NATIONAL RESEARCH COUNCIL
COMMISSION ON BEHAVIORAL AND SOCIAL SCIENCES AND EDUCATION
2101 Constitution Avenue Washington, D. C. 20418

COMMITTEE ON HUMAN FACTORS

Telephone (202) 334-3027

March 26, 1985

Dr. Kenneth R. Boff
Director, Human Engineering Division
USAF AMRL/HE
Wright-Patterson Air Force Base, OH 45433

Dear Ken:

I am pleased to forward the letter report on Recommendations for Content Revision and Alternate Delivery Modes for the Human Engineering Guide to Equipment Design (HEGED) prepared by the National Academy of Sciences/National Research Council Committee on Human Factors under ONR grant number N00014-85-G-0093.

This letter report was prepared in response to a request from the Air Force representative of HFE-TAG who asked for the committee's advice on whether a revision of the guide was appropriate. If positive, the committee was asked to make recommendations for content of the revision and alternate delivery systems that should be considered in the light of currrently available information delivery system technology.

If I can provide any additional information, please let me know.

Sincerely,

Stanley Deutsch

Stanley Deutsch
Study Director

enclosure

cc: Dr. David A. Goslin
Dr. Thomas B. Sheridan
Mr. Gerald A. Malecki
Mr. Michael McCracken
Mr. Gary Dwoskin
Ms. Eugenia Grohman

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March 26, 1985

Dr. Kenneth Boff
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Research Laboratory
Wright Air Force Base, OH 45433

Dear Dr. Boff:

At its meeting on October 4-6, 1983, the Department of Defense Human Factors Engineering Technical Advisory Group (HFE-TAG) recommended that the National Research Council consider the need for and an approach to revising the Human Engineering Guide to Equipment Design (HEGED). At the November 1983 meeting of the Committee on Human Factors, the Air Force representative of HFE-TAG requested the committee's advice on whether a revision of the Guide was appropriate and, if so, what its general contents and format should be for the greatest availability to users.

As mentioned in Dr. Pew's letter to Col. Birt dated May 22, 1984, the committee does not feel it can undertake or supervise the work of revision. However, Dr. Pew expressed the committee's willingness to prepare recommendations on the format and content of such a revision, as well as its desire to suggest some possibilities for alternate forms of publication.

The committee discussed these concerns at several subsequent meetings. On the basis of these deliberations and with the concurrence of the committee, this letter report was prepared primarily by Richard Pew and Thomas Landauer. This letter presents the committee's views on both revisions and delivery systems; a list of committee members is attached to this letter.

The purpose of the Guide is to assist designers, engineers, human factors specialists, researchers, system developers, and others in the understanding and application of human factors engineering principles. Since its last publication in 1972, extensive additional useful data and tecbnological innovations have been generated. Various users have need for different levels of detail, and access to several sections may be required for system design. Some users may prefer only general rules and principles, others may

need greater detail, including information on original resources from which the guidelines were developed. The current book format cannot easily meet the needs for each application nor readily accommodate different users' requirements for levels of detail. Applications of modern technology can greatly enhance the availability and integration of data in the Guide in ways that were not feasible at the time of the last revision.

Content of Revision

During the committee's deliberations, we attempted to develop a revised table of contents, analogous to the contents of the current Guide. We rapidly gave up in despair. We found that the topics came in packages, such as documentation, warning methods, and design of hand tools, and that these topics lend themselves more to a network configuration than to a linear table of contents or a hierarchical tree structure. Warnings, for example, are related to auditory and visual display design and to human attention mechanisms, as well as to workplace layout and design for safety. This feature has implication for the design of presentation mechanisms as well as for the development of a comprehensive list of appropriate topics.

The committee did not attempt to produce a comprehensive list of topics. Instead we suggest as a starting point for revision the index of the existing Guide and that of recent textbooks. We suggest starting with the index instead of the table of contents because it provides a better basis for preparing the reorganization and interlinking that we believe is essential to a more usable Guide. In lieu of a list of topics, the committee has identified areas that were immediately evident as important and for which adequate coverage was not provided in the current Guide:

Design of hand tools
Ergonomics of visual display units
Design of remotely operated devices
Design of software for usability
Design of procedures
Design of documentation
Performance of teams
Human factors aspects of artificial intelligence
Behavioral issues in expert system development

At a more general level, the committee discussed the perspective from which a revised Guide should be approached. In contrast to a standard that simply provides rules, it should be aimed at the thinking designer. It therefore should include human performance data and methodology as well as design recommendations. A recommendation should be provided only when there are either data to back it up, or the expert developing the material believes there is enough accumulated experience to justify it.

Especially when there are insufficient data for a confident recommendation, it is useful to provide examples of good and bad design to assist the designer in understanding how the recommendations apply. Data and recommendations should be accompanied by statements about the conditions

under which they apply so that the user can decide whether to generalize from them.

It is also important to identify gaps in the data and conditions for which is has been demonstrated that the data do not apply. Evaluative statements providing the expert's opinion of the validity of the data are also useful. In newer areas, in which the data are less well-developed, the expert should provide greater emphasis on the methodological techniques that would be useful for collecting needed data or making design decisions in the area.

Alternate Delivery Modes

The printed handbook is undoubtedly a very useful tool for a designer, and a revision of the present Guide is clearly needed because of advances in various aspects of the field. However, the view of the committee is that this manner of providing information to designers is far from optimal, that its value is decreasing as technology and methodology continue to change ever more rapidly and heterogeneously, and that new developments in information storage and delivery promise better modes for the provision of such information in the future. Thus, we would like to see serious consideration given to developing new formats for fulfilling the purposes of the Guide. We do not believe that it would be wise to move to an electronic format immediately, because there are many difficult problems concerning implementation. Instead, we think that the development of a new mode of delivery should be viewed as a research project of 5 to 10 years' duration. Such a system would be likely to evolve in unpredictable ways with use, and this should be encouraged rather than preempted. The committee suggests some mechanisms for developing and maintaining an electronic form of the Guide, and some ideas for how one might be designed. These suggestions should be viewed as no more than initial ideas to stimulate thought. We also propose a way of handling the revision in order to make it somewhat more responsive to changing needs and to make future revisions fit more easily into eventual transfer to electronic form.

The committee suggests that the Guide be revised under the guidance of an editorial board, after the example of such publications as the Annual Review of Psychology. The board would choose topics for successive revision of the handbook, solicit contributors to write chapters or sections on these topics, with the mix and updating of particular topics a matter for frequent, periodic review. The experts chosen for a particular topic or section would be asked to serve terms of 4 to 5 years, during which time they would be responsible for updating the contents of their part. They would have this responsibility both for new editions of a printed version of the handbook and for potentially more frequently updated versions of its electronic form.

Given such a start, the electronic mode might begin by being a source of material on only one or two topics, presumably chosen on the basis of both their suitability for conversion and the interest of the topic experts. As time went on, new topics could be added to the electronic version. It would be important in developing an electronic system to keep it constantly

modifiable and to be able to try comparison versions either sequentially or concurrently. It would also be important to institutionalize user feedback, either through on-line or other questionnaires or by instrumentation of the computer-based system itself.

One of the greatest promises of a computerized Guide would be the frequency with which its information could be updated. However, the need for maintenance of both the content and programs that run such a system would be a very real problem. One approach would be to constitute the computer-based Guide as a basic compendium of data and information, and to allow the tools that are used to search and display the information to be designed and maintained separately. The subject matter experts who are responsible for topics would be required only to provide fairly standard text and to be available for limited amounts of consultation. They might serve as filters for other people who wish to have new data, say anthropometric measurements of a new population, entered into the system. Their editorial review and comments could be part of a newly stored text.

The committee envisions as an early first try at the system, a computer-based version of part of the revised Guide. The system would consist of a centralized data base accessible by public telephone network, on the model of the document retrieval systems currently available over systems such as Timenet. At first the content would be a straightforward transfer of the textual information in the printed handbook into an electronic form. Additional information, tables, reference lists, added comments, or new topic sections would be made as the experts saw the need or obtained new information.

The first computer software tool that would be needed would be a form of editing program that would make such additions easy. The next set of program tools would give users access to the information in other ways than simple page turning. A large variety of such tools suggest themselves, among them: (1) browsing schemes that allow people to look for key words or combinations of key words, or truncated key words or their combinations, (2) cross-indexes to contents in various sections, (3) adaptive indexes that gradually learned what parts of the text or data were found relevant by people with particular kinds of questions, and (4) on-line interactive checklists for designers.

Moving in this direction requires of the upcoming revision that it be produced in machine-readable form and that the text material itself be organized into two or more levels. A first level might be a more or less traditional text presentation of rules, design guidelines, principles for design, examples, and case histories of particular pieces of equipment or tasks relevant to each topic. Other levels would access detailed data, tables, graphs, references, and supporting literature, all keyed to guideline-level advice. If done in this way, the guideline-level text could be printed separately and might be very useful to a large class of designers. For those with no access to the on-line system, the details, data, and references could be provided in a separate, easily updatable fashion such as an insert notebook. For those who use the system on line, the two or three different levels would be easily accessible.

This design realizes a minimum structure for the on-line system and allows enhancements to evolve. We give two examples of somewhat fancier enhancements: (1) methods for obtaining tailored graphical presentation, wherein the data put into the graph are just a subset wanted by a particular user and (2) an expert system that operates over the data relevant to some topic and actually gives advice in response to an interactive dialogue with the designer-user. Simply by starting with the text of an ordinary printed guide on-line, most of the interesting additional features and tools could probably be added as time went by. For example, using such a text, someone (a user, a software vendor) could develop a checklist for a particular purpose and simply add it as a feature accessed by referring to that topic. Similarly, a high-powered query system for examining the contents of a section could be added, using the text or transformations of the text as its data base.

There are, of course, a large number of technical details to be resolved in order to make available an on-line computerized version of an engineering guide. Among the considerations are whether the data should be centrally stored and transmitted over phone lines or other networks, or whether it should be distributed on discs or tapes. The initial thought of the committee is to follow the example of some of the large on-line data bases that are currently available commercially or otherwise. It suggests that an umbrella organization sponsored by grants from interested agencies undertake the initial development of such a system. This organization would continue to oversee and supervise the editorial board and the accumulation and revision of content material.

However, the committee thinks that such an organization itself could not effectively carry out the maintenance and operation of the computer systems and programs involved. For those functions, the committee recommends that an independent organization, such as a commercial data base distributor, be given responsibility. This organization would make the information available to the general scientific and technical community and should be enabled to receive inputs from this community. In addition, there should be organizations within the military services and other government agencies responsible for maintaining access appropriate to their special needs.

Yours very truly,

Thomas B Sheridan

Thomas B. Sheridan
Chair
Committee on Human Factors

COMMITTEE ON HUMAN FACTORS

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At the request of the Technical Advisory Group (TAG) on Human Factors Engineering, sponsored by the Joint Army-Navy-Air Force Steering Group, the Committee on Human Factors in the National Academy of Sciences/National Research Council prepared recommendations on content revision and alternate delivery systems for the Human Engineering Guide fo Equipment Design (HEGED).

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