might be expected, salary correlates positively with age, highest degree, and number of years since receipt of highest degree. Highest degree is the variable most highly correlated with salary.

Men were consistently paid more than women across type of employer and areas of work; the difference was greatest in aerospace, communications, and transportation and least in computers and health and safety work.

Self-Perception of Professional Identity

Most nonsupervisors (66%) and supervisors (56%) who were sampled consider themselves to be human factors specialists. Those who do not identified themselves as an industrial engineer, some other type of engineer, a psychologist, a computer scientist, or an industrial designer.

Perceived Importance of Human Factors to Projects

Most human factors specialists and their supervisors rate human factors as being important to the project on which they spend or have recently spent most of their working time. On a seven-point scale, 88 percent of nonsupervisors and 86 percent of supervisors used the top three scale positions to indicate the level of importance of human factors to their projects.

The Training of the Supervisors of Human Factors Specialists

Few (9%) human factors specialists report that their supervisors are trained in human factors. The immediate supervisors and nonsupervisors of human factors specialists were reported by specialists to either know little or nothing about human factors (37%) or be quite knowledgeable about the field (49%).

The Interactions of Human Factors Specialists

During the course of a typical work week, human factors specialists report frequent interactions with engineers (86%) and other human factors specialists (81%). Other specialists with which somewhat fewer interactions take place are computer programmers, systems users, and systems analysts.

The Nature of Human Factors Work

The 52 different types of tasks performed by human factors specialists define what they do. These tasks can be grouped into a few main categories: systems analysis, risk and error analysis, design support, test and evaluation, instructional systems design, and communications. Among the most prominent tasks performed are task analyses, oral and written presentations, proposal preparation, application of human factors principles, and evaluation of reports written by others. As might be expected, which tasks are performed and how often depend on the systems being worked on and whether they are military or nonmilitary.

Personal Characteristics of Specialists

Most specialists (71%) have advanced degrees; 37 percent have doctorates and 34 percent master's degrees. Doctorates are found more frequently in some work settings, such as education institutions and government agencies, than in others, such as industrial process and transportation organizations. Only 20 percent of doctorates specialized in human factors; other doctorates were spread across many areas of specialization.

The majority (60%) of human factors specialists sampled were under age 45, and only 15 percent were 55 or older. Supervisors are older than nonsupervisory human factors specialists: 69 percent of supervisors were 35 to 54 years of age; only 56 percent of nonsupervisors were in this range.

Human factors specialists are predominately white and male. Over 94 percent of the sample was white and 81 percent was male. Of those with supervisory responsibilities, 87 percent were male and 13 percent female.

The Education of Human Factors Specialists

Where were Education and Training Obtained?

For each of 52 listed activities, specialists were asked whether they performed the activity as part of their job and if so where they had learned it. Most activities were learned as part of a formal graduate program, with far fewer being learned in continuing education, in employer training, or in other ways. A few activities, which we're performed frequently on the job, appeared with low frequency in formal education programs: proposal preparation, verifying conformity to human factors specifications, planning and coordinating evaluations, and specifying evaluation objectives. Findings also demonstrated that formal education tends to stress theoretical issues and laboratory research more than practical topics.

How Did Specialists Perceive the Quality of Their Formal Education?

Specialists who received their highest degree within the last five years were asked to evaluate how well their education prepared them for their first human factors job. On a scale from 1 (very poorly) to 7 (very well), specialists rated the quality of their education higher than did their supervisors: two-thirds of the specialists gave a response of "5 or above" to this question; less than half of supervisors judged that specialists were well prepared to perform job activities. Some topics are not taught very often in formal programs: accident and malfunction analyses, computer-based topics, social issues, and maintainability. Some topics that were taught infrequently were also not judged to have been taught well: error and accident analysis, human reliability analysis, products liability law, computer input tool design, and speech recognition and synthesis.

What Deficiencies Did Supervisors Report in Specialist Training?

Three quarters of all supervisors responded that new hires lack certain skills and abilities. Deficiencies mentioned more than 10 times ranged from communication skills and knowledge of system analysis techniques, to experimental design, engineering and technical skills, and government system acquisition procedures.

Characteristics of the Education Programs

The mail-in survey of graduate programs yielded some interesting findings. The majority of programs are in engineering departments, followed by psychology departments and trailed by four programs affiliated with other departments. Most programs had links with departments other than their primary home department. Psychology topped this list at 82 percent of all departments with such links.

Most programs (88 percent) offered both master's and doctorate degrees. Minors are required by a larger percentage of engineering departments than psychology departments at both of these degree levels. Undergraduate concentrations in human factors were available in 26 percent of the programs. A thesis was optional more frequently in engineering than in psychology departments; practical experience was required by a higher percentage of psychology than engineering departments.

The number of core faculty per program averaged 5 to 6, with engineering departments having fewer core faculty than psychology departments. Engineering and psychology programs were rated the same across two key variables: adequacy of libraries and computer hardware and software for faculty. The mean rating for library adequacy was lowest and for computer hardware the highest.

Support for human factors education programs from outside sources has increased at an average or above-average rate, with more engineering programs receiving support at a higher-than-average rate than psychology programs.

Many ties in the form of internships, research contracts, guest lectures, and adjunct faculty appointments exist between university programs and outside organizations. However, the findings suggest that university programs may only be skimming the surface of potential additional contacts with business and government.

The most frequently required courses center around research methodology and statistics; sensory, cognitive, and motor abilities and processes; anthropometry and work physiology; and design of displays, controls, and work stations. Less frequently covered topics, required by one-quarter or less of the programs, tend to deal with applications of human factors to automation, computer-assisted design, aging, transportation, robotics, and teleoperations. Only 30 percent of programs cover MANPRINT and related topics, which are the focus of a recent Department of Defense initiative to make technology design and procurement more human centered.

When asked, if they could change any part of their programs, what would they change, program directors most often mentioned adding faculty. Many program directors (68%) believe that human factors education will increase its emphasis in the next five years on computers and industrial applications. Several programs predicted that future programs will be strengthened if plans for program accreditation are implemented.

Specialists were asked about continuing education and books and periodicals read on a regular basis. About half of all specialists, and 40 percent of supervisors, have taken continuing education in the past five years. However, neither group feels that they are getting enough continuing education due to its lack of availability. Approximately 90 percent of supervisors and specialists read periodicals regularly. The journal and the bulletin of the Human Factors Society were the most frequently read periodicals, followed by computer magazines. The top four specific books mentioned contained one textbook (Sanders and McCormick, 1987) and three handbooks (Van Cott and Kinkade, 1972; Salvendy, 1987; Woodson, 1981).

The Supply and Demand of Human Factors Specialists

One of the principal goals of the project reported here was to assess the state of balance between supply and demand for human factors specialists in general and to make forecasts concerning the potential growth in demand or supply in the predictable future.

Using several data sources, the panel estimated that the current supply of human factors specialists in the United States to be 9,100 people. The method of calculation used was conservatively biased, and there could be as many as 10,000 specialists, although it is unlikely that there are more than 15,000.

The net growth of the Human Factors Society since its founding in 1958 has been 188 members per year on the average. If this is used as a basis to make a linear extrapolation of the growth of the profession, then the current total of 9,100 in 1989 may reach a supply level of 10,745 in 1995.

When trends in human factors employment are extrapolated into the future, about 530 individuals will enter the field annually as 255 leave.

Finally, it appears that demand for human factors work is elastic. It is estimated that jobs for an additional 6,500 human factors specialists could be created if supervisors were given the authority and funding to do so. If that occurred, then the supply could not keep up with the demand.

It should be pointed out that the findings on the supply-demand relationship reported here are based on data collected in 1988 and 1989. One change that took place since that period that may have an impact on the forecasts made: military funding, a long-standing source of support for human factors research and design, has been reduced and, as a result, the demand for human factors programs and personnel may have diminished. If that is indeed the case, then the validity of the supply and demand estimates reported here would be affected. No data yet exist to clarify the issue. Still, there is no reason to believe that other findings in this report have been affected in any important way by intervening events.

CONCLUSIONS AND RECOMMENDATIONS

A major conclusion drawn by the panel from the results of the surveys reported here is that the design of academic curricula adequate to the needs of employers with a great diversity of needs is a significant challenge that must be faced by the profession.

The panel's major recommendations center on measures that need to be taken to strengthen the education and training of both human factors specialists and supervisors. Special emphasis should be given to interdisciplinary training; to the need to define and base education around a core curriculum; to the promotion of effective training for supervisors; and to the encouragement of graduate internship and traineeship programs. Other recommendations are to place more emphasis in funding research on inter-disciplinary and applied human factors problems rather than the support of traditional, academically oriented disciplinary approaches and values; to more actively promote human factors among women and racial minorities; and to extend human factors to new areas of societal needs, such as the problems of the aging population.

1—

Introduction

BACKGROUND

Technology is an integral part of modern life. People interact with technology everyday in automobiles, airplanes, boats, banks, supermarkets, industrial plants, schools, hospitals, military systems, homes, and numerous other places. Unfortunately, people have been frustrated, injured, and killed by technical devices that have been incompatible with their human capabilities and limitations or by systems that just perform poorly. The role of human factors specialists is to overcome these problems by emphasizing and effecting people-oriented design that keeps the human user, rather than technology, central to the design process.

What is a human factors specialist? Where and how are they educated and trained? Where do they work and what do they do? Does the education and training of these specialists meet the needs of their employers? These are the questions addressed in this report.

The Human Factors Specialist

The definition of a professional charged with overseeing this people-oriented design philosophy varies. The term *Human Factors Specialist* has been selected by the panel from a large number of possible terms to name this profession. Recently, Licht, Polzella, and Boff (1989) reviewed 74 definitions of this specialty from 400 references. Terms such as *anthropometrics, applied ergonomics, applied experimental psychology, biomechanics, biotechnology, engineering psychology, ergonomics, human engineering, human factors, human factors engineering, human factors psychology, human* *performance engineering, industrial ergonomics*, and *psychotechnology* were used. The three most prevalent terms included *human factors, human factors engineering*, and *ergonomics*. Although these terms are often interchangeable, in the United States human factors tends to be the broadest category; human factors engineering tends to emphasize design; and ergonomics tends to be concerned with people at work.

For the purposes of this study, the individual of interest is referred to as a human factors specialist. This specialist is an individual who is concerned primarily with the performance of one or more persons in a task-oriented environment interacting with equipment, other people, or both.

Origins of the Study

In response to a request from the Army Research Institute for the Behavioral and Social Sciences, the National Research Council, through the Commission on the Behavioral and Social Sciences and Education, under-took a study to determine the nature and prevalence of the skills required of human factors specialists when they enter the industrial work force. Despite the rapid rise in the number of degree programs, senior management personnel in the Department of Defense (DoD) concerned with the system acquisition process anticipate that the demand for qualified human factors specialists who can function at the design level may exceed the available supply, leading to shortages in industry at the lower-and mid-career levels. A shortage of design-oriented human factors specialists could have a negative impact on system performance, since the application of human factors principles and methods in all system domains (design, maintenance, operation, etc.) is deemed essential to improve the efficiency of these systems.

The Army Research Institute requested that a panel of the Committee on Human Factors be established to determine the extent and nature of the needs of major industrial organizations for human factors specialists and the relationship between their needs and the human factors curricula taught by universities. To do this, a survey was undertaken (1) to identify and describe the tasks performed by human factors specialists in selected industries in the design, development, production, maintenance, training, and operation of complex military and nonmilitary systems and of consumer products used in and around the home, at play, and at work and (2) to identify the extent to which universities educate students in human factors to perform these tasks. Data collection occurred in 1989; data analysis was completed in 1991.

Two recent trends underscored the need for this study. First, the major U.S. professional society of human factors specialists, the Human Factors Society, has demonstrated steady growth in membership and activity during the last decade. According to its 1990 directory, the society's membership had increased approximately 150 percent over the previous 10-year period, to a current level of 3,904 members. In the latest directory of graduate training programs in human factors, Sanders and Smith (1988) listed 59 U.S. programs, located in a variety of academic departments, including a relatively even split between behavioral and social science pro-grams and engineering programs. The curricula in these programs are often interdisciplinary, changing, and quite varied. Periodically, the membership of the Human Factors Society is surveyed in terms of educational background, area of employment, professional activities, and salary (Sanders, 1985). These surveys, however, have been limited to members and, prior to 1991, had not been conducted since 1985. Nonetheless, the growth in the society's membership and the educational background of members are critical indicators of the supply of human factors specialists.

Second, there is growing emphasis on system integration among government agencies involved in the development and procurement of highly technical, people-oriented systems. Chief among these activities was the Manpower and Personnel Integration (MANPRINT) program developed during the 1980s. MANPRINT is a major military system procurement initiative adopted by the Army to focus on the needs and capabilities of the soldier. This program is unique in that it integrates six areas of user concern throughout the development cycle of Army matériel, including human factors engineering, manpower, personnel, training, health hazards, and system safety (Booher, 1990). At this writing, the MANPRINT pro-gram has not yet been enforced in all areas of system procurement.

Table 1.1 summarizes some of the technical considerations in each of the six major areas of MANPRINT. Muckler and Seven (1990) conclude that, although no single professional area covers all the considerations of MANPRINT, the human factors specialist comes closest to having the most comprehensive technical background. Interestingly, they point out that the topics related to the manpower area shown in the table are not well covered either in the human factors textbooks or in existing human factors graduate training programs. Muckler and Seven conclude that the establishment of centers of excellence in graduate training as well as appropriate licensing and certification are needed to improve the background of the human factors specialist for MANPRINT.

Similar approaches to MANPRINT are being used in other military services. The Hardware Versus Manpower (HARDMAN) program in the Navy, the Integrated Manpower, Personnel, and Comprehensive Training/ Safety (IMPACTS) program in the Air Force, and the Manpower, Personnel, Training, and Safety (MPTS) concept in DoD each represent a user-oriented design and acquisition approach. In addition, the United Kingdom has initiated MANPRINT-related activities in the Ministry of

Defense, the Royal Navy, military laboratories, defense schools, and British industry.

Table 1.1 Technical Considerations in the Six Major Areas of MANPRINT

MANPRINT Areas	Technical Considerations
Human factors engineering	Psychological and physiological capabilities and limitations Mission, function, and task analysis Anthropometric and biometric criteria Display-control task design Workspace requirements and design Organizational design
Manpower	Human resources system predictions Manpower models Personnel models Assignment models Training models
Personnel analysis	Skills, knowledge, and abilities (SKA) Personnel selection SKA/training trade-offs Personnel quality and performance prediction Motivation, incentives, and performance
Training	Human learning and transfer of training Training requirements and needs analysis Instructional system design Training media and devices Training system evaluation
System safety	System reliability analysis Human error analysis System safety planning Safety training
Health hazards	Environmental stressors identification Psychological stressors identification Designing for health and safety Personal protection and equipment Controlling workplace hazards Product reliability and liability

Source: Adapted from Muckler and Seven (1990). Copyright © 1990 by Van Nostrand Reinhold.

Awareness of MANPRINT is growing rapidly. For example, the Federal Aviation Administration is interested in these activities as a means of improving aviation safety and air traffic control. Likewise, MANPRINT considerations also have been discussed in connection with nuclear safety and advanced manufacturing. Current events, such as the reduction in ten sions between East and West and the increased tension in the Mideast due to Desert Storm, make it difficult to assess the current validity of survey estimates of the personnel needed to work on MANPRINT-like military programs.

Extension of the MANPRINT philosophy to other application areas can easily offset the possible reduction in military programs. Examples include the rapid growth in demand for specialists in human-computer interaction and recent interest in human factors issues associated with the aging population and with the use of increasingly complex medical technologies and devices. Even in the military, new human factors problems may arise whether the services are downsized or increased. In such areas, training may be needed to overcome rapid technological obsolescence. All of these activities, however, result in an increased demand for the services of human factors specialists.

However, the U.S. Army is currently facing very large reductions in force. The resulting threat to the human factors community, like many others, is that it is likely to receive at least a proportional cut in resources, even though many indicators suggest that the demand for human-centered research and development is increasing. This situation results from increased reliance on automation, which in turn leads to the logic for increasing the funding of human factors research and development resources; doing so makes it possible to decrease systems' manpower and associated life-cycle costs while maintaining the same, if not increased, levels of military readiness. Manpower is one of the most costly resources of the military; the human factors community can provide decision aids to policy makers to help them make manpower cuts where they will have the least damaging impact.

Issues

On the basis of these trends, a variety of questions dealing with the education and utilization of human factors specialists need to be addressed:

Skill Requirements. What tasks do human factors specialists currently perform relevant to the design, development, production, maintenance, and operation of consumer products and military systems? What skills and knowledge are required by human factors personnel in order to contribute effectively to the design, development, training, and evaluation of complex systems and operational procedures and to the development of training programs?

Qualifications. To what extent are the human factors courses and pro grams in universities congruent with the task requirements in industry in the behavioral (e.g., cognitive, sensory, learning, performance, social), engineering (e.g., computer science, engineering and industrial design), physiological (e.g., strength, biomedicine, neurophysiology), and interdisciplinary domains? Is there a disparity between job requirements and current education programs? Are human factors specialists receiving the type of analytical skills and training needed so that they may adapt appropriately to future requirements?

Training Curricula. How qualified are recent graduates? How extensive are on-the-job training requirements for newly hired graduates? Can postgraduation learning time be reduced without compromising performance? Are modifications or redirection needed for the mode of education or curricula to enhance the contributions of human factors specialists in the industrial environment?

Supply and Demand. What is the number of students currently being trained in human factors, and what is the projection for the future? Is the supply of faculty in the various fields adequate to meet current and future needs? Are qualified minorities and women being attracted to careers as human factors specialists and faculty?

Actions. What actions can governmental and private organizations take to ensure an adequate supply of human factors specialists and faculty? How can these actions be enhanced?

OBJECTIVES OF THE STUDY

Reliable information is needed in order to address the various issues related to the education and utilization of human factors specialists. The panel used the results of surveys of human factors specialists and education institutions as the bases for its discussion and conclusions. Its overall objective was to recommend improvements for the education, training, and utilization of human factors specialists in four areas:

1. *Job Definition*. Define the jobs and tasks performed by human factors specialists involved in the design, development, production, maintenance, operation, and supportability of integrated systems.
2. *Skills and Knowledge*. Identify the knowledge and skill requirements of human factors specialists.
3. *Education*. Evaluate the extent to which human factors education and training currently satisfies the needs of industry and government.
4. *Supply and Demand.* Assess and project the demand and supply for qualified human factors specialists.

ORGANIZATION OF THE STUDY

Chapter 2 describes the method used to sample and survey the human factors community using both a mail-in questionnaire and a computer-aided telephone interview technique. The mail-in questionnaire was used to survey the directors of educational programs in human factors. The CATI technique was used to survey human factors specialists and their managers. Appointments were made to contact sampled individuals for subsequent telephone interviews. Branching points were built into the protocol logic to cue the telephone interviewer as to what questions to ask next depending on the respondent's answer to the previous question.

Categories of questions used in surveying the human factors specialist covered the employment setting, education and training received, work activities performed, methods and tools used, degree fields, career problems, and salary information. Supervisors were asked to project their needs for human factors professionals and the degree to which current human factors employees are proficient in the knowledge, methods, and tools required by the job. Directors of graduate education programs were asked to describe their curricula and the relative emphasis given to specific topics. The surveys used in this study are reproduced in Appendices A and B.

Chapters 3, 4, and 5 summarize the major results of the surveys. Chapter 3 deals with the characteristics and use of human factors specialists. A profile of the human factors specialist is presented in terms of the work setting, the role of human factors in that setting, the nature of supervision and interactions with others, personal characteristics of the specialist, and the specific tasks performed by human factors professionals.

Chapter 4 presents survey results pertaining to the education and training in human factors. The scope of educational experiences in terms of a profile of required skills is provided; the quality and importance of educational topics are assessed; and a summary description of the general nature of existing graduate education programs in terms of curricula, faculty, and facilities is presented. Supplementary training programs that allow the human factors specialist to remain current in the field are described.

A data base of the complete survey results are available to the reader for further analyses through the Department of Defense Crew System Ergonomics Information Analysis Center (CSERIAC) operated by the U.S. Air Force Armstrong Laboratory under contract to the University of Dayton. A description of this data base and procedures for accessing these data from CSERIAC are described in Appendix C.

Chapter 5 addresses some of the implications of this study that deal directly with career progression as well as the supply and demand of human factors professionals. Projections of supply are based on the educators' estimates; estimates of demand are based on the supervisors,' estimates.

Finally, Chapter 6 summarizes the overall findings and recommendations of the study panel. Two major conclusions are discussed in terms of the job description and the required skills and knowledge of the human factors specialist. The report concludes with 11 general recommendations concerning the supply and demand of human factors specialists and the improvement of human factors education. These recommendations deal with the academic specialty, educational curriculum, supervisory training, graduate internships, graduate traineeships, research opportunities, availability of specialists, women and minority representation, awareness of human factors, areas of application, and future trends.

2—

SURVEY METHODOLOGY

To survey the human factors community, two data-gathering techniques were used: a computer-assisted telephone interview (Appendix A) and a mail-in questionnaire (Appendix B). The computer-assisted telephone interview (CATI) was used to survey human factors specialists and the supervisors of human factors personnel. The mail-in questionnaire was employed to survey the directors of graduate programs offering specialized education in human factors. The methods used in the two surveys are described below.

THE COMPUTER-ASSISTED TELEPHONE INTERVIEW SURVEY

The purpose of this survey was to question human factors specialists and supervisors about their professional and job-related activities and education. The method of choice for obtaining this information was the computer-assisted telephone interview. During the last decade, CATI systems have become a standard method for conducting interviews because of the flexibility that they offer in comparison with self-administered questionnaires. In a CATI interview, neither the respondent nor the interviewer uses pencil and paper to record responses to questions. Instead, the interviewer contacts members of a preselected sample by telephone at a time previously agreed on. A branching interview protocol on the interviewer's computer screen prompts the interviewer to ask questions. Respondent answers are entered by the interviewer on a keyboard as either coded or free-text information.

The principal advantage of the CATI survey method is that it permits a questionnaire to contain branching questions that can be asked or not de pending on responses to previous questions. With this if-then branching structure, a line of questioning is continued by an interviewer if a respondent's replies meet certain criteria and stopped or switched to another line if responses meet other criteria. This is very difficult with a self-administered questionnaire, even when the respondents are highly motivated. Well-trained interviewers can follow complex questionnaires, but under the pressures of an interview even a highly skilled interviewer can make a large number of errors in either not asking all of the questions that should be asked or sometimes asking questions that should not be asked. The CATI method eliminates these sources of error and allows the interviewer to concentrate on communicating with the respondent. A CATI interviewer can also define terms and clarify questions for a respondent.

Questionnaire Development

The questions used in this survey drew on four sources of information: (a) questions developed by Sanders and his associates (Sanders, Bied, and Curran, 1986) in job-descriptive surveys of members of the Human Factors Society (HFS), (b) studies of the activities of human factors specialists done by the American Psychological Association for the Army Research Institute, (c) unpublished task analyses of the work of human factors specialists completed by the Human Factors Society (internal communication, 1986) and (d) questions suggested by a resource group from government, industry, and academia solicited by the panel. This resource group was selected to represent the different types of employment settings and work in which human factors specialists are engaged (see the acknowledgments for their names).

Using these sources of information, three working subgroups of the panel were instructed to develop specifications for separate sections of the CATI questionnaire. These specifications were then discussed by the full panel, formatted, and pretested on a small group consisting of potential respondents and interviewers at the Survey Research Laboratory who were later to conduct the CATI interviews. This process helped to pinpoint ambiguous and misleading questions. The questions were then revised on the basis of these respondent and interviewer comments. In all, the questionnaire went through four revisions before a final draft was reached.

Sampling

The aim of the CATI survey was to obtain a sample of all human factors specialists and supervisors to which questions about their work and education could be asked. Because the panel judged that it would need analyses broken down by employer type, respondent age, respondent sex, and other categories, a sample of at least 1,000 respondents representative of the population of human factors specialists and supervisors was necessary. Although several different designs could be used to obtain a sample of this size, the only feasible and economically realistic alternative was to draw a sample from an enumeration of known human factors specialists and supervisors. Unfortunately no such common list has ever been compiled. Therefore, the survey contractor, the University of Illinois Survey Research Laboratory, constructed a master list using three sources: (1) the 1988 membership list of the Human Factors Society, (2) the most recent membership lists of other professional associations in which some members were believed to be engaged in human factors activities, and (3) nominations of persons obtained from interviews with sample respondents drawn from the association lists.

A major limitation to using these types of existing lists is the inclusion of ineligible persons such as those who have retired or have changed to jobs in an area other than human factors. While some ineligibles were expected even in the Human Factors Society, this problem was greater for the other professional associations, organizations, and network sampling methods.

In addition to the Human Factors Society, 14 associations were identified that the panel believed would contain some members engaged in human factors activities or in their supervision. These associations were invited to participate in the survey by providing the survey contractor with membership lists that could be sorted on members interested in or engaged in human factors. Of the 14, 10 societies agreed to cooperate:

the American Nuclear Society,
the American Industrial Hygiene Association,
the Industrial Designers Society of America,
the Aerospace Medical Association,
the American Institute of Industrial Engineers,
the National Security Industrial Organization,
the American Society of Agricultural Engineers,
the Association for Computing Machinery,
the Acoustical Society, and
the Institute of Electrical and Electronic Engineers: Systems, Man, and Cybernetics Division.

In the opinion of the panel, most human factors specialists or specialist supervisors who are not members of the Human Factors Society are likely to belong to one or more of these 10 organizations.

Of the four societies that did not participate, three did not have information that identified members who had human factors interests or were human factors specialists or supervisors of human factors personnel. The four societies were:

the American Society of Safety Engineers,
the Environmental Design Research Association,
the Society of Information Display, and
the System Safety Society.

Even if the members of these societies had been identifiable as human factor specialists or supervisors, it is likely that their number would have been so small as to have no appreciable effect on the results. It is also likely that at least some of this small number would also have been members of the Human Factors Society and thus available for sampling from its membership list.

The membership list of the Human Factors Society yielded 3,907 names, and those of the other 10 societies yielded a total of 12,552 for sampling candidates for CATI interviews (Table 2.1). From these two pools of names a sample of 1,027 was initially selected from the Human Factors Society list and another sample of 1,034 was drawn from the remaining 10 lists. The two samples were then checked for duplicates and people on the Human Factors Society list were excluded from the remaining lists. Those who were on more than one list were subsampled at a rate that was the inverse of the number of lists on which they appeared. This gave equal probabilities of selection to all sampled persons on the combined lists of the other professional societies.

Two approaches to determine eligibility were considered. One was to simply ask respondents whether they considered themselves to be a human factors specialist, leaving unspecified the meaning of that label. The major

Table 2.1 Characteristics of the Sampling Candidates for CATI Interviews

	Human Factors Society Members	Human Factors Specialists from 10 Other Sources	Network Nominees		
	Peers	Supervisors	Total		
Sample:	1,027	1,034	612	383	3,056
Ineligible	302	477	273	178	1,230
Eligibility unknown	73	354	223	98	748
Eligible:	652 (100.0%)	203 (100.0%)	116 (100.0%)	107 (100.0%)	1,078
Interviews	614 (94.2%)	170 (83.7%)	103 (88.8%)	84 (78.5%)	971 (90.0%)
Refusals	38 (5.8%)	33 (16.3%)	13 (11.2%)	23 (21.5%)	107 (10.0%)

drawback to such an approach is that persons who were actually doing human factors work but who did not regard themselves as human factors specialists (for example, engineering psychologists) would eliminate themselves from the sample. Because an important focus of the project was to determine whether human factors work was being done by nonspecialists, the self-identification method was considered inappropriate. Sample eligibility was therefore based solely on actual occupational tasks currently performed, with self-identification with a profession to be determined subsequent to selection for the sample.

Given these considerations, persons in the initial samples were contacted by telephone by trained interviewers from the Survey Research Laboratory and asked two screening questions:

1. In your current position, are you primarily concerned with human factors—that is, human capabilities and limitations related to the design of operations, systems, or devices?
2. Do you supervise any people who perform human factors activities?

People who answered no to both questions were classified as ineligible and were not interviewed. This screening procedure eliminated all those on the membership lists who might regard themselves as human factors specialists but actually did not do any human factors work in their jobs. Also excluded were academic professionals who teach human factors principles to students but who do not perform any other work in the field, such as consulting. This was considered appropriate because the educators' activities were covered by the university program survey. More important, the screening criteria also eliminated large numbers of people who did not do human factors work and probably did not think of themselves as human factors specialists.

As Table 2.1 shows, of the 1,027 Human Factors Society members sampled, 302 were ineligible because they did not meet the screening criteria, and the eligibility of 73 was unknown. This left 652 members eligible for interviewing. If viewed with respect to the membership at large, 68 percent would have qualified for interview. Of the 1,034 human factors specialists from the 10 other societies, 477 did not meet the screening criteria and were therefore ineligible, and the eligibility of 354 could not be determined. This left 203 persons eligible for interviewing: 30 percent of the human factors specialists from other societies whose eligibility was known. The lower percentage of eligible people among the members of the other societies had been anticipated and explains why a heavier sampling rate from the membership list of the Human Factors Society was used initially. It should be noted that, in this report, estimates are weighted to account for this differential sampling rate to eliminate bias.

In addition to the eligibles obtained from society membership lists, an additional 116 were obtained from network nominations by society members of peers who were not members of any society. An additional 107 supervisors of human factors personnel were also identified as eligible for interviewing. (This network nominations process is explained in greater detail later in this chapter.)

The number of individuals who refused to be interviewed once contacted was low, averaging 10 percent across the society member, peer, and supervisor groups. The refusal rate of 5.8 percent for members of the Human Factors Society was lower than that found in most surveys, suggesting a strong degree of interest by members in the survey as it was explained to them (see Table 2.1).

Making contact with potential respondents was a major problem faced in conducting the CATI survey. Many individuals had to be called more than 10 times before they could be located and screened and, as the table shows ("Eligibility unknown"), some could never be located or screened at all.

One factor that contributed to the problem of locating potential respondents was the vintage of society membership lists. While the Human Factors Society list was current, some of the other lists used were several years old, and some sampled respondents had moved and could not be located. For purposes of making estimates of the universe size and overall cooperation, we assume that the eligibility rate for those who could not be located is the same as for those who were located. Characteristics of the sample, including people who were not located, are shown in Tables 2.2, 2.3, and 2.4. Because of budget limitations, fewer efforts were made to locate those on the lists of organizations other than the Human Factors Society, since it had already been established that only a minority Would be eligible.

The panel wanted to include people who were not members of any professional societies in the CATI survey. As was mentioned earlier, this was accomplished by asking persons from the list sample to name their supervisor and other human factors specialists with whom they interact.

Table 2.2 Eligibility Rates of the Sample

	Human Factors Society		Other Associations		Network Nominees	
	N	%	N	%	N	%
Initial sample	1,027		1,034		995	
Located eligible	652	68.3	203	29.9	223	33.1
Located ineligible	302	31.7	477	70.1	451	66.9
Total	954	100.0	680	100.0	674	100.0

Table 2.3 Estimated Eligibility Rates for Interview Candidates Who Could Not be Located

	Human Factors Society		Other Associations		Network Nominees	
	N	%	N	%	N	%
Estimated eligible	50	(68.3)	106	(29.9)	106	(33.1)
Estimated ineligible	23	(31.7)	248	(70.1)	215	(66.9)
Total	73		354		321	

This technique is sometimes called *network sampling*. As Table 2.1 shows, a total of nearly 1,000 nominations was obtained: 612 specialists and 383 supervisors. These nominations were first checked against the society membership lists; those not on the lists were then screened for eligibility. As with the list samples, not all were eligible or could be located.

Network sampling requires that nominated persons be weighted by the inverse of the network size of the nominator. This was done so that these cases could be added to the list sample cases for analytic purposes. A more complex weight, which takes account of the respondents' network sizes, was used for people selected by network nomination. The probability that a person was nominated depends on the number of other specialists he or she knows. If someone is not known by anyone else (an isolate), they will never be nominated. If someone is known to many people, the chances are higher that one or more of these people will nominate the person. For supervisors, the probability of nomination depends on how many human

Table 2.4 Estimated Cooperation Rates Including Those Who Could Not Be Located, Based on Total Sample Data

	Human Factors Society		Other Associations		Network Nominees	
	N	%	N	%	N	%
Completed	614	87.5	170	55.0	187	56.9
Refused	38	5.4	33	10.7	36	10.9
Not located	50	7.1	106	34.3	106	32.2
Total estimated eligible	702	100.0	309	100.0	329	100.0

factors specialists he or she supervises. Thus, for an estimate to be unbiased, the weight assigned to the nominator was divided by the network size.

Interviewing

Except for the problem of locating respondents, computer-assisted telephone interviewing was accomplished with minimal difficulty. The Survey Research Laboratory at the University of Illinois used a group of 20 experienced telephone interviewers and five supervisors. Interviewers were briefed on the purposes of the survey, the meaning of such terms as *human factors*; they spent at least one day of practice interviews before beginning actual cases. For reference use, each interviewer was provided with detailed printed instructions for each question.

During the interviewing, a supervisor was on duty at all times to answer questions. The supervisor also monitored interviewer performance on a random basis. During most of the interviewing, there was one supervisor monitoring three to eight interviewers, the average being around five. Interviewers reported that respondents were very cooperative and had little difficulty in responding to the questions presented to them.

Advance announcements in the *Bulletin* of the Human Factors Society and letters to the other cooperating societies were prepared to explain the purposes of the survey. Before the interview, an initial letter from the National Research Council was sent to each person in the sample along with the list of human factors job activities and a list of topics covered in specialized human factors training; these materials made the actual interview proceed smoothly. Virtually all respondents had examined the materials and had them available at the time scheduled in advance for the interview.

The CATI survey was scheduled for the period of April-June 1989, prior to summer vacation season. The interviewing actually stretched out an additional month, as the Survey Research Laboratory made final efforts to locate respondents who were away from their offices on long-term assignments or vacation.

THE MAIL-IN QUESTIONNAIRE

The purpose of the mail-in questionnaire was to obtain information about university graduate programs in engineering, psychology, and other departments that offer specialized education in human factors. Questionnaires were mailed to the directors of all programs in the United States and Canada that were listed in the 1988 edition of the *Directory of Human Factors Graduate Programs in the United States and Canada* published by the Human Factors Society, the largest professional association of human factors specialists in North America.

Questionnaire Development

The questions used in the mail-in survey were developed by the panel and took as points of departure: (1) questions that had been used by Sanders in earlier surveys of the membership of the Human Factors Society (Sanders, Bied, and Curran, 1986); (2) information presented in the *Directory of Human Factors Graduate Programs*; and (3) additional items that the panel judged were relevant. The final mail-in questionnaire is shown in Appendix B.

Sampling

The universe for this survey was the 65 programs described in the program directory. All program directors were contacted by mail with followup by mail and telephone by staff of the Survey Research Center of the University of Illinois. Additional follow-up calls were made by panel members to those programs that had not responded by the stated deadline. Survey data collection began in spring 1989 and continued until the late fall.

Cooperation Rate

In North America, 58 universities offer 65 graduate education programs with a specialization in human factors. Some universities offer programs in more than one department. Of these, 59 programs are in the United States; 6 are in Canada. Of the U.S. programs, 48 responded, a cooperation rate of just over 81 percent. The failure of all but one Canadian program to respond lowered the combined cooperation rate for the United States and Canada to 75.4 percent. These cooperation rates were somewhat lower than had been expected and may be attributed to the complexity and length of the questionnaire and the amount of detail that was requested.

There is no reason to believe that sample biases's had an impact on the overall findings from the program survey. For example, the response rate from small programs was not appreciably different from that of larger programs.

Quality of Data

The data received from program directors was generally of high quality. Unfortunately, some questionnaire items were not completed. The most serious problem of missing data was that some respondents from institutions with both master's and doctoral programs reported on one but not both programs. For further details on the actual sample sizes for each question in the survey, see Chapter 4.

3—

Characteristics and Utilization of Human Factors Specialists

The main objectives of the study involved the following questions: What do human factors specialists do? Where do they do it? How do they do it? Obtaining answers required an examination of the work setting, the role of human factors in that setting, the nature of supervision, the extent of interaction with others, personal characteristics, and above all the specific tasks performed. In addition, differences among subsamples of specialists were examined for insights they might reveal. Any differences noted in this section were statistically significant at the 0.01 level.

THE WORK SETTING

Type of Employer

The principal workplace of the human factors specialists surveyed was in private business, with 74 percent reporting such an organization as their employer. This percentage included those employed by private nonprofit organizations and those employed by private consulting organizations. Among those remaining, 15 percent worked for government agencies and 10 percent for education institutions (Figure 3.1). To be included in the study, those who worked for education institutions also had to consult regularly for private business or government agencies. Only 1 percent reported a place of work in other than one of the three employer categories.

This distribution of employment settings existed among those who thought of themselves principally as human factors specialists as well as those who did human factors work but thought of themselves as something else, such as engineers or computer scientists. The one exception was among those who called themselves psychologists. Almost as many psychologists were employed in government agencies, 41 percent, as in private business, 47 percent.

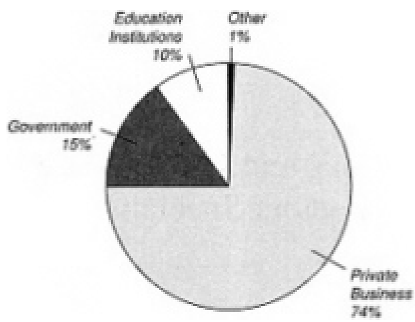

Figure 3.1
Principal workplace of human factors specialists.

As one would expect, the type of systems addressed by the human factors specialists was related somewhat to type of employer. For example, those who worked on office products or industrial processes were mainly in private business. Those who worked in the area of health and safety were much more likely than others to be found in education institutions, 33 percent, or government agencies, 25 percent.

Focus of Work

At the time of the study, 60 percent of human factors specialists principally worked in just three areas—computers, aerospace, and industrial processes. These and six other areas—health and safety, communications, transportation, energy, consumer products, and office products—encompass 87 percent of the sample (Table 3.1). Of the remaining 13 percent of human factors specialists, no single area accounted for more than 0.5 percent of the sample. Examples of these other areas are publishing, mining, recreation, tourism, and financial services.

A relatively large amount of human factors work was being performed for military purposes. Somewhat more than 30 percent of the sample reported that at least half of their work was for the military. The main areas of military emphasis were aerospace, computers, communications, and transportation. The distribution of work among the various areas is shown in the table.

Agencies within the Department of Defense have developed programs and procedures to help integrate efforts that address human factors issues in the development of new systems. These programs, as discussed earlier, are known by the following acronyms: MANPRINT, HARDMAN, RAMPARTS, and IMPACT. Overall, 12, percent of the sample reported currently working under one of these programs. Of those whose work was half or more on military systems, 42 percent reported working under one of these programs.

Hours Worked Per Week

In all, 80 percent reported that they worked 40 hours or more in a typical week. There were, however, notable differences between those with supervisory responsibilities and those without them in the number of hours worked. For purposes of the study, supervisors were defined as those who reported that they supervised human factors specialists and either had a current job title of supervisor, manager, etc., or reported that they supervised three or more people. The modal category of hours worked per week was 40–44 for nonsupervisory specialists, with 47 percent reporting these numbers. The modal category for supervisors was 50 or more hours per week, with 47 percent reporting these numbers. Those who reported working fewer than 20 hours per week (17 percent) were all nonsupervisors and included educators doing part-time consulting work.

Work History

Most people working in the field of human factors have not been in their current job long—39 percent have had their present position for two years or less, and 70 percent for five years or less. Only 11 percent have had the

Table 3.1 Principal Areas of Work of Human Factors Specialists (percentage)

		Percentage of Time Working for Military	
Area of Focus	Overall	Less than 50%	50% or More
Computers	22.3	28.1	10.3
Aerospace	21.6	7.7	51.9
Industrial processes	16.5	23.9	0.4
Health and safety	8.9	11.7	2.4
Communications	8.2	7.9	9.1
Transportation	5.3	4.2	7.5
Energy	2.2	2.7	1.3
Consumer products	1.4	2.0	0.0
Office products	0.7	1.0	0.0
Something else	12.9	10.8	17.1
Total	100.0	100.0	100.0

same job for more than 10 years. This pattern was relatively consistent across types of employers, areas of work, supervisors and nonsupervisors, degree of involvement in military work, and sex.

In their previous job, 63 percent had a position that was primarily concerned with human factors, and in 44 percent of the cases that position was with the same organization. The distribution across types of employers—private business, government agency, or education institution—was about the same for previous as for current employment.

Salary Received

The distribution of before-tax annual salaries reported for the present job, by supervisors and nonsupervisors, is presented in Table 3.2. Salary levels for supervisors were generally higher than for nonsupervisors. The median salary for nonsupervisors was $46,000, and that for supervisors was $57,000. A finding that may come as a surprise to some and that seems to contradict popular wisdom is that the distributions of salary levels were not greatly different across types of employers, areas of work, or the degree of involvement in military work.

Salary levels did correlate positively, as expected, with variables such as age, level of highest academic degree, and number of years since receiving the highest academic degree. Level of highest academic degree was the variable that correlated most strongly with salary level. Of those holding the doctorate degree, 52 percent reported an annual salary of $60,000 or greater compared with 28 percent of those holding master's or bachelor's degrees.

Interpretation of the data in the table must be made in light of the fact that they are from somewhat less than the total sample, because of refusals by 17 percent to provide this information. Also, it should be noted that some of the lower annual salaries entailed part-time work.

Table 3.2 Gross Annual Salary Levels of Nonsupervisors and Supervisors (percentage)

Salary Level	Nonsupervisors	Supervisors
$30,000 or less	11.8	3.3
$31,000–40,000	24.5	8.1
$41,000–50,000	25.6	19.3
$51,000–60,000	18.3	21.2
$61,000–70,000	9.8	20.1
$71,000–80,000	2.8	14.4
More than $80,000	7.2	13.6
Total	100.0	100.0

Table 3.3 Male and Female Human Factors Specialists in Each Age Category Paid an Annual Before-Tax Salary of at least $60,000 (percentage)

Age	Male	Female
55 years and older	54.5	31.6
45–54 years	54.6	16.8
35–44 years	40.3	27.5
Under 35 years	12.0	1.6

Men consistently were paid more than women by different types of employers and across all areas of human factors work. However, there were some significant variations in this regard in some areas. Salary differences between men and women were greatest in aerospace, communications, and transportation; they were least in computers and health and safety. Although the women in the sample tended to be younger than the men, Table 3.3 shows that salary differences existed at each age level.

ROLE OF HUMAN FACTORS IN THE WORK SETTING

Human Factors Specialist or Something Else?

To be selected as respondents for the study, persons contacted must have indicated that in their current position they were primarily concerned with human factors, that is, with human capabilities and limitations related to the design of operations, systems, or devices. One of the questions asked later was whether or not they considered themselves to be human factors specialists or something else. In response, 66 percent of nonsupervisors and 56 percent of supervisors said they considered themselves to be human factors specialists.

Those who considered themselves as something else mainly said they were industrial engineers, engineers other than industrial, psychologists, computer scientists, or industrial designers. Thus, although a majority of people doing human factors work think of themselves as human factors specialists, a significant proportion do not see themselves as members of the human factors profession.

Importance of Human Factors to Projects

Most human factors specialists worked in settings in which human factors was considered to be important to the projects conducted. Respondents uniformly rated human factors as being important to the project on which they spent, or had recently spent, most of their working time. Using a seven-point rating scale, 88 percent of nonsupervisors and 86 percent of supervisors used the top three scale positions to indicate the level of importance of human factors to their projects. Using an identical seven-point scale, respondents also indicated how important their supervisor considered human factors to the project that consumed most of their working time. The top three scale positions were used by 77 percent of nonsupervisors and 82 percent of supervisors to indicate that their supervisors also considered human factors to be important in their projects.

Supervisor Background In and Knowledge of Human Factors

Human factors specialists were asked about the training and experience of their supervisors. Relatively few, 9 percent, responded that their supervisors had training or experience directly in human factors. Others reported that their supervisors had training and experience in engineering (34 percent), behavioral science (16 percent), business (13 percent), industrial design (11 percent), a science other than behavioral (11 percent), or something else (6 percent) (Figure 3.2).

Specialists who did half or more of their work for the military were more likely to have immediate supervisors with a background in human factors (15 percent) and behavioral science (25 percent) than those who did less than half of their work for the military. In viewing these findings, it must be kept in mind that nearly half of the sample of specialists had some

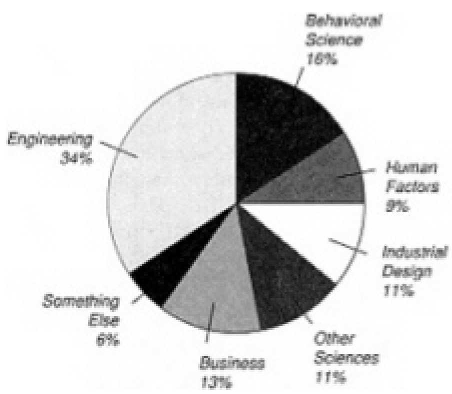

Figure 3.2
Training and experience of supervisors reported by human factors personnel.

supervisory responsibilities themselves. Therefore, nearly half of the immediate supervisors encompassed in this assessment were supervisors of supervisors of human factors specialists and likely to have responsibilities broader than human factors. Even so, the distribution of training and experience of immediate supervisors, as provided above, was essentially the same for supervisor and nonsupervisor specialists.

A substantial proportion of both supervisors and nonsupervisors, 37 percent, reported that their immediate supervisor knew little or nothing about the field of human factors. A somewhat larger proportion of both groups, 49 percent, reported that their immediate supervisor was quite knowledgeable about the field. Thus, most supervisors were reported to be on one end or the other of the continuum of human factors knowledge.

SUPERVISION AND INTERACTION

Nearly all human factors work is done within an organizational context—private business, government agency, or education institution. Moreover, much of it is done across multiple organizations—departments, divisions, companies, agencies—and multiple functions within organizations. Consequently, the study examined the supervision of human factors specialists and the interaction of specialists with others.

Span of Supervision

The sample of 971 human factors specialists consisted of those who had supervisory responsibilities (45 percent) and those who did not (55 percent). As indicated earlier, supervisors were defined as those who reported they supervised human factors specialists and either had a supervisory job title (supervisor, manager, etc.) or supervised three or more total personnel Distributions are provided in Table 3.4 for numbers of human factors specialists and total personnel supervised by those defined as supervisors.

As shown in the table, the span of direct supervision for most who had supervisory responsibilities was relatively narrow. More than half supervised only one or two other human factors specialists; 82 percent directly supervised five or fewer other human factors specialists; and about three-fourths supervised 10 or fewer total personnel. At the other end of the spectrum, approximately 4 percent of supervisors had direct responsibility for more than 15 human factors specialists.

Profile of Supervisory Tasks

A profile of supervisory tasks was prepared for human factors specialists who had supervisory responsibilities. The profile (Table 3.5) was prepared from responses to questions about whether or not the task was performed as part of the person's job and how important it was to the performance of the job.

Table 3.4 Human Factors Specialists and Total Personnel Supervisors Manage

Specialists Supervised		Total Personnel Supervisors Manage	
Number Supervised	Percentage of Supervisors	Number Supervised	Percentage of Supervisors
1	31.7	—	—
2	25.2	—	—
3–5	25.0	3–5	43.2
6–10	10.0	6–10	30.8
11–15	4.2	11–15	13.6
16+	3.9	16+	12.4
	100.0		100.0

The tasks are ordered in the table by the percentage who stated that the task was a part of their job. The importance measure for each task was the percentage who rated the task in one of the top three points of a seven-point rating scale of importance.

Nearly all those with supervisory responsibility were performing those tasks required in the direct supervision of subordinates—selecting, assigning,

Table 3.5 Profile of Supervisory Tasks Performed by Human Factors Specialists With Supervisory Responsibilities

Task Description	Percentage Performing Task	Percentage Rating Task Important
Select, assign, or train subordinates	91.7	74.9
Schedule and monitor project activities	90.5	82.1
Promote the use of human factors methods and information in projects	90.5	72.1
Set group objectives and monitor the performance of subordinates	86.7	80.0
Evaluate the performance of subordinates	84.8	74.5
Prepare and monitor budgets	73.4	71.8
Manage proposal preparation and contract negotiation	56.2	75.1

training, monitoring, and evaluating. In addition, nearly all were engaged in the promotion of human factors methods and information in their projects. Fewer supervisors were involved with budgets and proposals than with the direct interaction with their subordinates. As shown in the table, there were no notable differences among the importance ratings given to the tasks.

Interactions With Others

Work was conducted by human factors specialists with a relatively high level of interaction with other human factors specialists; professionals in other fields; and with the ultimate users of the systems, operations, or devices developed. Interaction with other professionals occurred mainly with engineers, systems analysts, computer programmers, marketing specialists, health professionals, and industrial designers. The extent of weekly interactions with others is illustrated in Figure 3.3.

Figure 3.3
Extent of weekly interactions human factors specialists have with others.

As the figure shows, most interaction was with engineers and other human factors specialists, with 86 percent of the sample reporting weekly interactions with engineers and 81 percent reporting weekly interactions with other human factors specialists. At the next level were computer programmers, 76 percent; systems users, 66 percent; and systems analysts, 65 percent. Substantially lower levels were reported for marketing specialists, 37 percent; industrial designers, 32 percent; and health professionals, 20 percent.

Some significant differences were noted between supervisors and nonsupervisors. A greater percentage of supervisors interacted with others, in every specialty, than did nonsupervisors. On the average, 17 percent more supervisors reported weekly interactions with others than did nonsupervisors.

Those who did half or more of their work for the military reported relatively more extensive interaction with other human factors specialists and with systems analysts than did those who did less work for the military. Also, those who worked mostly for the military reported relatively less interaction with marketing specialists, industrial designers, and health professionals.

As one would expect, differences in the nature of interactions with others were found among the various areas of work. Only in the areas of computers, aerospace, industrial processes, health and safety, communications, and transportation was there a sufficient number of human factors specialists in the sample to permit analysis. A matrix, with area of work on one axis and specialty interacted with on the other axis, was prepared to facilitate comparisons (Figure 3.4). The basis for comparison was the percentage of human factors specialists reporting weekly interactions with persons in each of the' other specialties. Each cell of the matrix indicates the extent of interactions by human factors specialists working in the different areas relative ' to the extent of interactions of specialists in the total sample.

As shown in the figure, there are differences in the patterns of interaction among the different areas of human factors work, with no two areas having the same pattern. Of course, certain cells in the matrix are logically predictable, such as the greater level of interaction of specialists working in health and safety with health professionals, and specialists working on computers with computer programmers. Other differences shown in the matrix appear to be much less predictable, such as the lower level of interaction of human factors specialists in transportation with systems analysts or those in communications with systems users.

THE NATURE OF THE WORK

The deployment of human factors specialists in private business, government agencies, and other work settings was defined by the tasks that specialists perform. Building on unpublished task analyses completed by the Human Factors Society, 52 tasks of human factors specialists were identi

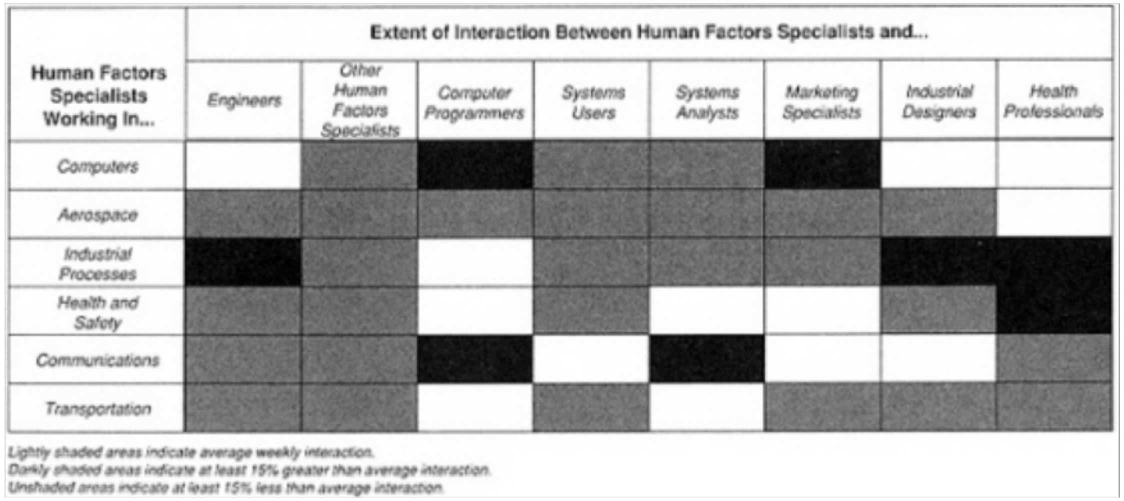

Figure 3.4
Relative extent of weekly interactions with others as reported by human factors specialists working in different areas. Symbols indicate differences from the total sample of 15 percent or more.

fied and employed to help define the nature of the work performed. The percentage of specialists who performed each task was determined by asking each respondent whether or not the task was performed as part of his or her current job. In the presentation of results, the tasks were grouped into six categories:

1. Systems analysis,
2. Risk and error analysis,
3. Design support,
4. Test and evaluation,
5. Instructional systems design, and
6. Communications.

The principal differences among human factors specialists in the tasks they performed was a function of the type of systems, operations, or devices that served as the focus of the work—computers, aerospace, industrial processes, health and safety, communications, and transportation. In addition, differences in task profiles were noted between those who worked primarily for the military and those who did not. Consequently, task performance profiles are provided for subsamples in each of these areas as well as for all areas combined.

Although more than six areas of focus were identified in the study (see Table 3.1), only six had sufficient numbers in the sample to permit the construction of separate profiles; these six areas accounted for the work of 83 percent of the sample.

A variety of other variables was investigated and found to have little effect in producing significant or practical differences among subsamples in the profiles for these tasks. These variables included: classification of respondents as supervisors or nonsupervisors, whether or not respondents considered themselves to be human factors specialists or something else (industrial engineers, psychologists, etc.), and the demographic variables of age, sex, salary level, education level, and years since receipt of highest degree.

Task performance profiles are presented in Tables 3.6 through 3.11. Each table lists a set of tasks in one of the six clusters. Tasks are listed in decreasing order relative to the percentage of human factors specialists who performed that task as a part of their current job. For example, Table 3.6 presents profiles for tasks in the systems analysis cluster. As the table shows, the task "analyze tasks" is performed by 81 percent of all surveyed human factors specialists. "Health and safety," which is one of the seven main subdomains of human factors work, is performed by 67: percent of all specialists surveyed. That 67 percent is more than 15 percent smaller than the 81 percent for all areas combined. It is considered a significant difference and so the respective block is shaded in the table.

TABLE 3.6 Task Performance Profiles: Systems Analysis (Percentage of Specialists in Each Area of Human Factors Work Who Perform Each Task)

	Focus of Human Factors Work							
Systems Analysis Tasks Performed	All Areas Combined	Computers	Aerospace	Industrial Processes	Health and Safety	Communications	Land Transportation	Military
Analyze tasks	81	80	78	86	67	77	90	83
Specify human user, operator, or maintainer requirements	78	83	82	84	64	71	71	80
Assess mental workload	47	40	66	32	49	43	54	64
Develop or conduct computer simulations	46	60	53	37	15	52	40	52
Assess physical workload	45	23	44	72	59	21	66	41
Analyze effects of environmental stressors	37	18	48	44	48	26	54	48
Write or debug computer programs	32	48	28	35	11	30	21	26
Conduct network analyses	24	18	26	28	24	29	37	27
Perform human reliability analyses	22	20	22	25	26	23	24	25

Shaded cells indicate a significant difference (± 15%) from the percentage for all areas combined.

TABLE 3.7 Task Performance Profiles: Risk and Error Analysis (Percentage of Specialists in Each Area of Human Factors Work Who Perform Each Task)

		Focus of Human Factors Work						
Risk and Error Analysis Tasks Performed	All Areas Combined	Com-puters	Aero-space	Industrial Processes	Health and Safety	Commu-nications	Land Transpor-tation	Military
Collect data on errors, failures, or accidents	39	37	32	55	52	33	48	36
Develop analytical models and methods	34	32	44	27	34	40	42	46
Perform safety analyses	31	14	25	53	59	13	60	31
Assess performance risks	27	18	31	25	39	28	38	31
Conduct root-cause analyses	20	14	11	38	20	81	33	14
Perform failure-mode-and-effects analyses	14	11	16	13	24	5	22	15
Develop and analyze fault trees	13	11	11	19	18	3	21	14
Support product-liability litigation	11	3	10	11	37	3	24	9

Shaded cells indicate a significant difference (± 15%) from the percentage for all areas combined.

TABLE 3.8 Task Performance Profiles: Design Support (Percentage of Specialists in Each Area of Human Factors Work Who Perform Each Task)

	Focus of Human Factors Work							
Design Support Tasks Performed	All Areas Combined	Computers	Aerospace	Industrial Processes	Health and Safety	Communications	Land Transportation	Military
Apply human factors criteria and principles	85	89	90	86	88	83	90	88
Verify design conformance to human factors specifications	63	63	78	54	61	69	68	74
Design human-equipment interfaces	55	64	67	49	44	53	44	58
Design workspace layouts	49	26	48	74	54	38	64	48
Design software-user interfaces	48	86	49	27	16	55	21	44
Prepare or review design drawings for conformance to human factors specifications	46	38	57	50	34	44	49	50
Prepare specifications for software	45	75	44	23	18	60	27	42
Prepare design mockups	38	44	49	29	26	35	40	39

Shaded cells indicate a significant difference (± 15%) from the percentage for all areas combined.

TABLE 3.9 Task Performance Profiles: Test and Evaluation (Percentage of Specialists in Each Area of Human Factors Work Who Perform Each Task)

	Focus of Human Factors Work							
Test and Evaluation Tasks Performed	All Areas Combined	Com-puters	Aero-space	Industrial Processes	Health and Safety	Commu-nications	Land Transpor-tation	Military
Interpret test and evaluation results	72	70	83	58	67	78	81	83
Design data collection procedures and questionnaires	68	65	80	50	64	69	65	79
Specify or perform data analysis procedures and statistical tests	61	54	75	47	55	71	53	73
Collect data in field settings	61	55	53	64	59	53	75	60
Plan and coordinate evaluations	57	54	73	40	42	56	76	67
Specify evaluation objectives	56	61	73	36	53	57	54	64
Develop criterion measures	55	51	70	44	51	58	48	64
Design evaluations	48	49	68	23	42	45	49	60
Collect data in laboratory settings	40	46	61	10	41	45	37	50

Shaded cells indicate a significant difference (± 15%) from the percentage for all areas combined.

TABLE 3.10 Task Performance Profiles: Instructional System Design (Percentage of Specialists in Each Area of Human Factors Work Who Perform Each Task)

	Focus of Human Factors Work							
Instructional Systems Design Tasks Performed	All Areas Combined	Com-puters	Aero-space	Industrial Processes	Health and Safety	Commu-nications	Land Transpor-tation	Military
Prepare instructional or procedural documents	47	47	41	60	32	48	31	43
Define instructional requirements	44	45	38	45	33	47	47	43
Specify training objectives	43	38	39	59	42	33	23	46
Assess the effectiveness of training (systems, courses, aids, simulators)	42	37	33	51	48	27	28	45
Conduct training	37	26	26	66	34	22	35	30
Design training aids	36	37	25	49	32	28	34	35
Develop training content and instructional methods	35	35	26	51	39	26	17	34
Design simulation systems	24	25	40	10	16	27	14	34
Prepare product warnings	18	15	18	16	34	19	18	17

Shaded cells indicate a significant difference (± 15%) from the percentage for all areas combined.

TABLE 3.11 Task Performance Profiles: Communications (Percentage of Specialists in Each Area of Human Factors Work Who Perform Each Task)

	Focus of Human Factors Work							
Communications Tasks Performed	All Areas Combined	Computers	Aerospace	Industrial Processes	Health and Safety	Communications	Land Transportation	Military
Prepare and conduct oral presentations	90	90	94	85	87	90	92	94
Prepare or contribute to written reports	85	82	94	83	81	84	84	94
Prepare or contribute to project proposals	80	78	85	85	75	79	78	82
Evaluate reports written by others	79	77	84	76	81	79	81	82
Review and summarize the results of previous research	67	73	81	39	80	70	49	83
Interpret research results	64	70	81	31	81	68	49	78
Develop hypotheses and theories	52	60	61	31	64	48	39	60
Interpret engineering drawings	47	25	53	76	41	26	72	50
Prepare engineering drawings	21	10	20	41	18	10	33	14

Shaded cells indicate a significant difference (± 15%) from the percentage for all areas combined.

The profile provided by the percentages in the first column are based on the total sample ("All Areas Combined"). The next six columns provide profiles for each of the six areas of focus of human factors work. The last column shows the profile for those who perform half or more of their work for the military, regardless of area of focus. Since somewhat more than half of these specialists worked in aerospace, there is a positive correlation between the aerospace and military profiles. Shading is used in each table to highlight differences among profiles. For any task, the percentage shown in a shaded cell is greater or lesser, by 15 percent or more, than the percentage given in the column for all areas combined.

As these tables reveal, some tasks were performed by most specialists across all areas. Prominent among these tasks were:

- Task analyses,
- Oral and written presentations,
- Proposal preparation,
- Application of human factors principles, and
- Evaluation of reports written by others.

The range among tasks in the percentages of specialists performing them was great, however: from 90 to 11 percent. There are also wide ranges across areas of work for a given task. For example, 86 percent of specialists who work with computers design software-user interfaces, but only 16 percent of those who work in health and safety do. Thus, the task profile for any area of work must be obtained by inspecting the tables directly.

CHARACTERISTICS OF HUMAN FACTORS SPECIALISTS

Highest Academic Degree

Advanced degrees predominate the academic backgrounds of human factors specialists, with 37 percent having received doctorates and 34 percent having received master's degrees. The distributions of doctorate, master's, and bachelor's degrees in various work settings are provided in Table 3.12.

As shown in the table, those with doctorates' have greater representation among those employed by education institutions and government agencies; those who work on health and safety, computers, communications, and aerospace; and those who work mainly for the military. They have less representation among those in private business and those who work on industrial processes and transportation. The distribution of degrees among supervisors was no different from the distribution among nonsupervisors.

The areas of specialization of the highest degree were spread across a relatively broad spectrum—human factors, various fields of psychology,

TABLE 3.12 Distributions of Highest Academic Degree Among Human Factors Specialists in Different Work Settings

		Employer			Focus of Work						
Highest Academic Degree	Total Sample	Private Business	Government Agency	Education Institution	Computers	Aerospace	Industrial Processes	Health and Safety	Communications	Land Transportation	Military
Doctorate	37	30	46	76	45	44	12	56	45	27	45
Master's	34	36	31	21	32	40	39	24	27	37	33
Bachelor's	24	28	22	1	22	14	35	10	28	29	21
Less than bachelor's	5	6	0	2	1	2	14	10	0	7	1

Shaded cells indicate a significant difference (± 15%) from the percentage for the total sample.

engineering, business, computer science, industrial design, and a variety of other areas. Human factors was the area of specialization in only 20 percent of the total sample. Areas of specialization differed somewhat between supervisors and nonsupervisors; greater percentages of supervisors specialized in engineering and business, and lower percentages in human factors and various areas of psychology than did nonsupervisors.

Distributions of academic specialization differed also among those working in different areas. Table 3.13 shows distributions for the different areas of focus of human factors work as well as the distribution for those who work primarily for the military.

Although the table shows differences in the academic specialization of those who work in the different areas, the principal message is that no one area of specialization dominates any of the areas of work. The relatively wide spectrum that exists in the total sample also exists in the specific areas of work.

A relatively even distribution existed among human factors specialists in the number of years since receipt of the highest academic degree. This distribution is shown in Table 3.14 for both supervisors and nonsupervisors. The main difference among nonsupervisors and supervisors is the expected one for those with relatively recent degrees: recent graduates are less likely to be supervisors. This result matches the logic that some experience on the job is required prior to acquiring supervisory responsibilities.

Age, Gender, and Ethnic Origin

Over 60 percent of human factors specialists are under the age of 45; 15 percent are 55 or older. There are some differences in age distributions related to employer and to those who have supervisory responsibilities. As shown in Table 3.15, the greatest percentage (65 percent) of specialists under age 45 is found in private business, while the lowest percentage (36 percent) is in education institutions.

Compared with nonsupervisors, supervisors were mainly in the middle of the age distribution—69 percent of supervisors were 35 to 54 years of age while only 56 percent of nonsupervisors were in this range. Larger percentages of nonsupervisors were both 55 and older and under 35 than were supervisors.

Human factors specialists were predominately white males. Over 94 percent of the sample was white and over 81 percent was male. In some areas, male dominance was even greater. Of those with supervisory responsibilities, 87 percent were male, 13 percent female; of those who worked on industrial processes, 92 percent were male, 8 percent female; and of those who worked in health and safety, 86 percent were male, 14 percent female.

TABLE 3.13 Distributions of Areas of Academic Specialization Among Areas of Human Factors Work

Area of Specialization of the Highest Academic Degree	Focus of Work							
	Total Sample	Computers	Aerospace	Industrial Processes	Health and Safety	Communications	Land Transportation	Military
Human factors	20	20	28	18	12	20	24	24
Experimental psychology	19	25	28	6	26	22	21	30
Engineering	16	4	4	20	9	19	18	12
Business	9	1	8	13	7	6	10	6
Other psychology	8	9	14	3	4	7	11	12
Computer science	4	9	4	3	0	0	7	3
Industrial design	2	1	2	1	6	2	2	1
Other areas of specialization	21	25	12	36	18	24	7	12

Shaded cells indicate a significant difference (± 15%) from the percentage for the total sample.

Table 3.14 Years Since Human Factors Specialists Received Their Highest Academic Degrees (percentage)

Years Since Highest Degree Received	Nonsupervisors	Supervisors
5 or less	27.9	15.0
6–10	20.6	23.5
11–15	15.0	17.7
16–20	10.3	21.0
More than 20	26.2	22.8
Total	100.0	100.0

Table 3.15 Age Distribution of Human Factors Specialists (percentage)

Age	Total Sample	Private Business	Government Agency	Education Institution
55 and over	15.2	13.2	18.0	23.7
45–54	23.8	22.2	20.9	40.0
35–44	38.0	38.2	45.5	27.0
Under 35	23.0	26.4	15.6	9.3
Total	100.0	100.0	100.0	100.0

Among those working on computers, the predominance of males was not quite so great: 70 percent were male, 30 percent female; and among those working on communications systems, 74 percent were male, 26 percent female.

With this characterization and description of human factors specialists and their work, we turn now to where they were educated, how that education is viewed by employee and employer, and how employees receive continuing education.

4—

The Education of Human Factors Specialists

An objective of this study was to describe the scope of educational experiences of human factors specialists, the quality of that education, and the nature of formal educational programs for human factors specialists. This chapter is organized around these objectives.

SCOPE AND QUALITY OF EDUCATION

Where Do We Learn What We Do?

Respondents were asked, for each of 52 activities or tasks, whether they performed the activity as part of their current job and if so where they learned about it (formal education, continuing education, company training, personal study, on-the-job experience, other). Relatively few respondents indicated continuing education, company training, personal study, or other as where they learned about the various activities or tasks. The percentage of respondents indicating continuing education ranged from 2 to 13 across the 52 items; all but 5 items were under 10 percent. For company training, the range was from 1 to 15 percent with only 7 items at or above 10 percent. For personal study, the range was 2 to 19 percent with 22 above 10 percent. The "other" category never accounted for more than 1 percent of respondents on any item. Table 4.1 presents the 52 activities and tasks in order by percentage of respondents who perform them as part of their current job. The percentages of respondents learning from formal education or on-the-job experience correlate highly with the percentage performing the activity or task—.88 and .98, respectively. The correlation between formal educa

TABLE 4.1 Source of Knowledge About Performing Human Factors Activities and Tasks (percentage)

Activity or Task	Performs in Current Job	Received Formal Education in It	Has On-The-Job Experience
Prepare/conduct oral presentations	90	34	63
Prepare/contribute to written reports	85	42	58
Apply human factors criteria/principles	85	39	50
Analyze tasks	81	34	51
Prepare/contribute to project proposals	80	22	57
Evaluate reports of others	79	29	54
Specify user requirements	78	30	53
Interpret test and evaluation results	72	35	43
Design data collection procedures/questionnaires	68	34	41
Review/summarize prior literature	67	36	37
Interpret research results	64	38	36
Verify conformance to human factors specifications	63	19	42
Specify/perform data analysis	61	38	30
Collect field data	60	24	40
Plan/coordinate evaluations	57	20	39
Specify evaluation objectives	56	19	38
Design human-equipment interfaces	55	22	36
Develop criterion measures	54	22	35
Develop hypotheses/theory	52	31	29
Design workspace layouts	49	21	31
Design evaluations	48	20	32
Design software-user interface	48	16	32
Interpret engineering drawings	47	18	31
Assess mental workload	47	20	27
Prepare instruction/procedure documents	47	13	32
Develop/conduct computer simulations	46	15	24
Assess physical workload	45	18	27
Prepare software specifications	45	13	30
Prepare/review design drawings	45	12	31
Define instructional requirements	44	14	29
Specify training objectives	43	11	28
Assess training effectiveness	42	13	28
Collect laboratory data	40	24	23
Collect error/accident data	39	12	27
Prepare design mockups	38	9	26
Conduct training	37	12	25
Develop analytical models/methods	36	18	21
Design training aids	36	10	24
Develop training content/methods	35	11	22
Write/debug computer programs	32	18	16
Perform safety analyses	31	9	21
Analyze effects of environmental stressors	30	13	22
Assess performance risks	27	7	18
Design simulation systems	24	7	15

tion and on-the-job experience is .79. It appears that, in general, formal education tracks well the activities performed on the job. If performance on the job is a criterion of a need for education on an activity, then there are a few items for which the percentage of respondents receiving formal education is lower than would be expected:

Activity or Task	Performs in Current Job	Received Formal Education in It	Has On-The-Job Experience
Conduct network analyses	24	9	13
Perform human reliability analyses	22	7	14
Prepare engineering drawings	21	11	13
Conduct root cause analyses	20	7	12
Prepare product warnings	18	5	12
Perform failure-mode-effect analyses	14	5	8
Develop/analyze fault trees	13	5	7
Support product liability litigation	11	3	7
Mean	45.4	18.1	28.8
Standard deviation	20.2	10.5	13.3

Preparing/contributing to written proposals,
Verifying conformation to human factors specifications,
Planning/coordinating evaluations, and
Specifying evaluation objectives.

There are also activities for which the percentage of respondents receiving formal education is a little higher than would be expected given the percentage of respondents actually performing them:

Specify/perform data analysis,
Develop hypotheses/theory,
Collect laboratory data,
Develop analytical models/methods, and
Write/debug computer programs.

The pattern is clear and not surprising to the panel: formal education tends to stress theoretical issues and laboratory research, while in practice evaluation studies are emphasized. This finding is consistent with the traditionally different roles of the university as educator and the employer as trainer.

Quality of the Educational Experience

Several questions on the specialist survey relate to the quality of the education received by human factors specialists. Two questions deal with the issue from the specialist's perspective, that is, how they perceive the quality of their education. Two additional questions deal with the issue from the perspective of an employer, that is, how supervisors perceive the quality of the education of those they hire.

The Human Factors Specialists' Perspective

Survey respondents who received their highest degree after 1984 (i.e., within the law five years). were asked how well their formal education prepared them for their first human factors job. Responses were made on a 7-point scale from 1 (very poorly) to 7 (very well). A value of 4 represents the midpoint of the scale. Figure 4.1 presents the cumulative percentages

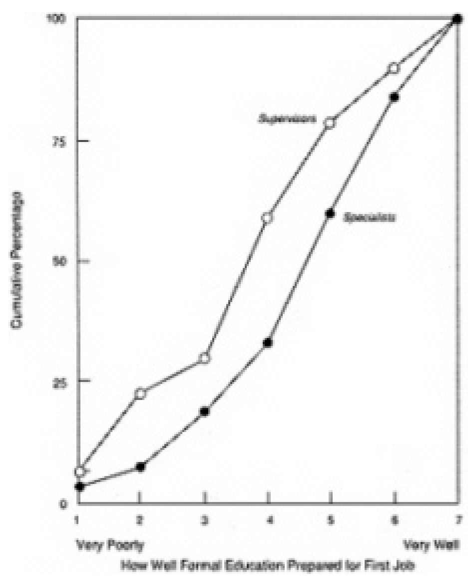

Figure 4.1
Cumulative percentage of specialists (N = 405) and supervisors (N 241) who obtained their highest degree in the last 5 years responding to how well their formal education prepared them for their first human factors job.

for specialists and supervisors to this question. Overall, supervisors felt that formal education prepared the specialists less well than the specialists thought. Two-thirds (66.7 percent) of the specialists gave a response of "5 or above" (i.e., greater than 4) to the question, while less than half (40.9 percent) of the supervisors so responded.

Respondents were also asked to indicate which of 77 topics they received training in during their formal education. If they indicated they received such training and they received their degree since 1984, they were asked, on a 7-point scale (1 = not very well; 7 = very well), how well the topic was covered. Table 4.2 presents, for each of the 77 topics, the percentage of all respondents receiving formal education in that topic and the mean rating of quality given. The correlation between the two columns of the table is .76, indicating that topics that were included in the education of more people also tended to be fated higher in quality than topics not covered as often.

The topics that were rated below 4.0 (the midpoint) are listed below. Less than 22 percent of the respondents reported that these topics were covered in their formal education:

1. Error/accident analysis,
2. Human reliability analysis,
3. Products liability law,
4. Computer input tool design,
5. Human/computer dialogue design,
6. Speech recognition/synthesis,
7. Teleoperators,
8. Aging,
9. Handicapped, and
10. Maintainability.

They divide into four categories. The first (items 1 through 3) deals with topics involved in accident and malfunction analyses. The second (items 4 through 7) deals with computer-based topics that have a relatively short history and have not been developed within academia until recently. The third (items 8 and 9) deals with social issues that are becoming more important but have not been given attention in formal education programs until recently. The last item (maintainability) cannot be easily placed within the other classes; certainly this topic has been important to human factors for many years, yet formal education has apparently not adequately addressed it.

Several topics that were not taught very often (reported by less than 25 percent of the respondents) but when taught were covered at least adequately (assuming a mean rating of 4.0 or greater is adequate):

TABLE 4.2 Quality Ratings of Topic Coverage by Human Factors Specialists and Supervisors

Topic	Percentage Receiving Formal Education[a] in the Topic	How Well Topic Was Covered (1 to 7 Scale)
Transportation systems	74	4.1
Process control	73	4.6
Experimental design	71	5.8
Univariate statistics	71	5.5
Computer program languages	69	4.6
Multivariate statistics	67	5.2
Facilities design	67	4.5
Perception	64	5.4
Learning	64	5.2
Visual processes	64	5.0
Oral presentation	64	5.0
Cognitive processes	63	5.1
Auditory processes	58	4.7
Survey methods	55	4.6
Laboratory instrumentation	54	4.8
Attention	53	4.9
Analytical models	53	4.8
Task analysis	53	4.8
Technical writing	52	5.0
Time and motion study	49	4.7
Physical environmental effects	49	4.5
Physical measurement	47	4.5
Motor abilities	46	4.5
Group dynamics	45	4.7
Subjective measurement	45	4.7
Group problem solving	45	4.6
Motivational and reward structures	43	4.7
Workload analysis	43	4.7
Computer simulation	43	4.3
Psychometrics	42	4.7
Physiological measurement	40	4.6
Operations research	39	4.8
Work station design	36	4.6
System requirements analysis	36	4.6
Health and safety	36	4.5
Design guidelines	36	4.4
Project management	35	4.5
Team performance	34	4.9
Design checklists	33	4.5
Manufacturing and quality control	32	4.7
Control design	32	4.5
Cost estimation	31	4.4

Topic	Percentage Receiving Formal Education[a] in the Topic	How Well Topic Was Covered (1 to 7 Scale)
Anthropometry	31	4.3
Human needs analysis	31	4.3
Function allocation	30	4.5
Panel display design	30	4.5
Computer architecture	29	4.4
Work physiology	29	4.2
Design walk throughs	27	4.4
Use of mockups	26	4.5
Manual control theory	26	4.1
Artificial intelligence	26	4.1
Software tools	25	4.3
Handtool design	25	4.1
Biomechanics	25	4.0
Computer display design	24	4.6
Organizational impact analysis	23	4.3
Usability evaluation	22	4.4
Aging	22	3.8
Communication systems	21	4.2
Error/accident analysis	20	3.9
Human reliability analysis	20	3.8
Speech recognition/synthesis	20	3.7
Human-computer dialog design	20	3.7
Instructional systems design	19	4.4
Handicapped	18	3.8
Maintainability	18	3.7
CAD/CAM	17	4.3
Robotics	17	4.1
Office automation	17	4.1
Negotiation	16	4.5
Aerospace systems	15	4.3
Products liability law	15	3.9
Command and control	13	4.3
Computer input tool design	13	3.9
Teleoperators	7	3.1
MANPRINT, etc.	5	4.1
Mean	37	4.5
Standard deviation	17.8	0.4

[a]Includes only those who received degrees since 1984.

Computer display design,
Usability evaluation,
Communication systems,
Instructional system design.
CAD/CAM,
Office automation,
Robotics,
Negotiation,
Aerospace systems,
Command and control, and
MANPRINT, etc.

The Perspective of Employers of Human Factors Specialists

Supervisors were asked to consider human factors personnel that they hired in the past two years and whether there were any skills or abilities that they lacked when they first came to work. Three-quarters (75 percent) responded that skills and abilities were lacking in new hires; when asked to list some examples, a wide range of responses were recorded. An analysis of these revealed the following deficiencies (mentioned more than 10 times):

Experience on the job and in the field,
Communication skills (written, oral, and interpersonal),
Human factors and psychology knowledge and approach,
Systems analysis (task analysis, function allocation, etc.),
Experimental design and research skills,
Organizational skills,
Engineering and product/technical skills,
Computer science,
Government acquisition/contracting, and
Analytical skills and methods.

Supervisors were also asked if there were any topics in human factors university degree programs that they felt were not being taught or not being taught well enough. About half (54 percent) of the supervisors thought that there were. Analysis of the topics listed revealed essentially the same items as those found for skills and abilities lacking in new hires.

EDUCATION PROGRAMS

A questionnaire form was mailed to each of 59 U.S. education programs listed in the *Directory of Human Factors Graduate Programs in the United States and Canada* (Human Factors Society, 1988). The following profile is based on the 48 programs that returned questionnaires.

Program Description

Table 4.3 lists the percentage of programs by department of primary affiliation. The majority of the programs are in engineering departments with the remainder of programs divided among psychology and other. Only four programs affiliated with something other than engineering or psychology; therefore, because of the small sample size, when data are presented by primary affiliation, these four programs are not discussed. Programs were asked to indicate any informal or formal links they had with programs outside their department. Across all programs, 33 percent reported some type of link with other departments. Among the engineering programs reporting links to other departments, 82 percent listed psychology first. Of the psychology programs with links, only 54 percent listed engineering first, the remainder listed links with human factors and business/management programs first.

Figure 4.2 presents a distribution of programs by the decade in which they were established. Two things stand out. First is the accelerating growth of new programs in engineering departments compared with the irregular establishment of new programs in psychology departments. Second is the relatively large increase in new psychology programs in the 1980s compared with the number established in prior decades. Thirty-five percent of all of the programs are relatively young, having been started during the 1980s. These trends are encouraging and suggest that the number of programs dealing with human factors may continue to grow during the 1990s.

Graduate Degrees Offered

Among engineering programs, 88 percent offer both master's and doctorate degrees, the remainder offer only master's degrees. Among psychology programs, 47 percent offer both master's and doctorates, 21 percent offer only doctorates, and 32 percent offer only master's degrees.

Table 4.4 summarizes degree requirements for master's and doctorates within engineering and psychology departments. The results should be

Table 4.3 Primary Affiliation of Graduate Programs in Human Factors

Affiliation	Number	Percent
Engineering	25	52
Psychology	19	40
Other	4	8

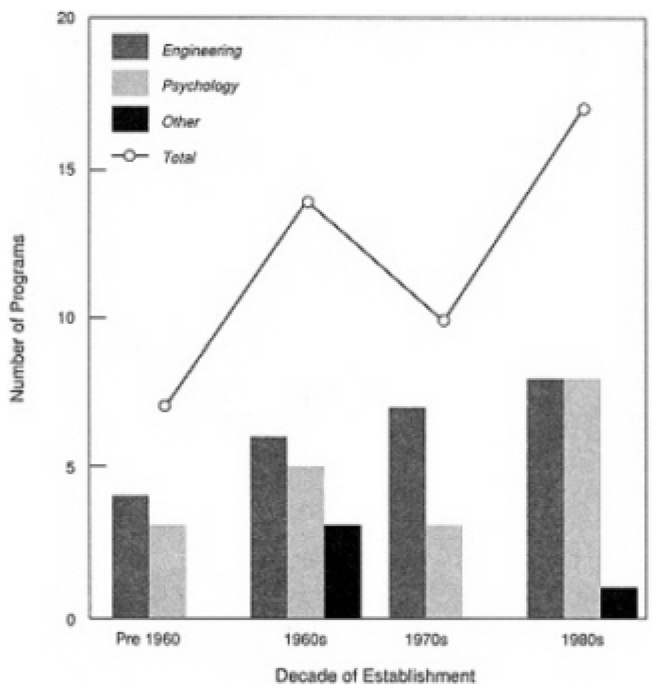

Figure 4.2
Distribution of programs by decade established and affiliation.

Table 4.4 Degree Requirements of Programs in Human Factors

	Master's		Doctorate	
Requirement	Engineering	Psychology	Engineering	Psychology
Mean number of units requirements	11.1	10.7	27.8	26.4
Percentage requiring:				
Minor	21	0	50	31
Thesis	57	92	86	100
Practical experience	17	33	27	62
Percentage with optional thesis	35	8	14	0

viewed with caution due to the small number of programs responding to some items (in all cases: less than 25 engineering and less than 15 psychology master's programs; less than 15 engineering and less then 15 psychology doctorate programs). A few clear trends appear. Minors are required by a higher percentage of engineering programs than psychology programs at both the master's and doctorate level. Larger percentages of engineering programs have an optional thesis than is the case with psychology programs, for which a higher percentage require a thesis. Finally, practical experience is required by a higher percentage of psychology programs (at both the master's and doctorate levels) than is the case among engineering programs.

Undergraduate Human Factors

Across all programs, 26 percent reported having an undergraduate human factors program, concentration, or minor. The percentage of engineering (25 percent) and psychology (21 percent) programs with undergraduate offerings was similar. Among the four "other" programs, two indicated some form of undergraduate offering.

Faculty

A total of 279 core faculty members were listed as actively involved in the 48 human factors programs. Thus, there is an average of 5 to 6 core faculty per program. The median number per program is 4 to 5. It appears that on average, engineering programs (mean = 5.5 per program; median = 4 per program) have fewer core faculty than do psychology programs (mean = 6.2 per program; median = 6 per program). In fact, 44 percent of the engineering programs have 3 or less core faculty compared with only 5 percent of psychology programs. The program with the largest number of core faculty (22), however, is an engineering program. The largest number of core faculty in a psychology program was 12.

For each core faculty member listed, the survey asked for the number of off-campus professional meetings attended last year at which a paper was given or a session was chaired. Nine programs did not supply information on the faculty listed. Across all programs, the median number of meetings per faculty member was 2. There was no difference between engineering and psychology faculty with respect to involvement in professional meetings.

Across all programs, as well as within both engineering and psychology programs, the median percentage of faculty engaged in outside consulting is 67 percent. This proportion would indicate that in most programs there is ample opportunity for students to be exposed to real-world problems through the firsthand experience of their professors. Across all programs and within both engineering and psychology programs, the median percentage of faculty with outside grants is 50 percent.

Facilities and Resources

Respondents were asked to rate, on a 7-point scale, the adequacy of their university and department libraries with respect to human factors books and journals, the adequacy (availability, age, quality) of computer hardware for faculty, and the adequacy of computer software for faculty. Figure 4.3 presents the cumulative distributions of these three ratings for all departments. There were no significant differences ($p > .05$) between engineering and psychology programs on the ratings. Although not significant, the mean rating of adequacy was lowest for libraries and highest for computer hardware.

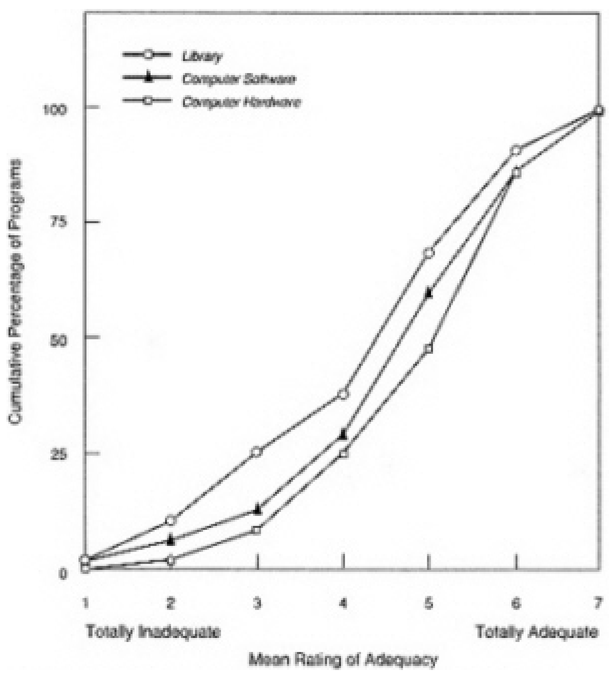

Figure 4.3
Ratings of adequacy of program resources.

Respondents were also asked to indicate, in an open-ended question, what needs their human factors program has in the way of additional laboratories, library facilities, or equipment. Only 35 programs responded to the question. Forty percent of those responding listed various types of specialized equipment. Several programs specifically listed equipment in work physiology and biomechanics. Computer equipment was listed by 37 percent of the programs, additional space was listed by 29 percent, and more human factors books and journals was listed by 20 percent.

A little over half the programs (56 percent) indicated that they have received contributions of money or equipment in the past year from outside sources. The percentages did not differ significantly ($p > .05$) between psychology and engineering programs. When asked whether the support their program has received from the University increased at a rate above average, average, or below average compared with other university programs over the past few years, 31 percent indicated above-average, 49 percent average, and only 20 percent below-average increases. It appears that the support received by human factors programs is increasing at an average or above-average rate. A closer look, however, reveals that more engineering programs are receiving above-average support (37 percent) than is the case for psychology programs (22 percent).

Ties to Industry and Government

In the human factors specialist survey, respondents were asked whether their unit had any ties with universities that teach human factors courses; 44 percent of the respondents indicated such ties with universities. Listed below are the percentages of respondents that indicated specific activities with universities (the percentages add to more than 44 percent because multiple answers were permitted):

Percentage	Activities
30	Internships
26	Advising
21	Research contracts
20	Other

This response represents a very substantial percentage of organizations that maintain contacts with university human factors programs.

University programs were asked whether they had internship programs or used adjunct professors or guest lecturers. Table 4.5 presents the percentage of programs indicating such use of outside organizations. Although nearly half of the programs report some sort of internship program, only 72 students across all programs are currently involved. In like manner, al though more than half of the programs report using adjunct professors, across all programs there are only 65 adjunct professors. In the past year, across all programs, there were only 77 guest lectures by business or government employees.

Table 4.5 Programs with Ties to Industry/Government

Tie	Percentage of Programs
Internships	48
Adjunct professorships	59
Guest lectures	57

These statistics suggest that university programs are only skimming the surface of potential contacts with business and government. When asked about the advantages of adjunct professors, respondents cited specialized expertise, contact with real-world problems and issues, the cost-effectiveness of hiring adjuncts, and the fact that the use of adjuncts frees up regular faculty for other things. A number of disadvantages were cited: adjuncts are not always available to teach or to interact with students (the most commonly cited disadvantage); it takes a lot of time and energy to maintain contact and schedule adjuncts; adjuncts have less commitment to the program than do regular faculty; and adjuncts are not necessarily good teachers and often lack interest in research.

Advantages of using guest lecturers are similar to those cited for using adjunct professors: diversity, real-world applications, and information on what is happening in industry. About one-third of the programs that use guest lecturers reported no real disadvantages; other programs indicated difficulty in scheduling lecturers and the lack of coordination with the progression of material in the course. Cost was cited by only 12 percent of the programs as a disadvantage.

Curriculum and Student Experiences

Each program was asked to indicate how each of 77 topics were covered in their program: in required courses, elective courses, or not covered at all. Table 4.6 presents the topics and the percentages of programs indicating each category, organized by percentage of programs that cover the topic in required courses. Topics covered in required courses by at least two-thirds of the programs center around research methodology and statistics; sensory, cognitive, and motor abilities and processes; anthropometry and

TABLE 4.6 Topic Coverage in Required or Elective Courses (percentage of programs)

Topic	Required Course	Elective Course	Not Covered
Univariate statistics	83	15	2
Experimental design	83	15	2
Visual processes	81	17	2
Auditory processes	79	19	2
Work station design	79	17	4
Cognitive processes	79	15	6
Analytical models	76	15	9
Oral presentation	75	7	18
Anthropometry	74	17	9
Environmental effects	72	26	2
Work physiology	70	28	2
Motor abilities/limits	70	28	2
Perception	69	27	4
Task analysis	69	22	9
Control design	67	24	9
Attention	67	24	9
Panel display design	67	22	11
Hand tool design	64	19	17
Workload analysis	63	28	9
Computer display design	60	31	9
Function allocation	60	27	13
Design guidelines	58	24	18
Multivariate statistics	57	37	6
Computer program languages	57	30	13
Psychophysics/subjective measures	56	42	2
Health and safety	54	30	16
Biomechanics	53	36	11
Learning	49	40	11
System requirements analysis	48	43	9
Design checklists	48	26	26
Human needs analysis	46	36	18
Facilities design	46	35	19
Computer input tool design	46	29	25
Psychological measurement	45	41	14
Lab instrumentation	44	30	26
Human-computer dialog design	42	42	16
Human reliability analysis	42	36	22
Physical measurement	42	33	24
Technical writing/illustration	41	33	26
Time and motion study	40	36	23

Topic	Required Course	Elective Course	Not Covered
Error-failure-accident analysis	39	44	17
Manual control theory	36	40	24
Usability evaluation	34	23	43
Software tools	33	47	20
Design walk throughs	33	27	40
Psychometrics	32	41	27
Operations research	31	46	22
Manufacturing/quality control	30	42	28
Aerospace systems	29	33	38
Develop and use mock-ups	29	27	44
Process control	28	39	33
Computer simulation	26	57	17
Office automation	25	41	34
CAD/CAM	24	52	24
Product liability law	24	36	40
Survey methods	23	54	23
Maintainability	22	42	36
Project management	22	36	42
Motivation and reward structure	20	64	16
Aging	20	56	24
Speech recognition/synthesis	20	42	38
Communication systems	20	41	39
Team performance	20	33	47
Transportation systems	18	34	48
Cost estimation/budgeting	18	28	54
Robotics	17	57	26
Handicapped	16	57	29
Group dynamics	16	42	42
Group problem solving	16	33	51
MANPRINT, HARDMAN, etc.	14	16	70
Command and control	13	38	49
Artificial intelligence	11	72	17
Instructional systems design	11	34	55
Organizational impact analysis	7	33	60
Teleoperations	7	33	60
Computer architecture	7	31	62
Negotiation	5	25	70
Mean	41.2	33.3	24.2
Standard deviation	22.6	12.2	17.7

work physiology; design of displays, controls, and workstations; and oral presentations. The topics covered in required courses by one-quarter or less of the programs tended to be specific topics dealing with applications of human factors, such as office automation, CAD/CAM, aging, transportation systems, robots, and teleoperations; or they were more industrial/organizational topics, such as group dynamics, team performance, motivation, and organizational impact analysis. Somewhat disappointing was the number of programs that do not cover the topic of MANPRINT in their program (70 percent).;

A comparison of the percentage of psychology and engineering programs that cover each topic in required courses revealed surprisingly few (18) significant differences ($p < .05$); Table 4.7 lists the topics that reached significance. In all but three cases, when differences occurred, engineering programs were more likely to cover the topic in required courses than were psychology programs. It appears that engineering programs are covering

Table 4.7 Differences in Topic Coverage in Required Courses Between Engineering and Psychology Programs (percentage of programs)

Topic	Engineering	Psychology
Engineering Greater Than Psychology:		
Work station design	92	58
Anthropometry	88	53
Work physiology	84	53
Hand tool design	84	31
Environmental effects	83	53
Computer programming language	76	42
Biomechanics	76	22
Facilities design	58	26
Operations research	58	4
Manufacturing/quality control	52	5
Process control	46	11
Computer simulation	40	10
Motivation and reward structure	35	5
Cost estimation/budgeting	29	5
Artificial intelligence	20	0
Psychology Greater Than Engineering:		
Perception	46	95
Attention	41	90
Psychological measurement	32	67

Note: The table lists only differences that reached significance.

traditional psychology topics more than psychology programs are covering traditional engineering topics.

Programs were also asked to indicate in an open-ended question what specialties were emphasized in their program. One-third of the programs listed human factors/ergonomics as a specialty that was emphasized. Listed below are specialties listed by more than two programs:

Human-computer interaction	31 percent
Cognitive processes	21
Biomechanics/work physiology	17
Visual displays	14
Safety	10
Human performance	7
Sociotechnical/organizational	7

Another 14 different specialty areas were listed by one or two programs. It appears that considerable diversity exists to allow people to pursue specific specialties.

Respondents were asked if their program has responded to three specific areas: Defense Department initiatives such as MANPRINT, societal issues such as elderly and disabled people, and technical developments such as advanced manufacturing, robotics, and artificial intelligence. As would be expected, more engineering programs (96 percent) than psychology programs (68 percent) have reacted to technical developments. Reaction to societal problems is about equal among engineering (68 percent) and psychology (74 percent) programs. Hardly any programs (16 percent of both psychology and engineering) have reacted to Defense Department initiatives. Those that have responded have merely included the topic in their courses. This contrasts with the activities directed toward societal problems and technical developments: 21 percent report research activity on societal problems; 40 percent of the programs report research activities on technical development. And 27 percent report specific courses on societal problems; 23 percent report specific courses on technical developments.

Each program was asked to indicate which of 40 human factors activities their students do as part of their classwork (Table 4.8). At least two-thirds of the programs include various communication activities (oral presentations, preparing proposals) and research activities (collect data, perform statistical tests). Activities performed by one-quarter of the programs or less seem to center on training and reliability-related analyses. Comparisons of the percentages of engineering and psychology programs that have students perform these activities showed few significant differences ($p < .05$) (Table 4.9).

Table 4.8 Student Performance of Various Activities as Part of Their Classwork (percentage of programs)

Activity	Students in Program Do as Part of Course Work
Prepare/conduct oral presentations	88%
Collect data in laboratory settings	85
Analyze tasks	85
Specify/perform statistical tests	81
Collect data in field settings	73
Design data collection procedures/ questionnaires	71
Write/debug computer programs	71
Design workspace layouts	69
Prepare/contribute to proposals	69
Evaluate reports written by others	67
Design human-equipment interfaces	65
Assess physical workload	65
Interpret test and evaluation results	65
Analyze effects of environmental stressors	62
Develop analytical models/methods	58
Develop/conduct computer simulations	54
Assess mental workload	54
Design software interfaces	48
Verify design conformance to human factors specifications	46
Perform safety analyses	44
Develop criterion measures	42
Collect error/failure/accident data	42
Specify evaluation objectives	35
Assess effectiveness of training	33
Develop/analyze fault trees	31
Conduct network analyses	27
Prepare instructions/procedural documents	27
Prepare engineering drawings	27
Plan/coordinate evaluations	27
Prepare/review, design drawings to human factor's specifications	25
Prepare design mockups	25
Prepare specifications for software	25
Design training aids	25
Perform human-reliability analyses	25
Assess performance risks	23
Prepare product warnings	23
Perform failure-mode-effects analyses	23
Conduct training	21
Prepare training course materials/aids	13
Conduct root cause analyses	10
Mean	46.2
Standard deviation	22.3

Table 4.9 Differences in Student Performance of Various Activities Between Psychology and Engineering Programs (percentage of programs)

Activity	Engineering	Psychology
Engineering Greater Than Psychology:		
Assess physical workload	80%	47%
Perform safety analysis	60	26
Develop/analyze fault trees	48	16
Psychology Greater Than Engineering:		
Analyze tasks	80	100
Assess mental workload	40	74
Prepare training materials	12	42

Note: The table lists only differences that reached significance.

The Future

Respondents were, asked, if they could change any parts of their programs, what they would change and what was preventing the change from happening. A total of 38 programs responded. Although numerous specific changes were mentioned, adding more faculty was mentioned by 34 percent of the programs responding. As might be expected, the reason given for not hiring more faculty was fiscal limitation or lack of support for the area within the department or school.

Programs were also asked whether human factors education would change in the next five years and if so, how. Overall, 68 percent of the programs felt that human factors education would change in the next five years. A number of predictions were made; the dominant themes were that human factors education would be oriented more toward computers and industrial applications. Each of these were mentioned by 20 to 25 percent of the programs that responded. The Human Factors Society accreditation program was mentioned by five programs, predicting that the effect would standardize, formalize, and strengthen human factors education. One program predicted that small programs would suffer because of accreditation. Three programs predicted that education would become more specialized, a view that may be at odds with accreditation. Overall, the predictions were basically for "more of the same" and continuation of existing trends; no one predicted radical changes.

KEEPING CURRENT

Individuals were questioned about continuing education, professional activities, and books and periodicals that they read on a regular basis. Each of these sources of professional development is discussed in turn.

Continuing Education

About half (51 percent) of all human factors specialists, but only 40 percent of supervisors, have taken a human factors continuing education course in the past five years. Universities were the main source of such courses (35.2 percent) with professional associations (27.5 percent) and employers (19.7 percent) also being important. Private organizations or privately offered courses (10.4 percent) were less important. Overall, there is general satisfaction with the quality of continuing education courses. About 80 percent of specialists and supervisors rate their quality "5 or above" on a 7-point scale. Among specialists and supervisors, 54 percent do not feel that they are getting enough continuing education. The reason given by 66 percent of these people is something other than lack of course availability. Although not stated, probably it is because of a lack of time and/or support from employers.

Professional Activities

Table 4.10 presents the percentages of specialists and supervisors that indicated various professional activities in the last five years. These figures represent an active profession with considerable involvement by the rank-and-file.

Books and Periodicals Read

Approximately 90 percent (86.3 percent specialists and 92.2 percent supervisors) reported that they read periodicals regularly. The Human Factors Society *Journal* and *Bulletin*, mentioned by 28 percent of the respondents, were the most frequently mentioned periodicals. Computer magazines of

Table 4.10 Professional Activities Reported by Specialists and Supervisors

Activity	Percentage Reporting
Attended meeting of:	
1st organization mentioned	65.6%
2nd organization mentioned	55.0
3rd organization mentioned	57.8
Presented paper in past 5 years	60.5
Attended a workshop at a meeting	65.8

one sort or another were the next most frequently mentioned, but these were cited by only 6 percent of the respondents. The number of different periodicals that were mentioned was staggering, including defense-oriented publications, industry trade magazines, psychology journals, business magazines, and industrial engineering and design publications.

Table 4.11 Frequently Cited References

Reference	Number of Times Cited
Statistics/experimental design (various)	88
Military standards/handbooks (various)	81
Specific books:	
Sanders and McCormick (1987)	68
Van Cott and Kinkade (1972)	58
Salvendy (1987)	55
Woodson (1981)	47
Wickens (1984)	26
Boff, Kaufman, and Thomas (1986)	25
Eastman Kodak Company (1983, 1986)	25
Boff and Lincoln (1988)	24
Schneiderman (1987)	24
Smith and Mosier (1984)	21

Interestingly, about one-third of the respondents reported that they did not regularly refer to any particular books in the course of doing their current job. Respondents who did refer to particular books were asked to list them. As with periodicals, the list was staggering and, in addition, often contained insufficient or contradictory information, making it difficult to determine what book was being used. Table 4.11 presents the references listed by more than 20 respondents. Statistics/experimental design books and military standards/handbooks were each treated as a class and therefore were mentioned more than specific books. The top four specific books mentioned included one textbook (Sanders and McCormick, 1987) and three handbooks (Van Cott and Kincade, 1972; Salvendy, 1987; Woodson, 1981).

With this description of the education of human factors specialists and the characterization given in Chapter 3, we can examine the match or mismatch between the supply and demand of these professionals in the workplace.

5—

Supply and Demand of Human Factors Specialists

In this chapter the panel assesses the state of balance between supply and demand for human factors specialists in general and makes forecasts concerning the potential growth in demand or supply in the predictable future. A principal assumption of the sponsors of this study was that the demand for human factors specialists may well be growing in excess of supply as a result of recent pressure by the Defense Department on the military and industry to incorporate human factors into the design and acquisition of systems. While projected growth in demand is, in fact, greatest in the military aerospace domain, the demand projected for human factors specialists in other areas of activity is significant as well.

SUPPLY

We define supply in terms of the number of people currently working in the human factors field and the number of people expected to be available in the near future. In addition to the survey of human factors specialists, two additional sources of supply data were considered. First, the survey of graduate human factors programs (see Appendix B) queried universities to determine how many students graduated from human factors programs during 1988–1989, the number of students entering in fall 1988, and the percentage of students who have dropped out. A second source of supply data was the Human Factors Society membership for a 33-year period.

On the basis of the human factors specialists and supervisors survey data, it is possible to estimate the population of people who would report either that their position is primarily concerned with human factors or that they do human factors work. This was done by first establishing the number who were sampled and the proportion of these people who responded positively to the questions about their involvement and thereby became survey participants. This proportion was then multiplied by the total number in each population that was sampled and then the resultant numbers were summed over all the populations sampled. This procedure yields the overall estimate of 9,100 human factors specialists or 2.33 times 3,904, the 1989 membership of the Human Factors Society. The method of calculation, based on the best available data, is likely to be biased conservatively. There could be as many as 10,000 specialists, but it is unlikely that there are as many as 15,000.

In order to extrapolate this number into the future, we made the assumption that this growth in supply will continue to parallel the average growth in the Human Factors Society over its lifetime, when extrapolated linearly. Net growth in the society's membership since its founding in 1958 has been 188 members per year, on the average. Using the same proportion to extrapolate to the growth in the supply of specialists yields an estimate of 275 per year added to the field (Table 5.1).

On one hand, these numbers are not quite an estimate of supply because they are driven, in part, by available jobs; and, as was indicated earlier, nearly 37 percent of those represented in the survey moved from a job not primarily involving human factors to one that did. These are likely to be people who did not obtain their training in formal human factors graduate programs. On the other hand, it is not quite demand because, as we will see, open positions remain. Furthermore, it does not consider possible changes in the traditional base rate as a result of new Defense Department interest in design for the user. Nor does it consider the possible changes in military procurement as a result of normalized East-West relations or Middle East crises. It is best described as the expected state of equilibrium between supply and demand, given the status quo.

The data in the table suggest that we can expect approximately 275 more

Table 5.1 Estimated Growth in Number of Human Factors Specialists

Time Period	Human Factors Society Membership	Estimated Total
1989	3,904	9,100
1991	4,140	9,646
1993	4,376	10,196
1995	4,612	10,745

human factors specialists to be working in the field each year. To achieve this number, we must add enough new people to the pool to make up for those that are leaving the field as well. One survey question addressed this issue. When asked if they will continue to be primarily involved with human' factors in the next five years, 86 percent overall said yes. The only areas of work reporting lower percentages were industrial processes (79 percent) and consumer products (61 percent).

Of the 14 percent expecting to leave the field, 7.2 percent indicated that they were leaving to move into management or research, to retire or to pursue further education—goals that do not reflect on the viability of the profession. Only 4.5 percent indicated that they planned to change fields. If we take 14 percent multiplied by the estimated population of human factors workers and divide by 5, assuming these people will leave the field uniformly over the next 5 years, we can expect to lose 255 people each year.

The addition of 255 that are expected to leave the field would bring the total coming into the field to 530. Where do they come from? Some come from the recognized human factors graduate programs. Our survey revealed that the 49 responding programs graduated an estimated total of 245 with master's degrees and 127 with doctorates in 1988-1989, for a total of 372. If 37 percent of the people enter the field from sources other then recognized human factors graduate programs, then the number entering the field can be estimated at 590, a number that should be compared with the 530 above. Given the divergent ways these numbers were estimated, they are surprisingly consistent.

In addition, the survey of graduate human factors programs provided estimates that the 49 responding programs admitted a total of 426 students in all programs in fall 1988. If we correct this number by 7.15 percent for the reported number that drop out before they finish the program, then this suggests an aggregate output in a given year of 396 graduates. These numbers are consistent with the reported output of the year 1988–1989 of 372 and suggest that the source of supply is relatively stable.

DEMAND

The issue of demand is more difficult to address definitively. Several questions asked of the supervisors of human factors personnel who were interviewed provide some basis for the assessment of demand. First, supervisors were asked how many human factors personnel they had hired in the last six months; the answer, weighted to represent the total population, was 1,247. The survey respondents were also asked if they expected to employ more or fewer human factors specialists in two years and in five years and by how many. The results, shown in Table 5.2, together with the estimates of the number of new hires in the last six months, indicate that, on average, they expected to employ more, but they were much more optimistic for the two-year time frame than for the five-year time frame. This may imply a peaking of demand in two years and then a plateau between three and five years; however, one cannot be sure, in part because respondents gave predictions for the five-year time frame only if they had forecast a need for additional personnel in the next two years.

Table 5.2 Number of Recent Hires and Needs Forecast by Supervisors

Area of Focus	Recent Hires	2 Years	5 Years
Computers	183	600	96
Aerospace	436	1,245	156
Industrial processes	85	199	100
Health and safety	96	94	36
Communications	48	132	36
Transportation	22	99	14
Energy	16	64	0
Consumer products	4	8	-12
Office products	0	8	4
Something else	357	258	47
Totals	1,247	2,707	477
Greater than 50% military	266	1,189	94

The major growth areas, as expected, are aerospace and computers; these areas are projecting growth that will further distort their proportions in the overall mix of technical specialties utilizing human factors specialists.

Table 5.3 provides further detail. The first column of the table[1] reflects the distribution of human factors specialists currently at work and is taken from the first column of Table 3.1. Table 5.3 includes the percentage of personnel working on military systems 50 percent or more of the time. This number is a proportion of total personnel estimated rather than broken down by area as it is in Table 3.1. The total of 1,247 new hires is especially interesting in light of the fact that only 372 students were graduated from identified human factors programs in a comparable period. It suggests that,

[1] Column 1 is not fully consistent with the remaining columns because it is based on the full sample; the remaining columns are based on the supervisor sample.

for this period, more than 37 percent came from other specialties or transferred from other jobs. There was no difference between the number hired among those who said they now work on MANPRINT, HARDMAN, and IMPACT programs or anticipate doing so in the future.

Second, the supervisors indicated that they had 811 unfilled, funded job openings at the same time (Table 5.3). Third, the survey sought estimates of the elasticity in the demand for human factors specialists; however, the numbers are more speculative because of the nature of the questions. Respondent supervisors were asked, "Does your unit have a need for additional human factors personnel to do the work you currently have, but no funds for hiring? If so, how many people do you need?" and "Could your unit generate additional projects if you had additional human factors personnel? If so, how many could you use?"

The answers to these questions are also presented the table in terms of each area of specialty. Supervisors were rather bullish in their answers to these questions, indicating an additional 2,390 positions needed and 3,347 positions they could use, for a total (including 811 unfilled openings) of 6,548 positions.

While these numbers are very interesting, especially the imbalance between the number supplied and the number demanded, several caveats are in order. (1) These demand estimates are derived from the numbers reported in the survey by human factors supervisors and then weighted to reflect the population at large. There is always room for error in this weighting process. (2) The supply numbers are derived from 49 reporting human

TABLE 5.3 Recent Hires and Needs Forecast by Supervisors

Area of Focus	Currently At Work	Recent Hires	Openings N	Openings (%)	Need N	Need (%)	Could Use N	Could Use (%)
Computers	22.3	14.7	147	(18.1)	630	(26.4)	928	(27.7)
Aerospace	21.6	35.0	403	(49.7)	616	(25.8)	746	(22.3)
Industrial processes	16.5	6.8	73	(9.0)	214	(8.6)	381	(11.4)
Health and safety	8.9	7.7	35	(4.3)	200	(8.4)	290	(8.7)
Communications	8.2	3.9	27	(3.3)	227	(9.5)	193	(5.8)
Transportation	5.3	1.8	59	(7.3)	90	(3.8)	83	(2.5)
Energy	2.2	1.3	11	(1.4)	42	(1.8)	48	(1.4)
Consumer products	1.4	0.3	0	(0.0)	4	(0.2)	12	(0.4)
Office products	0.7	0.0	0	(0.0)	12	(0.5)	8	(0.2)
Something else	12.9	28.6	56	(6.9)	355	(14.9)	658	(19.7)
Total	100.0	100.0	811	(100.0)	2,390	(100.0)	3,347	(100.0)
Greater than 50% military	42.0	21.4	412	(50.1)	1,440	(43.6)	2,764	(40.0)

factors graduate program, sand not all of them reported all of the numbers. The extrapolation to the remaining programs assumes uniformity. (3) Both the graduate program' and the specialist supervisor surveys were administered in May-September 1989. This was well before the series of events in Eastern Europe and the Middle East that have significantly changed the military equation and probably should lead us to revise our overall estimates of demand for human factors specialties in aerospace and other specialties that have an emphasis on military work.

Table 5.4 Relationship of Activity Importance and Recent Hires

	Hired Someone in Past Six Months	
Kind of Work Considered Important	Yes	No
Apply human factors principles	89	78
Design human-equipment interfaces	67	53
Prepare product warnings	26	16
Perform reliability analyses	30	19

We attempted to determine if there were any specific kinds of work that seemed to be stimulating new hires disproportionately. The question to supervisors concerning whether they hired anyone in the last six months was cross-tabulated with one on the kinds of work they considered important for their job. Of the 52 categories of human factors topics examined, only 4 produced a 10 percent difference in whether that kind of work was important depending on whether they hired anyone in the last six months.

These categories are shown in Table 5.4. The first category, "Apply human factors principles," is not easy to interpret but perhaps implies that those who are approaching human factors work more systematically are hiring. The second category, "Design human-equipment interfaces," is easily interpreted as reflecting increased work in the computer software/hardware area. Similarly, the third, "Prepare product warnings," while only a low percentage overall, probably implies increased sensitivity to safety and to product liability. The last category, "Perform reliability analyses," may be interpreted in terms of increased emphasis on human reliability in the safety and energy-related specialties.

RELATIONSHIP OF SUPPLY TO DEMAND

When we attempt to extrapolate the trends of human factors employment over the last several years to the future, we predict that about 530 individuals are entering the field annually as 255 are leaving. It appears that less than 5 percent are leaving to move into other fields. In the year 1988–1989 an estimated 1,247 people were hired: this number is more than twice the yearly averages. The supervisors uniformly predicted continued growth in the field, but they were more optimistic over a two-year than a five-year time frame. Finally, there appears to be very great elasticity in demand if the funding for human factors work was to be increased. It was estimated that jobs for an additional 6,500 human factors specialists could be created, if the supervisors were given the authority and funding to do so. It also seems clear that, at the current rate of production, including both recognized human factors programs and other disciplines that contribute human factors professionals, the supply could not keep up with this potential demand. If it were to materialize, there would be many more people transferring into the field with unknown qualifications.

6—

Conclusions and Recommendations

The results of the two surveys described in the report have led the panel to make 2 general conclusions and 11 recommendations. These conclusions and recommendations are based on findings related to the principal objectives of the study: to recommend improvements in job definition and in the education and training of human factors specialists and to assess the match between the future supply and demand of human factors specialists.

CONCLUSIONS

Specific findings and some of their implications have already been presented in Chapters 3, 4, and 5. Two general conclusions can be drawn from these results.

Job Definition

Approximately 83 percent of human factors work currently centers in six areas: computers, aerospace, industrial processes, health and safety, communications, and transportation. The remaining 17 percent of the sample reported working in a wide variety of other areas. Considering the large number of these other areas, many of which were reported by only one or a few persons, the potential for more widespread application of human factors expertise may be great.

Most specialists report that the promotion of human factors is a major function of their current job, yet only about 40 percent of those doing human factors work identified themselves directly with the human factors profession. The others identified themselves with more traditional disciplines such as psychology and engineering. This finding suggests that, given the diverse backgrounds of people working in the field, a problem may exist in designing academic curricula and in developing certification programs for human factors specialists.

Skills and Knowledge

Different areas of human factors work emphasize different tasks and consequently require different skills and knowledge. Relatively few skills are emphasized consistently across the various areas of work. This state of affairs presents further difficulties in the design of university curricula, inasmuch as one primary curriculum is not suitable for training all human factors specialists. A defined set of core courses to which other electives can be added to meet specific educational objectives is one approach to the solution of this heterogeneity problem.

Additional implications for training stem from findings that human factors specialists need, but are not getting, adequate training in supervisory skills and that a large proportion of supervisors of human factors specialists lack adequate knowledge of the area. Furthermore, formal education was found to emphasize theoretical issues and laboratory research while evaluation studies were emphasized in the workplace.

RECOMMENDATIONS

The panel makes the following recommendations to enhance the development and utilization of human factors specialists and to match the supply of specialists with the demand for them.

1. Emphasize interdisciplinary training.

   Human factors work requires an extensive amount of coordination and communication among disciplines. Success in system integration, for example, requires that both engineering and psychological issues be addressed. More opportunities for training across disciplines should be provided to ensure that specialists have the appreciation and understanding required. These opportunities might take such forms as interdepartmental symposia, continuing short education and training courses and workshops inside and outside academia, and improved university-industry internships.
2. Base graduate training around a core curriculum.

   Specialists reported the need for a wide range of different types of knowledge and skills. Moreover, they reported that many of these subjects were not well covered in current programs of formal education. One promising ap proach to the solution of this problem is the development of a core curriculum. The core could be designed to provide essential human factors knowledge and skills and to be augmented by other courses to meet specific educational objectives. To keep both the core and the pool of specialized courses linked to the needs of specialists, more direct ongoing mechanisms for obtaining feedback from employers should be developed and instituted. A variety of mechanisms—such as periodic interviews with or surveys of local employers of the human factors specialists who have graduated from a university program—should be explored.

3. Provide supervisory training.

   Human factors specialists reported that they were not well prepared for supervisory responsibilities. There is little doubt that training is needed for the development of skills, knowledge, and abilities in support of supervisory tasks. However, because most of the current graduate education programs in human factors are now filled to capacity with required technical courses, it may be necessary to provide this management training through postgraduate continuing education, company in-service training, or one or more short courses in management and supervision offered throughout the year by various private organizations.

4. Encourage graduate internship programs.

   There appears to be insufficient student contact and direct experience with business and government work during graduate education programs. This is so despite opportunities that exist for university faculty to use their industrial consulting experience as a means of exposing graduate students to real-world problems. Even though some graduate programs require student internships and some companies have established formal internship programs, these activities need to be expanded. In addition, ways to improve current internships should be studied. To encourage more student participation and more university interest, the feasibility of tying internships more directly to thesis and dissertation research requirements should be explored. Program faculty engaged in industry consulting should explore linking student internships with their consulting efforts. Employers seeking interns should consult with faculty to identify programs and procedures that will lead to meaningful experiences for interns and will benefit their part-time employers.

5. Develop graduate traineeship programs.

   Most graduate training programs are not directly involved in the types of system integration activities required by industry and government. Instead, graduate courses tend to emphasize theory, methods, content, and laboratory research rather than user-centered design application. Study is required to define the correct emphasis on theory and laboratory research in human factors education. One procedure for encouraging a more applications-oriented program is to establish traineeships that are directed specifically to educating human factors specialists. These traineeships need to provide funding for graduate student stipends, necessary staff support, equipment and materials, and direct ties to government and industry laboratories involved in system integration activities. Links between the theory orientation of graduate programs and the practical issues associated with user-centered design should be strengthened. This might be accomplished, for example, by emphasis in the traineeship on the relationship between the computational models used to make a system a prototype in industry and the theories of human functioning from which such a computational model might be derived.

6. Focus research support on human factors problems.

   One dilemma in interdisciplinary areas such as human factors is that applied problems are often approached from traditional academic perspectives, such as psychology, industrial engineering, computer science, and physiology, rather than from an interdisciplinary perspective. Now that human factors graduate programs and user-centered design approaches in government and industry are well established, significant advances in science and application are possible. Research should be focused directly on interdisciplinary human factors problems and not used to support traditional disciplinary approaches and traditional values. This requires funding to be defined specifically for human factors, administered by human factors specialists, and conducted by human factors professionals.

7. Evaluate the availability of human factors specialists.

   Several survey results make it difficult to make conclusions about availability. Many specialists have worked a relatively short time on the job. About 30 percent of the sample were doing half of their work for the military, which implies a relatively elastic pool of expertise to expand military system integration considerations. Approximately 40 percent of the sample did not identify themselves directly as human factors professionals, which makes certification and licensing difficult. Consequently, further evaluation is needed on the availability of specialists.

8. Promote the profession among women and racial minorities.

   The results of this survey show that women and racial minorities are underrepresented in the human factors field. In addition, there appear to be inequities in salaries of male and female human factors specialists. Employers need to be sensitive to these differences and to track them over time in order to assess the adequacy of steps needed to eliminate inequalities.

Programs established by professional societies, industry, and government agencies to increase the number of qualified women and minority human factors specialists should be encouraged and supported.

9. Facilitate the promotion of human factors integration.

   One of the major findings of this study is the lack of human factors knowledge among supervisors of system integration activities. Increased awareness among supervisors is needed, and programs to increase this awareness should be initiated. Promotion of human factors application is a major job function of the specialist. Programs initiated by universities, industry, and government agencies to promote the application of human factors are needed to expand interest in user-centered design.

10. Extend human factors applications to new areas.

    Given the finding that 83 percent of current human factors activity is confined to just six areas, many opportunities exist for the expansion of human factors to new areas of application. Several promising areas of extension stem from societal needs that require a new emphasis on the application of technology to human use. Efforts need to be initiated to determine and promote the most promising areas of extension.

11. Maintain a survey data base to track trends in human factors.

    Although other surveys have been made of human factors specialists by the Human Factors Society and other organizations, to our knowledge this was the first comprehensive, scientifically based sample survey of the education and utilization of human factors specialists. Now that a data base of survey findings is available and accessible, it is possible for university, industry, and government agencies to carry out additional analyses for policy-making activities. Periodic follow-up surveys should be conducted and the results integrated with the data base established in the course of this study. In this way, trends in the utilization and training of specialists can be assessed. The findings, conclusions, recommendations, and policies resulting from these trend analyses should be of ultimate benefit in the harnessing and improvement of technology for human use.

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Appendix A—

Telephone Survey of Human Factors Specialists

HUMAN FACTORS QUESTIONNAIRE

INTRODUCTION: Hello, may I speak to __ . My name is __ and I'm calling from the Survey Research Laboratory of the University of Illinois. We're doing a survey for the National Research Council about the tasks performed by people in the human factors field and I'd like to ask you some questions.

1. In your current position are you primarily concerned with human factors? That is, human capabilities and limitations related to the design of operations, systems or devices?

Yes... 1
No 2

2. Do you supervise any people who perform human factors activities?

Yes... 1
No 2

IF "NO" TO Q.1 AND Q.2 END INTERVIEW

3a. Are you employed in a private business, an educational institution, a government agency, or something else?

Private business (Skip to Q.4a)...................... 1
Educational institution 2
Government agency (Skip to Q.4a)................. 3
Something else (Specify) (SKIP to Q.4a)........ 4

3b. Do you do paid consulting on human factors problems outside your institution?

Yes (GO TO VERSION 2)......................... 1
No (END INTERVIEW)............................ 2

4a. How many hours a week do you usually work as part of your job? __ Hrs.

4b. During the past year, what is the main area in which you personally have worked? Is it aerospace, communications, computers, industrial processes, health and safety, land vehicles or transportation, ships, or something else? (Accept up to two answers.)

Aerospace.................................... 1
Communications............................ 2
Computers..................................... 3
Industrial processes......................... 4
Health and safety............................ 5
Land vehicles or transportation......... 6
Ships... 7
Something else (SPECIFY)............. 9
____

5. What percentage of your own work is related to military systems?

__ %

(ASK ONLY IF "PRIVATE BUSINESS" IN Q.3A)

6. What percent of your work is funded by contracts from outside your company?

__ %

7. Are you currently working on any MANPRINT, HARDMAN, RAMPARTS, or IMPACT programs?

Yes (SKIP TO Q.9)........................... 1
No 2

8. Do you expect to work on any of these programs in the future?

Yes... 1
No.. 2

9. What is your current job title?

10a. How many years have you held this job?

__ Years

If less than one year

10b. How many months?

__ Months

11. What was the title of the job you held just before this one?

______________________________ ... 1

No previous job (SKIP TO Q.16)........... 2

12. In that job were you primarily concerned with human factors?

Yes....................................... 1

No.. 2

13. Was that in the same organization for which you now work?

Yes (SKIP TO Q. 16)........................ 1

No.. 2

14. Was that in ....

A private business.............................. 1

An educational institution.................. 2

A government agency, or.................... 3

Something else? (Specify).................. 4

15. What percentage of your work there was related to military systems?

_______ %

16. Do you consider yourself to be a human factors specialist or something else?

Human factors specialist.................. 1

Something else (Specify).................. 2

17. How important is human factors to the project which you spend most of your time working on (or have just completed)? On a scale of 1 through 7, where one means not at all important and seven means very important, how would you rate its importance?

Not at all important	Very important
1 2 3 4 5	6 7

I'D LIKE TO ASK YOU SOME MORE QUESTIONS ABOUT YOUR PRESENT JOB.

18a. Do you yourself (READ ITEMS 18-1 through 18-53 below) as part of your present job? You may just want to refer to the list we sent you and read the number by the tasks you perform. Yes=1 No=2

18b. How important a part of your present job is ( )? If 1 means not at all important and 7 means very important, where would you put this task?

Not at all important	Very important
1 2 3 4 5	6 7

18c. Where did you learn about ( )? Was it through...

Formal education..................................... 1
Continuing education................................. 2
Company training..................................... 3
Personal study, or..................................... 4
On the job experience................................ 5
OTHER (SPECIFY)................................. 6

(ACCEPT MULTIPLE RESPONSE; ENTER CODE NUMBER AND IF "OTHER," PLEASE SPECIFY ON LINE BELOW.)

18-1. (Do you yourself) Specify human user, operator, or maintainer requirements?

18-2. Analyze tasks?

18-3. Conduct network analyses?

18-4. Assess mental workload?

18-5. Assess physical workload?

18-6. Develop or conduct computer simulations?

18-7. Write or debug computer programs?

18-8. Perform human reliability analyses?

18-9. Analyze the effects of environmental stressors?

18-10. Apply human factors criteria and principles?
18-11. Verify design conformance to human factors specifications?
18-12. Prepare or review design drawings for conformance to human factors specifications?
18-13. Prepare design mockups?
18-14. Design human-equipment interfaces?
18-15. Design workspace layouts?
18-16. Prepare specifications for software?
18-17. Design software user interfaces?
18-18. Prepare product warnings?
18-19. Define instructional requirements?
18-20. Prepare instructional or procedural documents?
18-21. Specify training objectives?
18-22. Develop training content and instructional methods?
18-23. Design training aids?
18-24. Conduct training?
18-25. Assess the effectiveness of training (systems, courses, aids, simulators)?
18-26. Design simulation systems?
18-27. Specify evaluation objectives?
18-28. Plan and coordinate evaluations?
19-29. Design evaluations?
18-30. Develop criterion measures?
18-31. Design data collection procedures and questionnaires?

18-32. Specify or perform data analysis procedures and statistical tests?
18-33. Collect data in laboratory settings?
18-34. Collect data in field settings?
18-35. Interpret test and evaluation results?
18-36. Support product liability litigation?
18-37. Develop analytical models and methods?
18-38. Collect data on errors, failures, or accidents?
18-39. Conduct root cause analyses?
18-40. Perform failure-mode-and-effects analyses?
18-41. Develop and analyze fault trees?
18-42. Assess performance risks?
18-43. Perform safety analyses?
18-44. Perform human reliability analyses?
18-45. Prepare or contribute to written reports?
18-46. Evaluate reports written by others?
18-47. Prepare or contribute to project proposals?
18-48. Prepare and conduct oral presentations?
18-49. Prepare engineering drawings?
18-50. Interpret engineering drawings?
18-51. Review and summarize the results of previous research?
18-52. Develop hypotheses and theories?
18-53. Interpret research results?

19. What is your immediate supervisor's training and experience? Is it mainly in human factors, behavioral science, engineering, business, some other science, or something else? (Allow for more than one answer.)

Human factors.......................... 1
Behavioral Science................... 2
Engineering.............................. 3
Business.................................. 4
Other Science........................... 5
Something else (Specify).......... 6
No immediate supervisor (SKIP TO Q.22A).... 7

20. How important does your supervisor consider human factors to be to the project on which you spend most of your time working (or you have just completed)? On a scale of 1 through 7, where one means not at all important and seven means very important, how would you rate it?

Not at all important	Very important	Don't know
1 2 3 4 5	6 7	8

21. How much does your supervisor know about the field of human factors? If one means nothing at all and seven means a great deal, how would you rate him/her?

Knows Nothing	Knows A Great Deal	Don't Know
1 2 3 4 5	6 7	8

22. I'm going to read you a list of some other kinds of people that you may interact with on your job. Do you have at least weekly interactions with....

Yes No
(a) Other human factors personnel?....... 1 2
(b) Marketing or sales staff?................... 1 2
(c) Industrial designers?......................... 1 2
(d) Systems analysts?............................ 1 2
(e) Engineers?....................................... 1 2

(f) If yes to 22e, what kind of engineers?

Yes No

(g) Health professionals? 1 2

(h) Computer scientists or programmers? 1 2

(i) Systems users? 1 2

(j) Other types of people? 1 2

(Specify)

(If yes to 22a: How many of them are...

(l) your co-workers?

(n) subordinates? (Only if Yes to Q.2)

(o) clients?

(If no to Q.22a skip to Q.24)

23a. We are trying to add to our sample of human factors personnel. Could you give me the names of the human factors people you interact with on the job?

Yes... 1

No (Skip to Q.24)................... 2

23b. What are their names?

23c. Could you please tell me his/her telephone number

23d. Could you please tell me the name of the company he/she works for and its location?

Are there other human factors personnel with whom you interact on the job?

(23e-h) Name, Phone Number, Company and Location

(23i-l) Name, Phone Number, Company and Location

24a. In the past year was your salary on your current job before taxes...

Less than $50,000, or (SKIP TO Q.24f) 1

More than $50,000 2

Exactly $50,000 (SKIP TO Q.25) 3

Don't know (SKIP TO Q.25) 8

Refused (SKIP TO Q.25) 9

24b. Was it
Less than $70,000, or 1
More than $70,000 (SKIP TO Q.24d)..................2
Exactly $70,000 (SKIP TO Q.25).......................3
Don't know (SKIP TO Q.25) 8
Refused (SKIP TO Q.25)....................................9
24c. Was it less than $60,000?
Yes (SKIP TO Q.25) 1
No (SKIP TO Q.25)..2
Exactly $60,000 (SKIP TO Q.25).......................3
Don't know (SKIP TO Q.25)...............................8
Refused (SKIP TO Q.25)....................................9
24d. Was it more than: $80,000?
Yes..1
No (SKIP TO Q.25)...2
Exactly $80,000 (SKIP TO Q.25)......................3
Don't know (SKIP TO Q.25).............................8
Refused (SKIP TO Q.25)...................................9
24e. Was it more than $90,000?
Yes (SKIP TO Q.25)..1
No (SKIP TO Q.25)...2
Exactly $90,000..3
Don't know (SKIP TO Q.25...............................8
Refused (SKIP TO Q.25)...................................9
24f. Was it....
Less than $30,000, or.......................................1
More than $30,000 (SKIP TO Q.24h)................2
Exactly $30,000 (SKIP TO Q.25)......................3
Don't know (SKIP TO Q.25)..............................8
24g. Was it less than $20,000?
Yes (SKIP TO Q.25)..1
No (SKIP TO Q.25.)..2
Exactly $20,000 (SKIP TO Q.25)......................3
Don't know (SKIP TO Q.25)..............................8
Refused (SKIP TO Q.25)...................................9

24h. Was it more than $40,000?

Yes...1

No...2

Exactly $40,000..3

25. What was your annual salary before taxes on your previous job at the time you left it?

$_____________________________________

26a. Do you do any human factors consulting for payment in addition to your main job?

Yes...1

No (SKIP TO Q.27a)...2

26b. IF YES: Did you earn more than $20,000 before taxes from consulting in the past year?

Yes (SKIP TO Q.27a)...1

No...2

Don't know...8

Refused 9

26c. Did you earn more than $10,000 before taxes from consulting in the past year?

Yes..1

No..2

Don't know..8

Refused...9

27a. In the next 5 years will you continue to be primarily involved with human factors or do you plan to do something else?

Continue to be primarily involved (Skip to Q.28 if supervisor or Q.44 if not supervisor)...1

Do something else (specify)_______________ 2

27b. Why are you planning to do something else?

____

Question 28

TO BE ASKED ONLY IF RESPONDENTS WHO ANSWER "YES" TO Q.2, OTHERWISE SKIP TO Q.44

28a. You said you supervise people in your job. As part of that do you...

Yes=1	No=2

28b. How important a part of your job is ( )? If 1 means not at all important and 7 means very important, where would you put this task?

Not at all important	Very important
1 2 3 4 5	6 7

28c. Where did you learn about ( )? Was it through...(ACCEPT MULTIPLE RESPONSES; ENTER CODE NUMBER AND IF "OTHER," PLEASE SPECIFY ON LINE BELOW.)

Formal education..1
Continuing education.....................................2
Company training...3
Personal study..4
On the job experience.....................................5
OTHER (SPECIFY).......................................6

(a) Select, assign, or train subordinates?
(d) Evaluate performance of subordinates?
(g) Set group objectives and monitor performance of subordinates?
(j) Manage proposal preparation and contract negotiation?
(m) Schedule and monitor project activities?
(p) Prepare and monitor budgets?
(s) Promote the use of human factors methods and information in projects?

29a. How many people do you supervise directly?

_________ People

29b. Of those you supervise directly, how many are human factors specialists?

_________ People

30a. Have you hired any new human factors personnel in the past six months?

Yes..1
No (Skip to Q.31a)............................ 2

30b. IF YES: How many did you hire (in the past six months)?

_________ Persons

31a. Do you or your unit have any current funded openings for human factors personnel?

Yes...1
No (Skip to Q.34a)............................2

31b. How many openings do you have?

_________ Openings

32. Have you had any difficulty in finding qualified people to fill these jobs?

Yes...1
No (Skip to Q.34a)............................2

33. Were these serious or minor difficulties?

Serious..1
Minor..2

34a. (In addition to the openings you have) Does your unit have a need for additional human factors personnel to do the work you currently have but no funds for hiring?

Yes..1
No (SKIP TO Q.35a).........................2

34b. How many more people do you need?

_________ People

35a. Have you had to let any human factors personnel go because of lack of work?

Yes..1
No (Skip to Q.36a)............................ 2

35b. How many?

__________ People

36. Could your unit generate additional projects if you had additional human factors personnel (not counting any people you have mentioned)?

Yes...1

No (Skip to Q.38).............................2

37. How many people could you use?

______ People

38a. Two years from now, do you expect to employ more, fewer, or about the same number of human factors personnel than are currently employed?

More...1

Less 2

Same (Skip to Q.40).........................3

Don't Know (Skip to Q.40).............4

38b. How many more (fewer)?

________ Persons

39a. How about five years from now? Do you think you will employ more, fewer, or the same number of human factors personnel than you employ now?

More...1

Fewer..2

Same (Skip to Q.40)........................3

Don't know (Skip to Q.40).............8

39b. How many more (fewer)?

_______ Persons

40. Consider the human factors personnel that you have hired in the past two years. Overall, how satisfied were you with their training and experience? If one means not at all satisfied and seven means very satisfied, how would you rate your satisfaction?

Not at all satisfied	Very satisfied	Not Applicable
1 2 3 4 5	6 7	9

(Skip to Q.42a)

41a. Were there any skills or abilities that they were lacking when first came to work for you?

Yes..1

No (Skip to Q.42a)........................2

41b. IF YES: What were those skills?

____

____

____

42a. Are there topics in human factors university degree programs that you feel are not being taught or not being taught well enough?

Yes..1

No (Skip to Q.43a)........................2

Don't know (Skip to Q.43a)...........8

42b. What topics are these? [TAKE FIRST THREE]

____

____

43a. Does your unit have any ties with universities that teach human factors courses such as your offering internships to students, serving on advisory committees, or anything like that?

Yes..1

No (Skip to Q.44)........................2

Does your unit Yes No

43b. Offer internships?..1 2

43c. Offer advising?...1 2

43d. Provide research contracts to universities?........................... 1......2

43e. Offer anything else to universities? (SPECIFY).................... 1......2

____

44. What areas do you think represent the next major human factors thrust? [INTERVIEWER: PROBE FOR SPECIFIC AREAS]

(1)___________

(2)___________

Don't know................................ 8

FOR EACH AREA MENTIONED:

45. Is your organization currently working or preparing to work in the area of__ ?

	Yes	No
Mention 1....................................	1	2
Mention 2....................................	1	2

Now I would like to ask you some questions about your educational background.

46. What is the highest academic degree you've received?

Bachelor's...................................... 1
Master's... 2
Doctorate (Ph.D.)........................... 3
Other (Specify)............................. 4
____

47. From what school did you receive this degree?
____

48. In what department was that?

49. In what year did you receive that degree?
19__________

50. In what area of concentration was that degree?

Human Factors............................ 1
Other (Specify)............................ 2
____

(ASK ONLY IF DEGREE RECEIVED SINCE 1984)

51. How well did your formal education prepare you for your first human factors job? If one means very poorly and seven means very well, how would you rank your formal education?

Very Poorly						Very Well
1	2	3	4	5	6	7

QUESTION 52:

The letter we sent you included a list of topics that are covered in some academic programs. In your formal education did you receive training in (INSERT TOPIC)? You may prefer to just read the numbers next to the topics you selected.

52a. Respondent received training in this topic in his/her formal education

Yes = 1	No = 2

52b. (FOR EACH '"YES" IN Q.52A FOR THOSE WHO COMPLETED DEGREE ASK:)

How well was this topic covered in your formal education. If 1 means not very well and 7 means very well, how would you rank your training?

Not Very Well	Very Well
1 2 3 4 5	6 7

52c. Do you currently use________ in your present work?

Yes = 1	No = 2

(01) Biomechanics
(02) Work physiology
(03) Anthropometry
(04) Visual processes
(05) Auditory processes
(06) Attention
(07) Perception
(08) Cognitive processes
(09) Motor abilities and limitations
(10) Learning
(11) Group dynamics
(12) Team performance
(13) Group problem solving
(14) Work design (motivation and reward structures)
(15) Physical environmental effects on behavior (such as temperature, noise, weightlessness)
(16) System requirements analysis
(17) Human needs analysis
(18) Function allocation
(19) Task analysis
(20) Workload analysis
(21) Operations research

(22) Error-failure-accident analysis
(23) Human reliability analysis
(24) Computer simulation
(25) Manual control theory
(26) Analytical models (such as signal detection theory, decision theory, GOMS)
(27) Organization impact analysis
(28) Experimental design
(29) Laboratory instrumentation
(30) Univariate statistics
(31) Multivariate statistics
(32) Usability evaluation
(33) Psychometrics
(34) Survey methods
(35) Physical measurement
(36) Physiological measurement
(37) Psychophysics and subjective measurement
(38) Time and motion study
(39) Design walk throughs
(40) Design checklists
(41) Design guidelines
(42) Development and use of mockups
(43) Software tools (UIMS)
(44) Instructional system design
(45) MANPRINT, HARDMAN, RAMPARTS, or IMPACT
(46) Health and safety
(47) Compute programming languages
(48) Computer internal architecture
(49) Artificial intelligence
(50) Speech recognition and synthesis
(51) CAD/CAM
(52) Technical writing and illustration
(53) Oral presentation
(54) Project management
(55) Cost estimation and budgeting
(56) Product liability law
(57) Negotiation
(58) Panel display design
(59) Computer display design
(60) Control design
(61) Hand tool design
(62) Computer input tool design
(63) Human-computer dialogue design

(64) Workstation design
(65) Facilities design
(66) Office automation
(67) Communication systems
(68) Transportation systems
(69) Aerospace systems
(70) Manufacturing and quality control
(71) Process control
(72) Command and control
(73) Teleoperations
(74) Robotics
(75) Maintainability
(76) Aging
(77) Handicapped

53. In the past five years, have you taken any human factors related continuing education courses? That would include courses offered by universities, professional organizations, or your employer?

Yes..1
No (Skip to Q.58a)......................2

54a. What was the name of the course? (What was it about?)

____

54b. How long did the course last?

_____ / _____ / _____ / _____
Months Weeks Days Hours

54d. Was the course offered by...

a university....................................1
a professional association...............2
a private organization.....................3
your employer................................4
someone else.................................5

54e. How would you rate the quality of this course? If 1 is poor and 7 is superior, what rating would you give?

Poor	Superior
1 2 3 4 5	6 7

55a-e. (SAME AS 54 ABOVE)

56a-e. (SAME AS 54 ABOVE)
(NOTE: List only first 3 mentioned)
57. Are you getting as much continuing education as you would like?
Yes (SKIP TO Q.59)............................1
No...2
58. Is that because of lack of course availability or something else, or both?
Lack of course availability....................1
Something else....................................2
Both..3
59. Do you belong to any professional associations?
Yes..1
No (SKIP TO Q.63).............................2
60. What professional associations do you belong to? [RECORD UP TO THREE]
1.____
2.____
3.____
61. FOR EACH ASSOCIATION MENTIONED: In the past five years, have you ever attended any of the annual meetings of (association)?

Yes No
Association #1..1.....2
Association #2..1.....2
Association #3..1.....2
62. Have you presented a paper or participated in a panel discussion at these meetings in the past five years?
Yes..1
No...2
63. In the past five years, have you attended a workshop presented by a professional association?
Yes..1
No...2
64. Are there any periodicals that you read on a regular basis that you find useful for your job?
Yes..1
No (Skip to Q.66)..............................2

65. IF YES: What are their names?

1.____

2.____

3.____

66. In the course of your current job, are there any books that you refer to regularly?

Yes..1
No (SKIP TO Q.68)...........................2

67. Which ones? [RECORD AUTHOR, TITLE, AND PUBLICATION DATE WHENEVER POSSIBLE]

1.____

2.____

3.____

68. We are planning to talk with a sample of supervisors. Could you please give me your supervisor's name? (Ask R to verify spelling)

Name__________ 1
No Supervisor (SKIP TO Q.70)...................2

69. And what is his/her telephone number and extension?

Telephone Number ( )______________

Finally, we have just a couple of background questions to help us analyze the data.

70. In what year were you born?

19_______________

71. Are you...

White...1
Black...2
Hispanic..3
American Indian..4
Asian, or..5
Something else?...6

THANK YOU VERY MUCH FOR YOUR HELP.

72. INTERVIEWER RECORD BUT DO NOT ASK: RESPONDENT'S SEX

Male..1
Female...2

Appendix B—

Mail-In Questionnaire on Graduate Human Factors Programs

SURVEY RESEARCH LABORATORY UNIVERSITY OF ILLINOIS HUMAN FACTORS SURVEY UNIVERSITY QUESTIONNAIRE

(PLEASE CIRCLE ONE RESPONSE CODE FOR EACH QUESTION UNLESS OTHERWISE SPECIFIED.)

1. With which department(s) is the human factors program currently affiliated?

____

____

2a. In addition to this (these) affiliation(s), does this program have formal or informal linkages to other departments such as joint faculty, cross-listing of courses or advisory committees?

Yes............................... 1

No (SKIP TO Q.3)..........2

2b. Please list the departments and describe the linkages.

Departments Linkages

____

____

____

____

3. In what year was the human factors program at your institution first established?

19______

4a. Since the establishment of the program, have there been any major changes in the program such as the addition or deletion of degrees, a change of departmental affiliation, etc.?

Yes................................1

No (SKIP TO Q.5)..........2

4b. When did this occur?

19_____

4c. What was the change?

5. What graduate degree programs do you currently offer?

PLEASE COMPLETE QUESTIONS 6-19b FOR *EACH GRADUATE PROGRAM YOU LISTED IN RESPONSE TO QUESTION 5*. PLEASE COMPLETE ADDITIONAL COPIES OF THESE PAGES, WHICH ARE ATTACHED, IF YOUR UNIVERSITY OFFERS MORE THAN ONE GRADUATE DEGREE PROGRAM IN THE FIELD OF HUMAN FACTORS.

DEGREE PROGRAM___________________________ (PLEASE SPECIFY TITLE)

6. How many units are required to obtain this degree? (PLEASE SPECIFY IF SEMESTERS OR QUARTERS)

______________ Units

7. How many of these units must be within each of the departments with which the human factors program is currently affiliated?

Department Units Required

____

____

____

____

8a. Is a minor area required for this degree?

Yes..1

No (SKIP TO Q.9)....................................2

b. In what areas do students typically take their minor?

9. What courses are required for this degree? (IF POSSIBLE, PLEASE ATTACH A COMPLETE LIST OF REQUIRED COURSES)

10. What 3–4 electives are most frequently taken by human factors students working on this degree?

11a. Is a thesis required, optional, or not required as part of this program?

Required (SKIP TO Q.12)..........................1

Optional..2

Not required (SKIP TO Q.13a)..................3

11b. What percentage of your students have chosen the *non-thesis* option in the past two years?

____________ %

12. Thinking of the last few theses, were they based on...

Laboratory experiments..............................1

Field research, or..2

Something else? (PLEASE SPECIFY).........3

13a. Is practical experience required for this degree?

Yes..1

No (SKIP TO Q.14a)...................................2

13b. What kind of practical experience is required?

14a. For this degree, would you say that greater emphasis is placed on basic theory or on applied topics, or is there about equal emphasis on both?

Emphasis on theory......................................1
Emphasis on applied topics..........................2
Equal emphasis on both..............................3

14b. What specialties do you emphasize in this program?

15. How many years does it take the average student with a B.A. to get his or her degree in this program?

_________ Years

16. How many students graduated from this program last year?

_________ Students

17. What percentage of these students were unemployed or employed in a non-related field within six months after graduation?

_________ %

18. Among those students who were *employed in the human factors field*, what percent found jobs in each of the following?

Government..________________ %
University...________________ %
Consulting..________________ %
Private business/industry.........................________________ %
Something else (PLEASE SPECIFY)____________________ %

19a. What percentage of the students who start this program drop out before completion?

_____ %

(IF "0," SKIP TO Q.20a)

19b. Are these dropouts mainly doing human factors work or something else?

PLEASE COMPLETE QUESTIONS 6-19b FOR EACH DEGREE PROGRAM. USE ADDITIONAL PAGES SUPPLIED

20a. Do you have an undergraduate human factors program, concentration, or minor?

Yes..1

No (SKIP TO Q.22) 2

21. What is the name of that program?

22. What specific human factors-related computer programs do your students (both graduate and undergraduate) learn to use?

23a. What human factors laboratories do you have?

23b. What needs does your human factors program have in the way of additional laboratories, library facilities, or equipment?

24. On a scale of 1 to 7, where 1 is totally inadequate and 7 is totally adequate, how would you rate...

Totally inadequate ... Totally adequate

a. Your university and department libraries with respect to human factor books and journals?...

1 2 3 4 5 6 7

b. The adequacy (availability, age, quality) of computer hardware for faculty?......................

1 2 3 4 5 6 7

c. The adequacy of computer software for faculty?..

1 2 3 4 5 6 7

25. The following questions refer to the specific activities of the core faculty members who are actively involved in your human factors program. For each, please indicate (a) their name, (b) their specialty area, (c) the year of their highest degree, (d) the number of off-campus professional meetings which he/she attended last year at which he/she gave a paper or chaired a session, (e) whether he/she did consulting activity, (f) if so, the name of the organization served, (g) whether he/she consulted on human factor activities, (h) if he/she had outside grants or contracts, and (i) if so, the name of the major funding agency.

a. Name
b. Specialty area
c. Year of highest degree
d. No. of meetings w/ paper or chaired
e. Consulting activity

Yes	No

[ANSWER f AND g IF RESPONDED "YES" TO e]
f. Organization served
g. Human factors consulting area
h. Outside grants or contracts

Yes	No

[ANSWER i IF "YES" TO h]
i. Major funding agency

26a. Has your program received any contributions of money or equipment in the past year?

Yes...1
No (SKIP TO A27.a)...................2

26b. Who gave this to your program?
26c. What, specifically, was received?
27a. Do you have any internship programs?

Yes...1
No (SKIP TO Q.28a)..................2

27b. With what organization do you have such programs?

27c. How many students are currently involved?

_____ Students

28a. Do you have any adjunct professors from business or industry?

Yes..1

No (SKIP TO Q.29a)..................2

28b. How many?

_____ Adjunct Professors

28c. What are the advantages of using adjunct professors?

28d. What are the disadvantages of using adjunct professors?

29a. Did you have guest lecturers from business or government in the past year?

Yes...1

No (SKIP TO Q.30)...................2

29b. How many?

_____ Guest Lecturers

29c. What are the advantages of using guest lecturers?

29d. What are the disadvantages of using guest lecturers?

30. What is the total number of students currently enrolled in all of your human factors programs?

_____ Students

31. For the 1988–89 academic year, in total, how many students applied for admission to all of your human factors programs?

_____ Students

32. Including those who did not enroll, how many did you admit?

_____ Students

33. How many new students actually entered your program(s) in the 1988–89 academic year?

_____ Students

34a. In the past five years, has the number of students admitted increased, decreased, or remained about the same?

Increased..1
Decreased...2
Remained the same (SKIP TO Q.35).........3

34b. To what do you attribute this increase or decrease?

35a. Do you have any absolute requirements for admission, such as minimum grade point average, GRE score, or specific undergraduate degrees or courses taken?

Yes..1
No (SKIP TO Q.36).................................2

35b. What are these requirements?

36. What is the average undergraduate grade point of the students you accept? (PLEASE INDICATE WHETHER THIS IS A FOUR-OR FIVE-POINT SCALE)

_____ /4.0
_____ /5.0

37. What is the average GRE score of the students you accept?

Verbal___________________
Quantitative_______________
Analytical_________________
Overall___________________

38. What are the most common undergraduate degrees of the students you accept?

39. What other qualities do you look for when accepting students into your program?

40. What percentage of your admitted students have had relevant work experience before entering your program?

__ %

41a. Do you have any part-time students?

Yes..1

No (SKIP TO Q.42a)..........................2

41b. What percentage of your students are part-time?

__ %

42a. Do you make any special efforts to recruit students?

Yes..1

No (SKIP TO Q.43)............................2

42b. What do you do?

43. In the past few years, has the support that your human factors program has received from the university increased at an above average, average, or below average rate compared to other university programs?

Above average rate....................................1

Average..2

Below average..3

44a. If you could change any parts of your program, what would you change?

44b. What is preventing the change(s) from happening?

45a. Do you see any major changes occurring in the human factors field in the next decade?

Yes..1

No (SKIP TO Q.46a)...........................2

45b. What changes do you see happening?

46a. Do you think that job opportunities for people in the field will increase, decrease or remain the same in the next five years?

Increase...1

Decrease...2

Remain the same (SKIP TO Q.47).......3

46b. What percentage increase or decrease do you expect?

__ %

47. Do you think that the quality of students in human factors programs will increase, decrease, or remain the same in the next five years?

Increase...1

Decrease...2

Remain the same.................................3

48a. Do you think that human factors education will change in the next five years?

Yes..1

No (SKIP TO Q.49a)...........................2

48b. How will it change?

49a. Has your program responded in any way to new DoD human component/system initiatives such as MANPRINT, RAMPARTS and IMPACT?

Yes..1

No (SKIP TO Q.50a)...........................2

49b. How has the program responded?

50. Has your program responded to special societal problems such as the needs of the elderly and disabled?

Yes..1

No (SKIP TO Q.51a).........................2

50b. How?

51a. Has your program responded to technological developments such as advanced manufacturing technologies, robotics, or expert systems?

Yes...1

No (SKIP TO Q.52)..........................2

51b. How?

52. Below is a list of topics that are sometimes included in human factors programs. Please indicate, by circling the appropriate code number, which of these are covered in required coursework, which are covered in elective coursework, and which are not covered as part of your program.

	Covered in required coursework	Covered in elective coursework	Not covered as part of HF program
(01) Biomechanics	1	2	3
(02) Work physiology	1	2	3
(03) Anthropometry	1	2	3
(04) Visual processes	1	2	3
(05) Auditory processes	1	2	3
(06) Attention	1	2	3
(07) Perception	1	2	3
(08) Cognitive processes	1	2	3
(09) Motor abilities and limitations	1	2	3
(10) Learning	1	2	3
(11) Group dynamics	1	2	3
(12) Team performance	1	2	3
(13) Group problem solving	1	2	3
(14) Work design (motivation and reward structures)	1	2	3

	Covered in required coursework	Covered in elective coursework	Not covered as part of HF program
(15) Physical environmental effects on behavior (such as temperature, noise, weightlessness)	1	2	3
(16) System requirements analysis	1	2	3
(17) Human needs analysis	1	2	3
(18) Function allocation	1	2	3
(19) Task analysis	1	2	3
(20) Workload analysis	1	2	3
(21) Operations research	1	2	3
(22) Error-failure-accident analysis	1	2	3
(23) Human reliability analysis	1	2	3
(24) Computer simulation	1	2	3
(25) Manual control theory	1	2	3
(26) Analytical models (such as signal detection theory, decision theory, GOMS)	1	2	3
(27) Organizational impact analysis	1	2	3
(28) Experimental design	1	2	3
(29) Laboratory instrumentation	1	2	3
(30) Univariate statistics	1	2	3
(31) Multivariate statistics	1	2	3
(32) Usability evaluation	1	2	3
(33) Psychometrics	1	2	3
(34) Survey methods	1	2	3
(35) Physical measurement	1	2	3
(36) Psychological measurement	1	2	3
(37) Psychophysics and subjective measurement	1	2	3
(38) Time and motion study	1	2	3
(39) Design walk-throughs	1	2	3
(40) Design checklists	1	2	3
(41) Design guidelines	1	2	3
(42) Development and use of mockups	1	2	3
(43) Software tools (e.g. UIMS)	1	2	3
(44) Instructional system design	1	2	3
(45) MANPRINT, HARDMAN, RAMPARTS, or IMPACT	1	2	3
(46) Health and safety	1	2	3
(47) Computer programming languages	1	2	3

	Covered in required coursework	Covered in elective coursework	Not covered as part of HF program
(48) Computer internal architecture	1	2	3
(49) Artificial intelligence	1	2	3
(50) Speech recognition and synthesis	1	2	3
(51) CAD/CAM	1	2	3
(52) Technical writing and illustration	1	2	3
(53) Oral presentation	1	2	3
(54) Project management	1	2	3
(55) Cost estimation and budgeting	1	2	3
(56) Product liability law	1	2	3
(57) Negotiation	1	2	3
(58) Panel display design	1	2	3
(59) Computer display design	1	2	3
(60) Control design	1	2	3
(61) Hand tool design	1	2	3
(62) Computer input tool design	1	2	3
(63) Human-computer dialogue design	1	2	3
(64) Workstation design	1	2	3
(65) Facilities design	1	2	3
(66) Office automation	1	2	3
(67) Communication systems	1	2	3
(68) Transportation systems	1	2	3
(69) Aerospace systems	1	2	3
(70) Manufacturing and quality control	1	2	3
(71) Process control	1	2	3
(72) Command and control	1	2	3
(73) Teleoperations	1	2	3
(74) Robotics	1	2	3
(75) Maintainability	1	2	3
(76) Aging	1	2	3
(77) Handicapped	1	2	3

53. Please indicate which of the following human factors activities your students do as part of their classwork. (CIRCLE THE CODE NUMBERS OF ALL THAT APPLY.)

Analyze tasks 01
Conduct network analyses 02
Assess mental workload 03
Assess physical workload 04
Develop or conduct computer simulations 05

Write or debug computer programs 06
Perform human-reliability analyses 07
Analyze the effects of environmental stressors 08
Verify design conformance to human factors specifications 09
Prepare or review design drawing for conformance to
human factors specifications 10
Prepare design mockups 11
Design human-equipment interfaces 12
Design workspace layouts 13
Prepare specifications for software 14
Design workspace layouts 15
Prepare specifications for software 16
Design software-user interfaces 17
Prepare training course materials and training aids 18
Prepare product warnings 19
Prepare instructional or procedural documents 20
Design training aids 21
Conduct training 22
Assess the effectiveness of training (systems,
courses, aids, simulators) 23
Specify evaluation objectives 24
Plan and coordinate evaluations 25
Develop criterion measures 26
Design data collection procedures and questionnaires 27
Specify or perform data analysis procedures and statistical tests . 28
Collect data in laboratory settings 29
Collect data in field settings 30
Interpret test and evaluation results 31
Develop analytical models and methods 32
Collect data on errors, failures, or accidents. 33
Conduct root cause analyses 34
Perform failure-mode-and-effects analyses 35
Develop and analyze fault trees 36
Assess performance risks 37
Perform safety analyses 38
Perform human reliability analyses 39
Evaluate reports written by others 40
Prepare or contribute to project proposals 41
Prepare and conduct oral presentations 42
Prepare engineering drawings 43
Interpret engineering drawings 44
Review and summarize the results of previous research 45
Develop hypotheses and theories 46
Interpret research results 47

THANK YOU VERY MUCH FOR YOUR COOPERATION
PLEASE RETURN IN THE ENCLOSED POSTAGE-PAID ENVELOPE
TO:
SURVEY RESEARCH LABORATORY
UNIVERSITY OF ILLINOIS
1005 WEST NEVADA STREET
URBANA, ILLINOIS 61801

Appendix C—

Data Base Availability

Two data gathering techniques were used to survey the human factors community: a computer-assisted telephone interview of human factors specialists and their supervisors, and a mail-in questionnaire of graduate programs offering specialized education in human factors. A copy of the surveys can be found in Appendices A and B, respectively. The coded response data and the command files that explain each set of data can be obtained by contacting:

CSERIAC Program Office
AAMRL/HE/CSERIAC
Wright-Patterson AFB, OH 45433-6573
Phone: (513) 255-4842
Autovon: 785-4842
Facsimile: (513) 255-4823
Email (Internet): CSERIAC@Falcon.AAMRL.WPAFB.AF.MIL

The files can be obtained on a cost recovery basis, and they can be sent to the requestor on either two 5-1/4" disks or two 3-1/2" disks. The files were produced using SPSSX (Statistical Package for the Social Sciences software).

The names of the data files (which contain the interviewees' responses to the questionniares) end with a .DAT. The names of the command files (which contain information on the structure and identification of responses in the data files) end with a .TXT.

If you have any questions about the data structure, format, etc., please contact:

Dr. Beverly Huey
Committee on Human Factors, HA156d
National Academy of Sciences
2001 Wisconsin Avenue, NW
Washington, D.C. 20007
Phone: (202) 334-3027
Facsimile: (202) 334-2854
Email (Bitnet): BHUEY@NAS.BITNET

HUMAN FACTORS SPECIALISTS SURVEY

The Human Factors Specialists Questionnaire was administered to both human factors specialists and to the supervisors of human factors personnel. The purpose of the survey was to question human factors specialists and supervisors about their professional and job related activities and education.

If you are requesting 5-1/4" disks, the data set is large and has been compressed so that it would fit on one 360K disk. To get the data in a useable, uncompressed format, you need to copy the compressed data file (called HF.EXE) to your hard disk before conducting any analyses. After you copy the file HF.EXE to your hard disk, go to your hard drive and type the letters HF and press the enter key. This will uncompress the data file into a 1.3 megabyte file called HF.DAT. This HF.DAT file is the data file that is accessed by the command files. Please note that you cannot analyze the data directly in the HF.EXE file; you must uncompress it first!

If you are requesting 3-1/2" disks, the data set has not been compressed, and you may copy the HF.DAT file directly from the diskette to your hard drive.

There are three command files to analyze the data from the human factors specialists survey. The first file (called HF1.DAT) contains the commands to analyze the data from the first seven of seventeen records of data for each interviewee. This contains the responses to almost all questions on the survey, but it omits the responses to questions number 18 and number 52 of the survey. This is due to the limitations of the software to handle this large a number of variables. The command files for questions 18 and 52 are HF2.TXT and HF3.TXT, respectively.

HUMAN FACTORS SURVEY—UNIVERSITY QUESTIONNAIRE

The University Questionnaire was used to obtain information about university graduate programs in engineering, psychology, and other departments that offer specialized education in human factors.

The data file for this survey is called UNIV.DAT; while the command file is called UNIV.TXT. All data for the University Questionnaire is contained in one uncompressed file, and all commands relating to that data file are contained in another uncompressed file. These files can be copied directly onto the hard drive of your computer system.