SHARE

SHARE SESSION REPORT

61	M921/A065	Humanizing Human-Computer Interaction	125
SHARE NO.	SESSION NO.	SESSION TITLE	ATTENDANCE

Dept. of Defense Information Exchange	Vicent G. Pianalto	SSA
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Abstract

Although the computer does the work of many people, it is dependent on people to design it, program it, feed it data, correct data, etc. Since people are a necessary part of any computer system, their needs, limitations and capabilities should be an important consideration in the design of any system. Ideally, computer systems should increase productivity by permitting people to accomplish more tasks in a shorter period of time. Unfortunately, the potential benefits from systems are rarely achieved because of human factors problems. This article provides a model for inclusion of human factors in computer system design or redesign.

HUMANIZING HUMAN-COMPUTER INTERACTION

1. Background

Human factors (also known as human engineering, engineering psychology, or ergonomics) is based on the assumption that the design of equipment, systems, and environments can enhance or degrade their use by people. This scientifically applied discipline focuses on the human as the important component of the system or environment.

The human components of a computer system too frequently have been folded, bent, stapled, and mutilated to adapt them to the vagaries of the computer. In the past, the data processing industry has focused on the most efficient use of central processing units and storage media. Batch-oriented systems were run with little, if any, user involvement until the output was delivered. The relative neglect of human factors was justified because of the high cost of the technology, and because computers were used only by specialists. Over the last few years, though, computing costs have decreased while the number of people interacting with computers (the users) has increased tremendously. Personnel costs and usability have become the critical elements in a system because systems are being designed for interactive processing (Connell, 1982). Early inclusion of human factors requirements and specifications in the design allows for adequate consideration of human performance capabilities and limitations. Concern with human factors only after a system has severe problems, limits the options for correcting the problems. Therefore, human factors specialists or advocates should be included in all phases of system design or redesign (Hendricks et al, 1982). A human factors specialist is needed because of the multitude of factors involved in system design and because human factors applications remain something of an art. Applications depend on the skill of the human factors specialist in combining knowledge of system requirements, evidence from empirical studies, case histories, accepted practices, and logical arguments. Technical aids, like guidelines or checklists, can help point out the relevant factors for a particular application. An example of which is "Human Engineering Guidelines for Management Information Systems".(7) This document provides a summary of the human factor literature on computer systems, checklists for designers, and system evaluation forms.

The human factors advocate can play a crucial role in deciding whether a computerized system is needed, whether a new computer system should replace the current computer system, or whether the current system should be retained but in an altered form. Computer systems do not necessarily solve all problems. Some computer systems have caused at least as many problems as they have solved. The human factors specialists cannot operate in a vacuum. They will have to familiarize themselves with the system and collect data before they can make justifiable recommendations. Just as an electrical engineer must know power requirements, sequencing of events, etc., so the human factors specialist must specify the problems and requirements before evaluating solutions.

2. Requirements for system operation

The systems design process begins with the establishment of the need for a new computer system or a redesign of the current system and the establishment of requirements for what the system is expected to do. This task may sound trivial, but experience has shown that establishment of requirements is crucial and difficult. A major problem in computer design has been that users specify the requirements for the system without really knowing the capabilities, limitations, and costs of computer technology. This problem is aggravated by the speed of the technological advancements and the increasing number of software systems and data base management systems which are available. The resulting imperfect requirements, established by someone representing the user, are taken by the system designer and translated into a system architecture which is usually far from optimal.

The system designer usually seldom knows about computer applications and may have difficulty in interpreting the requirements. Because the designers speak a different language (computerese) than the users, there will be communication problems. Furthermore, designers often do now know how similar problems have been solved within other systems (Hendricks, 1980).

These problems are compounded by the complexity and interrelatedness of many systems. Because of the substantial technical hurdles that have to be overcome, the design often centers on building a system that performs the technical functions. Human factors considerations are ignored or shunted aside. After the technical problems are overcome, though, the human factors considerations will drive the usefulness and productivity of the system (Jong, 1982; Hendricks, et al, 1982).

3. Necessary data for design of an automated system

Once requirements are established, data are needed on current operating procedures so that good features can be duplicated or retained, and bad features lessened or eliminated.

The designers should get an overview of the system: where data come from, in what form they come, and where the data are sent. Interactions with other systems must be identified and analyzed to determine their affect on system design. Information should be gathered about data input, corrections, or updates, and what limitations these factors place on the system.

As data are gathered, potential users should be identified and defined in as many distinct ways as they appear. Their requirements must be kept uniquely defined and supported throughout the development. Two frequent, erroneous assumptions are that who the users are is known, and that a single user adequately represents all who will be using the system (Hendricks et al, 1982).

4. Data collection techniques

Questionnaires and interviews can be used to gather information about problems and benefits with the current procedures and attitudes both concerning the current system and towards changing this system. Questionnaires should be structured to elicit specific, design-related comments rather than general statements of feelings. If the problems of the current system are not identified, they may be repeated in the new system. If users contribute information and receive feedback about how that information influenced the system design, they might develop positive attitudes toward the new system.

Users are valuable sources of information but the information obtained from them should be evaluated in the light of empirical evidence. Users' experience and opinions should be employed in the design of a system when they do not contradict performance data. Users may be unable to describe the problems they encountered in a system because they have no experience with comparable systems or because they have adapted to their problems. Likewise, users' preferences are not reliable bases for predicting performance on various tasks.

Additional information can be obtained by observing users as they perform their various tasks. Care should be taken in interpreting the results, though, since people who know they are being observed may behave differently.

The experimenter can obtain further information by performing the tasks, or having operators teach someone to perform their tasks. These techniques are especially useful in identifying problems that users cannot express or have consciously or unconsciously remedied.

Several techniques are useful for structuring the analysis. Task analysis should be done before other techniques are used. A task analysis includes information such as listing of all tasks; location of tasks; tools, devices, and personnel needed; input and output requirements; time and accuracy requirements; potential failures; misuse; and allocation of the tasks to the human or the system. Based on this information, decisions can be made about operator selection and training. Other techniques, such as functional flow-diagramming, operational sequence-diagramming, time-line analysis, and link analysis, can be used to explain what various design options imply.

Once an initial design has been drafted, mockups or simulations can be developed to aid in further design refinement. When the proposed design is completed, the manager and operators who will use the system are again consulted. The designers explain how the system will work and how the users' input affected the system design. There may be more comments that will lead to further design refinements. The dialogue between users and designers should be a continuous one.

5. User attitudes

User attitudes toward the system are now being recognized as a key determinant of system performance. Meldman states that, "If people don't like the system, it won't work" (Leo, 1980). Since most people need their jobs, rather than quit they will try to adapt, and will be less productive than they could be. Some people may take direct action against the computer system. Dowling, in a sample of 40 installations, found that 45% had experienced some form of computer sabotage. Even though Dowling does not mention purposeful noncooperation or avoidance of the system, it is likely that these behaviors were even more prevalent.(Leo, 1980)

On the other hand, positive user attitudes can contribute significantly to system performance. User attitudes can affect dramatically both learning and performance with interactive systems. Shneiderman (1979) found that personnel with negative attitudes commit more errors and take longer to learn a system than those with neutral or positive attitudes. Initial positive attitudes can be increased while reducing resistance to a new system by participation of all levels of system users in system design, briefings on the system, and by minimizing initial system errors.

Initial positive attitudes will not last very long. Since initial positive attitudes are brief, experience with the system itself will be the main determinant of user's attitudes. They should be told to expect errors in the system when it first becomes operational. But if provisions are made to correct problems promptly, or at least to let people know when these problems may be corrected, users are more likely to develop or maintain positive attitudes toward the system (Gaines and Facey, 1975).

Transition to the new system should be planned, orderly and logical. Operators should be trained and equipment and devices installed and checked before the transition begins.

6. Ease of use

Another desirable feature of any system, but one that is difficult to specify or measure, is the ease with which it can be used. The ultimate criterion is whether the new system allows users to accomplish their tasks more efficiently. Ease of use includes: (a) the proportion of population that can learn to perform a task, (b) the length of time for this population to reach a certain level of proficiency, (c) the number of errors per unit time for number of operations, (d) the amount of time or number of operations to recover from system failures or to correct errors, (e) the number of exasperation responses per unit of time or number of operations, and (f) the attitude of users toward the system.

Each of these parameters can and should be measured and analyzed to increase the probability that problems will be detected and corrected. The information, however, must not be used to evaluate specific employees, because use of the information in this manner may violate privacy laws and alienate workers. Much of the data necessary could be gathered by automatic monitoring of dialogues, and by having users respond to problem forms at the computer.

Ease of use may also vary depending on user characteristics. For example, users unfamiliar with a procedure may need a menu selection dialogue which leads them through the process. After using a system, these people may become frustrated with the slowness of the menu selection dialogue, and may prefer a faster, programming-like command dialogue.

Software can minimize the difficulty of operator tasks (Military Standard 1472C). Tasks should be made as simple as possible, particularly for those requiring immediate responses, and should permit logical sequences with a minimum of actions required to complete the task (Military Standard 1472C).

Automatic monitoring of human-computer dialogue provides feedback to system managers concerning the operation of their systems, and shold allow accurate specification of system performance and possible identification of system problems (Tren, 1975; Smith, 1967; and Bois, 1974). Data that could be collected automatically include: system acknowledgment time, system response time, user delay time, user transmission time, frequency ofa command, frequency of errors, errors per command, and requests for help per command. The terminal also could be used to present questionnaires, and to collect and analyze that data. As mentioned, the monitoring should be for improving the system rather than rating specific users.

There are costs for the programming, storage, and computer time involved in monitoring the use of a system. It is difficult to compare these costs against the implicit costs of not collecting data or having an effective feedback system. Although the implicit costs may be difficult to measure, on a qualitative level, feedback is necessary both for the specification and correction of system problems.

The importance to remote users of finding the system available and responsive when they want to access it cannot be overemphasized. Availablity avoids both frustration and lost time (Gaines and Fasey, 1975). Excessive delays, inconsistent or highly variable response times, and long system response times cause lost productivity and frustration. Hendricks (1980) documented some of the adverse effects of system overloadin a recent survey. Operators could perform a whole day's work in a couple of hours by usingthe system before normal work hours. That is, operators could accomplish four times as much work when the system responded quickly--defined as about two seconds (Hendricks, 1980). Several studies indicate that response times of less than one second may be needed to optimize system performance (Doherty, 1982; Thadhani, 1982; Welyczkowsky, 1982; and Quick, 1982). Both performance quantity andquality appears to improve significantly with fractional second response times.

7. Software design

It has been stated that software may represent from 75% to 90% of the cost of a new system. Software costs are said to be increasing as a percentage of the total cost of a system, while hardware costs are decreasing. Frank, who claims to have originated this "Software Myth" in 1968, states that he has tried in vain to remedy this error. Cost ratios between hardware and software vary tremendously depending on what costs one chooses to place under each category.(Frank, 1983)

Nevertheless, software design usually involves a considerable investment of programming effort during system development. During subsequent system maintenance or modification further large investments of programmers' time and talent may be needed. Methodologies such as structured programming have been proposed as a tool to ensure that there is a coordinated software effort, and that proper documentation is provided. Several automated systems have or are being developed to assist in software production: CADES (Computer Aided Development and Evaluation), Unix/Programmer's Work Bench, Gandolf, and SAFA.(Campbell & Richards, 1981) Even with these developments, software is still the weakest link in system development.

An important aspect of software design is design consistency. Design consistency means (a) that users should be able to form a mental set or picture of what actions are required to perform tasks, (b) that similar actions are used for similar tasks, (c) that sequences of actions are logical and (d) that users should be able to predict system responses to their actions. For data display, design consistency means (a) that formats should be consistent from one frame of the display to the next, (b) that there should be standard locations for such things as the title of the display, the control options and the command lines, and (c) that labels should be worded, placed and highlighted consistently.

Another aspect of software design is to provide feedback to user actions. Absence of a response is usually not appropriate feedback. Unless some feedback is given, the user will not know if an action has been performed correctly or has been received by the system. Feedback needs to be appropriate to the action taken and not interrupt a sequence of actions.

8. Workload

Operator workload should be considered in system design. Workload is difficult to define in terms that allow accurate measurement. It involves some combination of the physical or mental effort expended in performing tasks and the quality of the task. If workload is too high, performance is degraded, and a recovery period is usually required before performance recovers. On the other hand, if there is an underload, the user may get bored.(Rouse, 1975)

Tomeski (1975) noted that the nature of the work is an especially important aspect of workload. He gives an example of a budget analyst who was responsible for preparing budget forecasts. After automation, his role was reduced to that of a robot, placing numbers in certain boxes on preprinted forms. The interesting work was done by the computer, leaving only dull tasks for the analyst. The analyst soon became inefficient at these tasks and began complaining. It became obvious that the role of the human in forecasting needed to be reexamined. There were many solutions to this problem like completely automating the forecasting, or creating a more meaningful role for the analyst.

Work should be divided between employees and the computer to take advantage of their respective capabilities. Employees should be given tasks that require interpretation of the data, while computers should perform tasks that require rapid, rigorous, and repetitive operations.

9. Communication

Communication is one of the most important aspects of system design or redesign. Feedback from the designers to the users allows a check whether the designers understood the problems expressed by the users, and whether the users perceive that the solution corrects the problem. Users often receive little or no feedback, and feel that their suggestions have not been considered seriously.

An on-line complaint-suggestion provision allows the user to remain at the terminal while informing the system manager of a problem. The operator may become upset when faced with a problem, but may be able to relieve some frustration if there is a convenient, simple way to tell the system manager not only that there is a problem, but also the nature of the problem. The user probably will be motivated to report the problem, and with the problem on the video display terminal (VDT) having just occurred, the user should be able to give an accurate description of the problem. The ability to report problems easily could lead to an increase in these reports and be a valuable aid to system managers especially if they reinforce such behavior by acknowledging receipt of the information, and provide prompt feedback about what can be done and when it will be done.

The final aspect of communication is continuity, that is, communication is a continuing process among the interested parties that should stay in force even after the system is operational. Channels of communications should be maintained to handle new problems or new requirements because computer systems rarely remain static; as they evolve, system managers must continue to communicate with system users.

10. Safety

Many concerns about the safety of VDT have been publicized, and it is important that factual information be given to VDT users. These concerns basically involve three issues: radiation diseases or damage, muscle and skeletal problems, visual symptoms and damage. The radiation levels emitted by a VDT are very low compared to current occupational exposure standards. The National Institute for Occupational Safety and Health has stated that VDTs "do not present a radiation hazard to the employees working on or near a terminal".(Murray, et al, 1981) Other researchers have delcared that: VDTs DO NOT cause cataracts or other radiation associated diseases. Field and laboratory studies have both found that VDTs do not present a health problem. If workers are concerned, measurements of radiation can be taken periodically. The results of these measurements SHOULD BE EXPLAINED to the employees so that their fears can be ameliorated.

There is no known way that CRTs can cause visual defects since CRTs CANNOT stimulate the growth of the eye, increase the power of the optical components or change the strength and pliability of the ciliary muscles. (Rosenthal & Grundy, 1980) Nevertheless, some people will experience symptoms of eyestrain or visual fatigue that are related to their work at the terminal. Eyestrain or visual fatigue is by no means a new problem, yet there is neither a satisfactory explanation of the origin of the pain or discomfort, nor a reliable measure of eyestrain or fatigue.(Stewart, 1976) Nevertheless, most of the symptoms can be accounted for by ocular defects, working conditions, or inadequate office design and equipment.

In tasks that are predominantly visual, any defect in the correct functioning of the eyes may cause symptoms of eyestrain, blurred vision or headaches; all of which may worsen as the task is prolonged. Since working at a CRT is considered a demanding visual task, these symptoms are more likely to occur if there is a visual defect. Research on the vision of workers has found that up to one-third of the personnel given visual tests have uncorrected or insufficiently corrected defects of vision. People who are experiencing eye problems associated with VDT use should be sent for a visual examination if an examination of the office environment reveals no factors associated with eyestrain.

There are a number of factors associated with eye problems. Eye problems have been linked or associated with glare and reflections on the CRT screen; flicker of the screen; poor image quality; inadequate adjustment of the screen keyboard or chair; poor lighting; inadequate space; and poor arrangement of the office. It is recommended that the CRT image should be clear and stable; the visual environment should be carefully designed to provide adequate but not excessive illumination and a relatively glare-free working environment. Screen angle, keyboard height and the user's chair should be easily adjustable and adjusted. Each employee should be taught how to adjust their furniture and equipment to reduce the likelihood of vision problems. Employees may benefit from training on factors associated with visual problems. Such training may increase the likelihood of employees adjusting their work places adequately. The user's work station needs to be designed based on human factors principles rather than be a result of haphazard acquisition and placement of equipment.

It is generally recommended that after every two hours of continuous CRT work, the user switch to some other work for 10-15 minutes to rest the eyes and counteract fatigue. Empirical support for this two-hour standard has not been found. Furthermore, the definitions of what constitutes resting the eyes include looking at relatively distant objects, doing any other work that does not involve an illuminated screen, performing eye exercises, and closing the eyes. Since there are no reliable physiological measures of eyestrain, it is unlikely that empirically based guidelines will be forthcoming soon.

VDTs frequently reduce the need for moving about an office. Thus, VDT operators often remain seated for long periods of time with their arms, hands, and heads in nearly fixed positions. The relatively static sitting position can lead to strain on the muscle-skeletal system which can result in temporary muscle fatigue and to permanent deterioration of joints, ligaments, and tendons.(Grandjean & Vigliani, 1980; Grandjean, 1981) Muscle and skeletal problems caused by the static nature of VDT operation can be exacerbated by poor design of the work environment. Field data suggest that VDT operators suffer from muscle and skeletal pain more frequently than typist or traditional clerical workers.(Smith, et al, 1981; Hunting, et al, 1981)

A recommendation for reducing the muscle and skeletal strain of VDT users is to provide chairs, desks, and VDTs that can be adjusted in the range needed by the employees to meet each individual's requirements regarding height, viewing distance, viewing angle, back and arm support, and keyboard position. Training is needed to teach individuals how to adjust their equipment and the health related factors necessitating these adjustments. Such training should increase the likelihood of individuals properly adjusting their workplace. An occasional walking or stretching break is also recommended as a partial remedy since proper equipment may not be procured for sometime. Although procurement of adequate adjustable equipment may be costly, there is some eivdence that these purchases can be cost justified. Dainoff (1983) recently issued a report that concluded that a well-designed work station, as compared to a poorly designed one, could not only reduce physical complaints, but also increase productivity by as much as 25 percent.

11. Data input

Ideally, the keyboard should have the overall appearance, feel, performance and operating characteristcs of an electric office typewriter. A skilled typist should be able to sit down and use it with minimal training. Touch that is over or under sensitivie is particularly annoying.

The keyboard layout should minimize the effect of likely errors, especially those that are critical. For instance, the delete key should never be located next to the carriage return or other frequently used keys. Character and function keys should not vary across equipment used by a single operator. The errors, frustrations and decreased productivity associated with negative transfer of training are correctable by selection of keyboards that are compatible.

All commonly used controls (e.g., on/off, modem on/off) should be readily accessible to the user. Both the control itself and the control setting should be visible to the user.

Users of systems that communicate by telephone should have immediate access to a telephone for "dialing up" the computer. Once the connection has been made, the telephone should be as unobtrusive as possible.

The keyboard should be separate from the VDT screen to facilitate adjusting it to a position comfortable for the user. When the screen is attached to the keyboard, many users will not be able to adjust the keyboard or the screen adequately in order to obtain the optimum or preferred height.

The weight of the keyboard should be sufficient to insure stability against unintentional movement.

There should be a visible or audible warning signal provided in the event of system or VDT malfunction.

12. Output

It is important to assess what information an individual needs and what format is most useful to the individual.

At one point in time, it was acceptable to place several inches of output on a manager's desk. The manager would spend hours, days, or weeks manipulating the data by hand in order to change it into a form useful for her/him. It is not cost effective to provide employees with data that is not usable by them, especially when the computer is very efficient and reliable at manipulating data. Output needs to be up, to date and received by the user on time. Output that is inaccurate because it does not contain current data or output that is not received on time may adversely effect productivity. The designer has to ensure that the output is legible and is printed on paper that coincides with the office use and storage requirements.

13. Workplace environment

Although the human factors specialist, the system managers, or the system procurers, may not have much control over design of the immediate workstation, the office, or the larger environment in which the system is placed, it MUST be acknowledged that factors within these environments can affect the performance of a user. The user's performance will degrade if noise, temperature, lighting, reach envelopes, etc., exceed certain ranges.

These suggestions may elicit the reaction, why are the computer system users different from other personnel? They are not. Present working environments commonly are used as a model. We suggest examining the benefits and limitations of current practices before adopting them. Even though there is not much empirical research which provides unequivocable answers, there are some studies and observations that provide data which can be used to attempt to minimize the negative effects on performance due to the workstation, office, and environment.

In today's computerized society, workstations are constantly undergoing change - change brought about by new equipment configuration, or additional equipment made necessary by changes in job responsibilities. Usually, such changes are not pre-planned, but are of the "make do" variety. Proper planning and design, however, can assure an efficient workplace and lead to increased productivity. The following suggestions emphasize the importance of tailoring both space and equipment to the physical limitations of the employee.

- Adequate space should be provided for work involving large computer printouts and necessary reference documentation.

- The workstation and associated job aids should be adjustable to accommodate comfortably the expected physical dimension ranges of the user population (usually the 5th to the 95th percentile of the adult population is used as the standard).

- All of the equipment workers must use to do their job should be located in the immediate area to insure maximum use.

- Even though security concerns may require isolating a terminal, avoid placing it in a small unattractive room.

- Proper eye position relative to the viewing tasks (i.e., keyboard-to-CRT, keyboard-to-control console, etc.) should be provided.

- Design should include the reach "envelope" of the arms and legs (i.e., the user in most cases should be able to reach the controls without having to stretch.

- The workstation should be adjustable so that the home keys on the keyboard are at 2 inches (50mm) below the elbow height. This is the optimum work height for typing.

- Every task should be structured in a way that allows the employee to change position regularly. Failure to permit postural changes will result in fatigue due to the static load on the muscles.

- As mentioned in the Safety section, office personnel should be given a short training session on how to adjust the office equipment to obtain a physiologically sound, comfortable position. This training should include the health problems associated with improper adjustment.

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SESSION REPORT

SHARE

61	M973	File Transfer Protocols Used at Universities	
SHARE NO.	SESSION NO.	SESSION TITLE	ATTENDANCE

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SESSION CHAIRMAN'S COMPANY, ADDRESS, and PHONE NUMBER

1. KERMIT - The File Transfer Protocol Used at Columbia

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   612 West 115th Street
   New York, NY 10025

   Installation Code: BWY

2. YTERM/PCTRANS FILE TRANSFER PROTOCOL

   Josh Auerbach

   Computing Center
   Yale University
   New Haven, Connecticut

   Installation Code: YU