Creating an in-house software ergonomics group:
A case study

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INTRODUCTION

They want proof. Software consumers are receiving supplier claims of “ergonomic superiority” and “ease of use” with caution. It’s a buyer’s market and usability has emerged as a significant competitive edge.

The field of software psychology, a branch of human factors engineering, has been a boon to the computer industry. It has expanded the market by demonstrating that, theoretically speaking, anyone can use a computer. This is not to say that a specific computer device can or should be usable by all people. In fact, the key to a successful design is to create a product targeted to a specific class of users. The design should draw upon the capabilities and compensate for the limitations of the intended users.

Establishing a successful human factors function requires careful staffing, calculated direction and appropriate tools of the trade. This paper comments on the organizational model of a human factors group and its application as an integral part of the software design process. It is the case study of creating a human factors team at Unisys.

HISTORICAL PERSPECTIVE

Human factors engineering activities at Unisys (the new company resulting from the merger of Burroughs and Sperry Corporations) have been traditionally organized and centralized at corporate levels, with a concentration on hardware-related issues. In response to market demands for more “congenial” software, though, there is a current trend toward: (1) decentralizing the function and strengthening expertise in software design, (2) assuming a “division of skills” strategy for development activities, and (3) expanding the envelope of usability criteria for the mainframe software.

Prior to 1984 most human factors personnel were located at world headquarters. Their role was to participate in hardware design and to provide varied services to the development plants as requested. As a result of the more recent increased emphasis on software development, the function has since migrated away from corporate positioning. Today, 85 percent of the human factors staff is located within the separate development organizations.

In addition to decentralizing human factors to the software engineering organizations, active measures were taken to integrate their expertise with product development activity. A “division of skills” strategy was taken to maximize development efficiency. Responsibility for human-computer interface design, historically with the project programmers, shifted to the human factors specialists. This allowed the programming groups to focus attention on functionality design and implementation. It is important to note, however, that the human factors and programming staff do not work independently; rather, they work as unique members of a multidisciplinary team.

The first human factors assignment in Mission Viejo, California addressed consistency in style between and within a family of menu-driven software applications. This initial project concentrated on quality in screen layout and screen traversal techniques. Objectives of current projects also include accurate identification of user classes and renderings of user tasks.

HUMAN-COMPUTER INTERFACE DESIGN TEAM

Staffing the right people is a critical gate to any successful function. A multidisciplinary cross-section of skills in support of a human factors core is often ideal for designing human-computer interfaces.

Human Factors Technologists

When identifying the human factors talent, it is important to understand that human factors itself can be viewed as multidisciplinary. It deals with the manner in which people interact with their world. Therefore, experience in applying its principles requires an understanding of human characteristics as well as a working knowledge of the technology being studied. For the design of computer-human interfaces, formal education in human factors engineering or equivalent is basic to understanding the human side of the interface. It is also important, however, to employ designers who have specialized in computer software—the other side of the interface.

The Mission Viejo facility employs six human factors professionals, and has plans for continued growth. The current
ratio of human factors-to-programming staff is 1:16. An appropriate target is estimated to be 1:8.

All six human factors personnel hold degrees in psychology and have an average of six years concentrated experience in software ergonomics. One person has a Ph.D. in cognitive psychology, two have an MS degree in industrial psychology, two are MS degree candidates in human factors, and one has a BS degree in psychology.

Multidisciplinary Support Team

The user’s interface to a computer is likely to consist of a combination of: hardware control panels, monitors, keyboards or other pointing devices, reference cards, application software, on-line assistance, and user manuals. Moreover, the design of the human-computer interface is based not only on knowledge about the user and intended functionality of the computer but also on knowledge about market demands. Therefore, the development team should represent an appropriate mix of skills, and might include:

1. Human factors technologists, to design, evaluate, and specify the way in which people and a computer will interact
2. Computer scientists, to provide counsel on the relative costs and benefits of implementation alternatives and to prototype software design concepts
3. Technical writers, to prepare the prose interfaces of online help and printed documentation
4. Market researchers, to identify market characteristics in terms of requirements for functionality as well as characteristics of the targeted user classes
5. Hardware engineers, to provide counsel on hardware design alternatives and prototype design concepts
6. Industrial and graphics designers, to contribute expertise in aesthetics and visual communications

The proper mix is of course dependent upon the nature of the design project.

Organizationally, the Human Factors group resides, with relative autonomy, within an organization responsible for the development of system software. Lines of communication and functional relationships with other key disciplines are being established. Most design teams, consisting of talent from computer science, marketing research, user documentation, industrial design, and training lie across organizational boundaries.

ROLE OF THE HUMAN FACTORS TECHNOLOGIST

The role of the human factors technologist is to serve as the users’ advocate during product development. The job begins during product conceptualization and continues until after the product is introduced to the market. During each stage of the product life cycle, broadly defined as analysis, design, and implementation, specific types of human factors activity should occur.¹

The analysis phase is typified by functionality definition, cost/benefits projection, identification of hardware and software constraints, and scheduling. The human-computer interface design team should also define the target user by: (1) prior relevant experiences, (2) anticipated product use patterns, and (3) cognitive, physiological, and perceptual characteristics.

During the design phase, a product is designed, coded, and tested. The role of the human factors technologist is to mold the human-computer interface by applying principles of software psychology and drawing from expertise within the design team. Development of the interface evolves through an iterative process of conceptualization, simulation or prototyping, and evaluation or validation.

Lastly, the implementation stage is established when a product is distributed and installed in its final locations, the uses are trained, and the product is in operation. During implementation the best test of usability takes place, and it occurs as a function of normal product use. Human factors responsibility lies in capturing and interpreting usage data as it becomes available. Errors are then corrected, features are added, and customer-driven ideas lead to new product plans.

Projects at Unisys Human Factors

The role of the Human Factors group at Unisys has recently undergone a transition from impromptu consultation and participation just prior to the “implementation” phase, to responsibility for design across product life cycles. This shift in emphasis reflects an explicit commitment to understanding and meeting user requirements by proactively applying expertise in the human side of the interface.

The group’s projects currently include human-computer interface design and evaluation for a variety of software products. The group is also developing in-house software ergonomics standards, and links are kept with the American National Standards Institute (ANSI) and the International Standards Organization (ISO). Major projects are described next.

Standard style design

Description. Design a standard presentation style for applications displayed on a family of character-mapped, monochrome displays. Prepare a specification for implementors of the User Interface Management System (UIMS). Write a style guide to accompany the UIMS as a framework of design for use by interface design teams.

Objectives. Maximize utilization of display capabilities. Meet the functional requirements of targeted applications to satisfy user needs while considering use patterns and user characteristics. Maintain consistency with associated products in such areas as keyboard functionality and pointing device behavior.

Team. Human factors specialists. Software engineers, for consultation on implementation costs.

Product design

Description. Design and specify the human-computer interface to four software products.
Objectives. Design a paradigm for functionality access so the interface predicts and reacts to a user's next move and steps aside when no prediction can be made. Involves providing a task-orientation across several user classes, accommodating users with varying levels of product expertise, and minimizing the likelihood of user error.

Team. Human factors specialists. Software engineers, for functionality definition, estimation of implementation costs, and prototype development. Marketing researchers, for competitive benchmarking and identification of user characteristics and use patterns. Industrial designers, for keycap label design.

Development of national software ergonomics standards

Description. Participate in the Human-Computer Interaction Standards Committee of the Human Factors Society. This committee, which represents ANSI and serves ISO in an advisory capacity, is developing standards of design for the interface between computers and their users.

Objectives. The major contribution from the Unisys representative to the committee will be to create standards and guidelines for the use of color based on established human factors research and practice.

Team. Human factors specialist.

TOOLS OF THE HUMAN FACTORS TRADE

There are basic resources which, when available, substantially increase productivity, efficiency and effectiveness of the human factors function. In addition, when used to document design specifications, such resources lead to increased efficiency and timeliness of user documentation development. These resources include computer technology, printer devices, and data recording tools. The functional requirements of each are described in this section.

Computer Technology and Printer Devices

Basic to the requirements for computer technology are productivity aids, for creating design documents with textual and graphic matter, and simulation tools, for representing design concepts. The remaining requirements for computer power as well as for the print devices should be driven by intended characteristics of the targeted product. The monitor should be capable of displaying an accurate representation of the human-computer interface design concepts; the printer should produce accurate hardcopy representations; and the software simulation package should be capable of modeling the technology of the intended product.

Data Recording Devices

Design ideas should be verified by observing and analyzing some representation of use. This can be accomplished with paper-and-pencil simulations, software simulations, or live prototypes. Regardless of the technique used, it is important to have a method of capturing the data from these usability evaluation sessions for later analysis.

Several types of techniques are available for capturing evaluation data. These include audio and video recording, logging and metering, and simple note-taking by the participant or observer. The best method for recording usability data should be determined by the nature of the evaluation and by the type of information which is relevant.

HUMAN FACTORS TOOLS AT UNISYS

The functional shift of Unisys Human Factors from pre-implementation phase consultation to support across product life cycles has created new toolkit requirements. Although the current set of tools are adequate for pre-market release usability evaluations and post-release field studies, they are not useful for the remaining majority of design activities. The tools currently in use as well as near term acquisition plans are described.

Today's Computers, Printers and Data Recorders

Current tools for creating hardcopy design documentation include workstations with character-mapped displays and word processing software. These have been used in conjunction with various draft- and letter-quality printers to prepare textual matter and to capture character-driven designs. Software simulation tools are not available; therefore, paper-and-pencil and live prototyping techniques are heavily used.

Combinations of audio and video tape recording and playback equipment are used for conducting usability evaluation and validation tests. Data recording strategies can include: (1) voice only; (2) voice and computer display only; and (3) voice, computer display, and motor activity. For voice only, a mini-cassette recorder is used, synchronized voice and computer display records are captured with a video cassette recorder and motor behavior is picked up by adding one or more cameras.

Toolkit Limitations

The current set of tools is limited in three areas: (1) representing designs for use in external documentation, (2) displaying bit-mapped design concepts, and (3) simulating human-computer interactions. The workstations and printer devices work well for creating internal documents. The accuracy with which those designs can be represented, however, is not sufficient to allow direct input to customer documentation. Moreover, this technology is limited to character-driven designs. Those which are pixel-driven cannot be represented at all.

The inability to simulate presentation as well as behavior of alternative human-computer interface designs also raises issues. First, the paper-and-pencil interaction is significantly different from intended interaction. Therefore, when used as a medium for design evaluation, it is likely to have some confounding effect on evaluation results. Furthermore, inability to capture the true interaction precludes its evaluation.

The second issue has to do with using live prototypes for design evaluation. When utilizing a prototyping technique,
there is often resistance to maintaining its disposability. Live prototypes are costly and therefore lead to hopeful expectations and schedule assumptions that the design will be right the first time.

**Fitting the Toolkit to New Requirements**

To follow the transition in human factors responsibility with an appropriate supporting toolkit, the following arrangements are planned:

1. Unisys PC/IT personal computers (IBM PC/AT compatible) with bit-mapped displays will replace the current character-mapped workstations. Software will provide capabilities for full function text formatting, advanced graphics design, and the ability to merge text and graphics. Tools for the creation of human-computer interaction simulations will also be established.

2. Laser printer devices will be added so that accurate hardcopy representations of human-computer interfaces can be created. Any design document will potentially be usable both as internal engineering specifications and as direct input to customer documentation.

In addition to increasing the functional capabilities of the Human Factors group, this new combination of tools can lead to increased product development efficiency overall. The process of customer documentation development can be initiated sooner by using product descriptions from early and accurate design specifications; documentation development can be aided by supplying high quality samples through the internal specifications; and the costs associated with evaluating interaction style design concepts can be reduced by utilizing software simulations in place of live prototypes.

**SUMMARY**

The most recent thrust by Unisys to tighten usability criteria was initiated by market preferences; it is reflected in product goals, and it has been carried forward by Human Factors. As a result of an enthusiastic response to the 1985 menu-driven offerings, corporate goals for new products regularly refer to ease-of-use intentions. These goals, though, are stated in general terms and require interpretation by the development groups. Human Factors has been responsible for defining measurable objectives and, according to the requirements described herein, has established a long range strategy for achieving those objectives.

Currently, a general regrouping of functional responsibilities is evolving, and changes to the product development process are being promoted and implemented. Although it is too soon to quantify the long term impact of this new approach to human-computer interface design, expectations are clear. They include:

1. Increased market opportunities from an expansion of the potential user base
2. Reduction in software development costs by more closely matching personnel expertise to development assignments, and thereby leading to fewer design iterations
3. Reduced costs associated with customer training, resulting from the design of self-evident product operation
4. Cost savings in documentation development, attributed to the use of accurate design examples from engineering specifications for user manuals

The ergonomic approach to software design offers a fresh opportunity for competitive advantages. The key to a leading edge includes unique staffing, appropriate tools, and purposeful direction.

**REFERENCES**