PNL-SA--20626

DE92 019124

HUMAN PERCEPTUAL DEFICITS AS FACTORS IN COMPUTER INTERFACE TEST AND EVALUATION

S. E. Bowser

June 1992

Paper presented at
Industrial Ergonomics and Safety Conference '92
June 10-14, 1992
Denver, Colorado

Work supported by
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

HUMAN PERCEPTUAL DEFICITS AS FACTORS IN COMPUTER INTERFACE TEST AND EVALUATION

Samuel E. Bowser, Ph.D.
Pacific Northwest Laboratory[a]

ABSTRACT

Issues related to testing and evaluating human computer interfaces are usually based on the machine rather than on the human portion of the computer interface. Perceptual characteristics of the expected user are rarely investigated, and interface designers ignore known population perceptual limitations. For these reasons, environmental impacts on the equipment will more likely be defined than will user perceptual characteristics. The investigation of user population characteristics is most often directed toward intellectual abilities and anthropometry. This problem is compounded by the fact that some deficits capabilities tend to be found in higher-than-overall population distribution in some user groups. The test and evaluation community can address the issue from two primary aspects. First, assessing user characteristics should be extended to include tests of perceptual capability. Secondly, interface designs should use multimode information coding.

INTRODUCTION

The focus of Human-Computer Interface (HCI) design literature and research has been on the software, displays, physical environment, and computer equipment aspects of the interface. The approaches to testing and evaluating human computer interfaces are usually based on the machine rather than the human portion of the computer interface. The perceptual characteristics of the expected user are rarely investigated, a interface design ignores known population perceptual limitations. Using color to transfer information does not take into account the potential incidence of color-deficient vision problems in the user populations. Using auditory codes does not take into account expected hearing deficit by frequency and adjust outputs according to known population characteristics. The distribution of visual acuity within the user population is usually not considered. It is more likely that environmental impacts on the system will be defined than will user perceptual characteristics.

(a) The Pacific Northwest Laboratory (PNL) is operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

The interface issues presented in the following material were initially identified by the author through workplace observations. The placement of computer displays was different in each office. The color schemes of the commercial software packages varied and were different from office to office. The level and nature of the auditory environment in each section varied greatly. Some individuals were forced to tilt their heads to read displays that were fixed in place. The effect of glare on fixed screens in both commercial and military environments (i.e., Automated Teller Machines (ATM) and/or other fix mounted displays) was often a serious interface problem for users. The need for larger displays and the small size of the text on the display were frequent operator complaints. These observations raised the questions about interface design and user perceptual problems.

BACKGROUND

The military test and evaluation community is exposed to numerous systems involving HCI. There are standard resources for anthropometry and volumes dealing with computer interface designs. Although information is extensive, the military standards system does not provide data about the distribution of perceptual deficits within military populations. Personnel entering the military are routinely screened for vision and hearing, and results are recorded in individual records. The lack of a deficit is used by the assignment system to screen personnel for some job categories. Data on perceptual capabilities of the overall personnel pool data have not been aggregated into an information resource. It is known that military personnel will have correctable vision to a given standard, hearing within a standard range, and physical characteristics within a standard range. But the distribution of color vision capabilities is not known and is not identified for specific personnel unless it is used as a job screening item. We do not know who wears glasses (contacts) and what types (i.e, bifocals, trifocals, reading glasses, etc.). We do not identify hearing limitations in the subject population or those that may occur due to a career-induced exposure. The distribution of hearing deficits for the overall population by frequency range is not aggregated. The military system does not provide a resource for cataloging perceptual deficits within the military population.

The military problems are a subset of the more general civilian issues. The civilian population represents a larger range of perceptual capability than does the military population. The details of perceptual problems among this larger, more diverse population are more difficult to obtain and less predictable. The various license agencies and professional medical associations could serve as a basis for estimating the extent of deficit within the general civilian population, but the

information is not systematically aggregated. Specific surveys are not generally available for problems, such as partial color vision deficit, and have not been accomplished in sufficient detail for population estimates to be reliable. The information that has been collected has not been under standard conditions, making aggregation difficult. There is no central resource or standard information base for the distribution of population perceptual capability. Self-reporting (i.e., questionnaires and surveys) of the general population is not a reliable source of information because large numbers of people are unaware of the nature or extent of their perceptual deficits. It is obvious that perceptual deficits are common in the general population based upon the observation of persons using perceptual aids and the amount of commercial activity associated with these items.

TEST AND EVALUATION RESULTS

The military regularly undertakes test and evaluation projects that involve HCI. In a number of recent experiments undertaken by the author and his associates, self-report data were collected on some aspects of visual perception. Data on the need for vision correction and types of corrective vision appliances were collected from participants by questionnaire. The incidence of color vision deficit was also solicited. The sample size was less than one hundred military personnel and did not qualify as either random or representative of the overall military population. Data were collected from officers and enlisted personnel who volunteered to participate in experiments testing prototype computer software. Participants' responses indicate that over fifty percent used some type of visual appliance. The most common was glasses with a single lens, rather than bifocal, trifocal, or blended lens. The user self-report distribution of near-sighted, far-sighted, and astigmatism was approximately equal. The reports on color vision problems were less certain. Approximately sixty percent could not state if they did or did not have any color vision deficit. The remaining forty percent reported some color vision deficit in about half the group, that is approximately twenty percent of the total group.

Since the identified problems extend to the general civilian population, observational data were collected by the author in the general commercial area. It was noted that most fixed mounted screen interfaces are placed at median eye height. Observation shows users of such interface frequently tilted their heads, and it was assumed they did this because they were required to use a multifocus lens to read the screen. It was also noted that environment glare was a common interface problem. The use of monochrome displays (i.e, plasma panels, liquid crystal displays (LCD), etc.) were observed to be difficult for many people to read when viewing conditions were less than ideal. The smaller the display font size, the more likely that the average user would have difficulty reading the screen. The use

of lower contrast color displays (i.e, color LCD) caused readability problems for persons with color vision deficits. The use of color to code information is a common commercial software technique. The color coding is often not redundant with some other modality and therefore a potential problem for users with color deficit. There appears to be no standard for auditory cues in terms of frequency or loudness. The loudness issue is complicated by environmental noise factors and, in most cases, no adjustment is provided to the user. A self-selection of frequency (hertz) has generally not been made available to users to accommodate persons with a hearing range deficit.

The commercial interfaces are unacceptable to persons who lack a perceptual modality or are handicapped. The screens do not in general provide an auditory modality for the blind or a visual mode for the deaf. The height of most screens does not allow for persons below the fifth percentile in height or the wheelchair-bound user. Total color blindness is not allowed for in most interfaces. Observation of interfaces, such as ATM, telephones, information displays, and public computer terminals, shows no design effort in the area of handicapped access. Given the less obvious nature of partial perceptual deficits, the interfaces are not designed to account for these problems.

CONCLUSIONS AND RECOMMENDATIONS

The investigation of user population characteristics is most often directed toward intellectual abilities and anthropometry. The difficulty of measuring perceptual capability combined with the lack of organized databases on these aspects of the specific populations has resulted in the issue being ignored. The problem is compounded by the fact that some of these perceptual deficits tend to be found in higher-than-overall population distribution in some user groups. The military, for example, selects for some job types on perceptual capabilities, which means that the groups in the military not selected for these jobs have a higher-than-population average of perceptual deficits. For example, the deficit group in the military is also more likely to be selected as computer operators because in general there are no perceptual screening programs for these jobs.

The scope of the problem in various populations should be explored to provide a better understanding of the extent of the problems. The test and evaluation community could and should include data collection on perceptual deficits as a standard part of user interface evaluations. Where possible, aggregate data from the general population should be consolidated. Interface designs should be evaluated with these limitations in mind. The test and evaluation community can address the issue by extending the assessment of user characteristics to include tests of perceptual capability.

The design community, as well as test and evaluation professionals, should identify possible compromises in the user interface to accommodate the larger population of users. For example, a public computer interface, such as an ATM, could be placed at a lower level and slanted. The level should allow the accommodation of the wheelchair-bound. The tradeoff would cause tall persons to bend down to use the interface but would increase the overall user access. The glare problem could be reduced by slanting the display and using glare-resistant screen covers. The lower position would aid the users who employ multifocus vision aids by improving the visual angle. The use of monochrome displays should include larger text fonts, since the contrast effects are limited by this display mode. When color is used for coding user information, at least one secondary coding method should be employed to assure the interface usability. It would also improve the interface if auditory signals could be directly adjusted by the user. Consideration should be given to voice interactive systems to aid the severely visually handicapped. The example of an ATM interface applies to all screen interfaces that require public access.

The military community may also need to change design and evaluation approaches. The use of monochrome displays is common, and the requirement for larger text sizes due to reduced contrast should be recognized. The need to allow vertical height and tilt adjustment of screen displays should be accommodated as much as possible. The impact of glare on low contrast displays should be a standard part of test and evaluation. The military environments are often noise filled, and the capability to adjust frequency and loudness of the auditory interface is important. The use of color coding in military systems is extensive. Interface designs should use multimode information coding. It follows from these main issues that the use of single mode information coding needs to be reduced and that the collection of perceptual capabilities data should be expanded.

REFERENCES

ANSI/HFS 100-1988 "American National Standard for Human Factors Engineering of Visual Display Terminal Workstations" Human Factors Society, Inc. 1988

Galitz, Wilbert O. "Handbook of Screen Format Design, Third Edition" QED Information Systems, Inc Mass. 1989

MIL-HDBK-761A "Human Engineering Guidelines for Management Information Systems" 30 September 1989

MIL-STD-1472D "Human Engineering Design Criteria for Military Systems, Equipment and Facilities" 14 March 1989

MIL-STD-1800A (USAF) "Human Engineering Performance Requirements for Systems" 10 October 1990

To read the display area above the visual center line, a person wearing multifocus lens must tilt the head back.

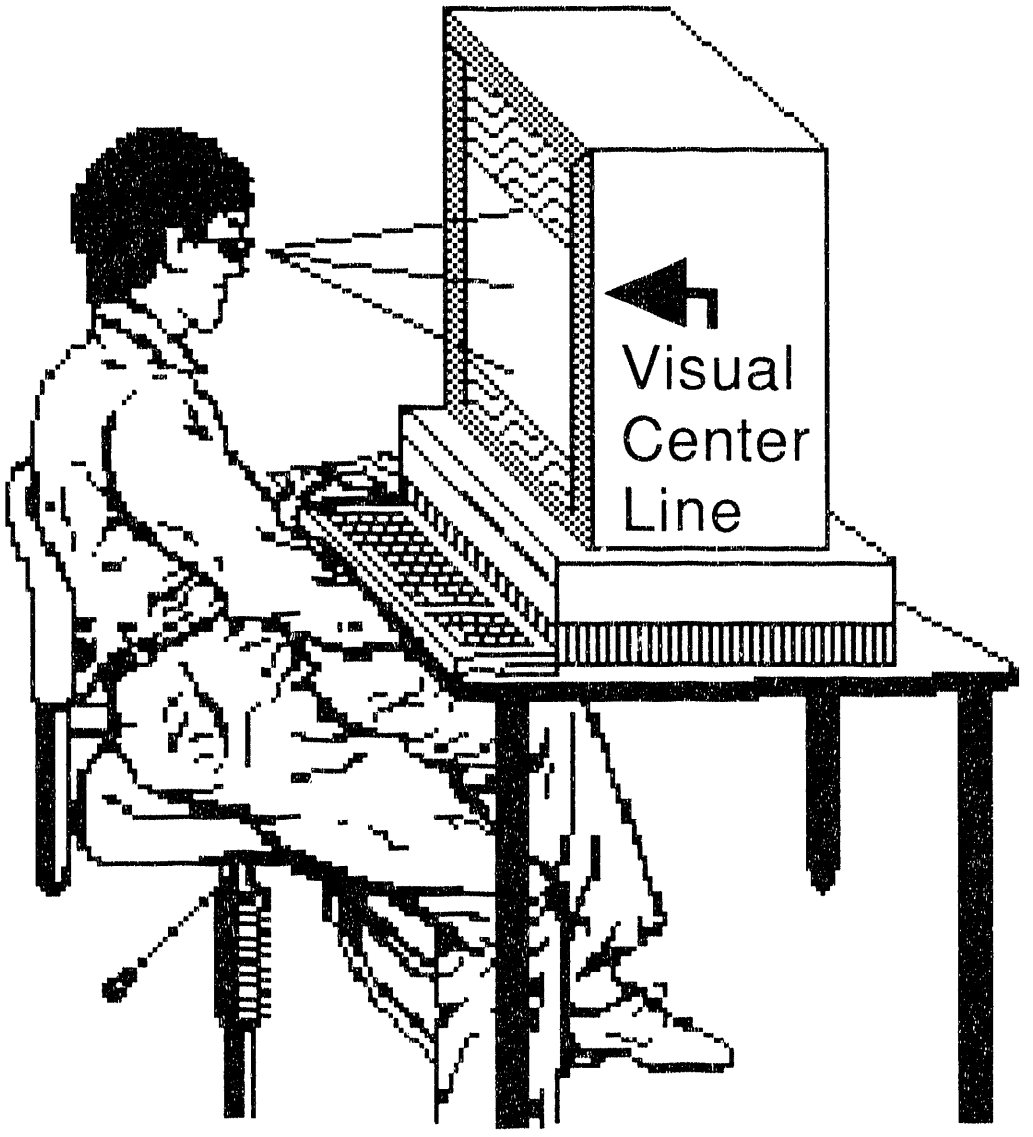

Figure 1. User Visual Range

END

DATE
FILMED
9/29/92