bias may be to confine data requests to the time period under evaluation and to display the average productivity of each employee.

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THE DEVELOPMENT OF A TASK-ORIENTED, MINIMAL CONTENT USER'S MANUAL

RICHARD GONG

Introduction

The intuition that computer manuals are scorned and disregarded by computer users is difficult to dispute. Informal conversations with users reveal that they generally believe that manuals contribute little to their immediate tasks. They assert that the entire experience of trying to use a manual is not worth the trouble; the manual is often too lengthy, the desired information is often difficult to find, and the language is often difficult to understand, among other objections.

A sampling of some existing manuals supports the contentions of these users. Many manuals require the user to systematically digest a considerable amount of introductory and preparatory material prior to encountering information for accomplishing specific tasks. Many use unfamiliar terminology and command syntax. Most are organized to orient the user to the larger system underlying the tasks to be done with the software, but not necessarily to the user's immediate needs or goals.

While historically many users have been computing professionals or dedicated hobbyists who were willing to learn from such instructional material, increasing numbers of users in the age of personal computing are non-professional users who do not like to read (Wright, 1983), are impatient to do real tasks on the computer, and approach the computer with specific personal agendas (Carroll, 1984).

Wright (1988) has observed that the writing of "adequate" documentation involves the integration of at least three basic decisions: (1) decisions about the content of the manual, (2) decisions about the presentation of the information in the manual, and (3) decisions about how the effectiveness of the manual should be evaluated. Carroll, Smith-Kerker, Ford, and Mazur (1986) have developed a manual format called the "Minimal Manual" which significantly addresses the first two decisions. The Minimal Manual aims to tailor the content and presentation format of a user's manual to the needs and behavior of non-professional computer learners and users. Such a format stands in sharp contrast to the traditional format of most user's manuals.

The study described in this report utilized the principles proposed by Carroll, et al. (1986) to write an alternative user manual for a particular occupational safety applications software which runs on the IBM PC. This software is published by the University of Michigan and is used to predict the likelihood of a low-back injury while performing certain kinds of manual labor tasks. The writing of an alternative user's manual was motivated by the difficulty experienced by novice users in the learning of the software. These difficulties occur in spite of the distribution of an existing user's manual to all licensed users of the software. Because the University cannot commit a large support staff to deal with user problems, reference materials for the software have become the focus of improvement in order to reduce user problems. A significant part of such a focus was the writing of an alternative user's manual, specifically a minimal manual using the principles proposed by Carroll and his colleagues.

This study also directly addresses the third issue which Wright (1988) has raised concerning the writing of adequate documentation, that being how the effectiveness of a manual should be evaluated. In order to judge the usefulness of the re-written minimal manual for the software in question, a small group of novice users were recruited to perform unfamiliar but representative tasks with the software. Subjects were assisted by the use of either the original manual or the re-written minimal manual. The manuals differed substantially in length, style, and presentation format. Performance measures such as time for completion of tasks and errors committed were used to contrast the manual types. Such an experiment, with its low level of sophistication and small number of participants, also served as a pilot study for investigating the viability of research in the specific domain of computer manuals. On a more pragmatic level, such an experiment would represent a "usability test" for evaluating the re-written user's manual. Such test could suggest areas for change and improvement in the re-written manual, as well as indicate areas which are effective for reference and instruction in the new manual.

Methods

Participants. Eight males and two females participated as test subjects. The subjects were recruited with the stipulation that they had some familiarity with an IBM Personal Computer (PC). All participants claimed to have used the PC at least one year. Six of the participants were graduate students at the University of Michigan; the remaining four were engineers at General Motors Corporation. None of the participants had ever used the software prior to the experimental sessions.

Design. The design was a simple two-factor, between-groups design. The groups differed only in the manual given to the participants during the experimental session.

Manuals. Two different manuals for the software were used in the study. The first was simply the original user's manual which is provided to licensed users of the software upon the completion a training program. This document contains 47 pages of text describing the features and operation of the program and an additional 20 pages of appendices which contain sample outputs from the program. The original manual can simply be described as similar in format and style to most software manuals. In conversations with users, it was apparent that they neither perceived it to be much better or much worse than other manuals they have encountered.

The alternate documentation was a re-written "minimal manual" containing much of the same information as the existing documentation. The minimal manual developed for this study sought to drastically alter the organization and presentation of the original manual while retaining the important content. This study purports to break no new ground in the theory of how documentation should be written or how technical information should be presented. Rather, the following heuristics and principles developed by Carroll, et al. (1986) were applied to develop the new manual:

1. Slash the verbiage. Trainers and users in the field were consulted as to which features of the software were the most frequently used, as well as which features were almost never used. The majority of users have little or no formal technical training and may use the software every few weeks or so. Virtually none will become expert users or will need to use some of the more powerful features of the program. Documentation of these infrequently used features of the software was excluded from the manual. Extraneous information such as the historical development of the algorithms, hardware requirements, and the making of backup copies was excluded. Procedural steps for accomplishing the more common goals were emphasized, and the conceptual background and explanations for the program steps were de-emphasized although not entirely eliminated. The resulting minimal manual was 23 pages in length, compared to 67 pages for the existing manual.

2. Focus on users' real goals and tasks. Based on discussions with trainers and users in the field, seven major goals of users were identified. These goals then served as major chapter headings in the minimal manual.

Procedural steps to accomplish each of these goals were developed using the GOMS model. The GOMS model, which stands for the Goals, Operators, Methods, and Selection rules of a user, was proposed by Card, Moran and Newell (1983) to model the user's task. Without describing the intermediate steps, application of the model yielded precise, step-by-step procedures for accomplishing the subgoals (if any) which made up the major goals or chapter headings. Conceptual and explanatory information were kept to a minimum and de-emphasized by the use of smaller print.

3. Support error recognition and recovery. The author attended two training workshops in which new users were trained for the first time and infrequent users were re-trained in the use of the software. Error patterns prevalent among novice and infrequent users were observed and iventoried. Information was then developed to help users to avoid errors, recognize error states, and return the user to the state prior to the errors. This information was included in the minimal manual in two different forms: one in the form of *warnings*, which were placed prior to the steps where it was observed users first stray off the correct path for performing a task; and the other in the form of *error recovery*, which was usually (but not always) placed after a procedural step which asked the user to check the state of the display. If the user has strayed off into an error pattern, a likely manner in which the user would recognize his error is by the mis-match in the state of the display and the description in the manual (either verbal or pictorial) of the what the display should look like. Such information was "flagged" in the manual by a different style of print and an appropriate symbol.

4. Encourage and guide the exploration of the user. Carroll, et al. (1984) have suggested that users are often active, rather than passive learners. Therefore, instructional material should encourage users to "get their nose out of the book" and learn about the interface through some exploration on their own. Such exploration should not be random but purposefully directed by the instructional material itself. Users can be encouraged to infer procedures and to direct their attention more to the screen through fewer illustrations and text queries such as "Can you find this prompt on the screen?".

For the particular software used in this study, a slightly different view of guided exploration was taken. The somewhat crowded nature of the software interface as seen in Figure 1 necessitated the inclusion of detailed display illustrations in the manual highlighting input or output fields being described in the procedures. An example of such an illustration is shown in Figure 2. By highlighting a specific portion of the display, it was hoped that when users did focus their attention on the screen, their efforts would be more productive than if they were left to find the field being described by only a textual description. Thus, for this particular software, the nature of the interface necessitated the inclusion of more illustrations instead of less.

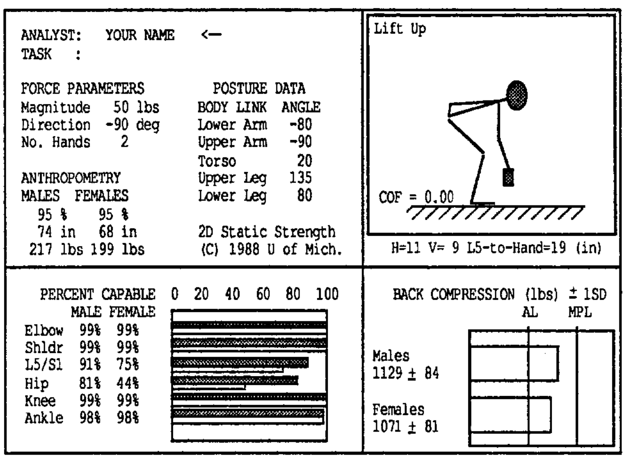

Figure 1. The main software display interface

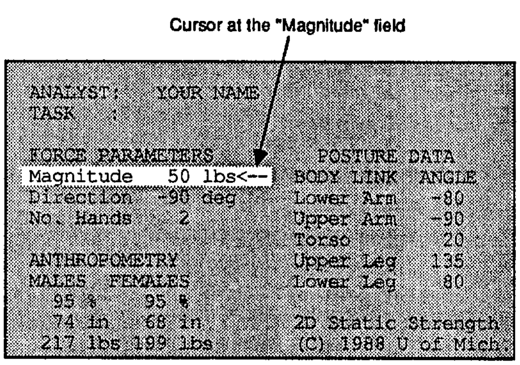

Figure 2. Sample illustration from the re-written manual with highlighted data input field

Tasks. The experimental session consisted of participants analyzing a hypothetical automotive assembly line task with the aid of the software. The hypothetical situation and the associated computer-based tasks for the experiment were developed by trainers who were not familiar with the re-written minimal manual. Participants were to put themselves into the role of an Industrial Engineer analyzing the potential hazards for a job lifting automotive parts weighing 35 pounds from pallets onto a conveyor. In order to successfully analyze this hypothetical situation, participants were required to master the following kinds of computer-based skills: (1) entering data with the keyboard, (2) obtaining and interpreting display output, (3) saving information into a data file, (4) recalling a data file, and (5) modifying previously inputted data to obtain new output.

The tasks which represented these kind of activities were not discrete, unrelated tasks; rather, they represented a logical sequence of activity that an Industrial Engineer might undertake in analyzing such a situation.

Results

For this pilot study, only the total time and total number of errors during the session were compared. Participants who were aided by the original manual averaged 44.2 minutes to complete the session and committed an average total of 14.6 errors during the session. In contrast, participants who were aided by the minimal manual averaged 28.9 minutes to complete the session and committed an average total of 7.4 errors during the session. Thus, subjects assisted by the minimal manual completed tasks an average of 35% faster than subjects assisted with the original manual and made an average of 50% fewer errors. The difference in total time between the between the two conditions was significant ($t(8) = 2.72, p = 0.026$) as was the difference in errors ($t(8) = 2.70, p = 0.027$).

Beyond a simple comparison of the two manual conditions, the participants were also divided into two groups according to their *tendency to use manuals.* Participants were judged to have a high or low tendency to use manuals by preferences indicated on questionnaires completed prior to the experimental session. The data was then re-analyzed in a 2 x 2 factorial ANOVA. While the main effect of manual type remains significant for total time of session and total number of errors, there was also a significant interaction between manual type and tendency to use manuals for the total time ($F[1, 6] = 11.631, p < 0.02$). This interaction is illustrated below in Figure 3. Participants with a low tendency to use manuals displayed a much greater difference in session time due the manual type than did participants with a high tendency to use manuals.

Discussion

Given the small number of participants in this pilot study, it is difficult to generalize from the results beyond the immediate group. Nonetheless, some intriguing issues for further investigation have been raised. While it may seem intuitive that the shorter manual facilitated faster perfor-

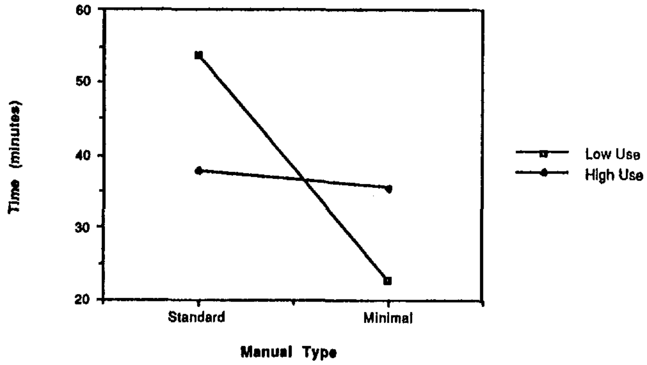

Figure 3. The effect of manual type and tendency of manual usage on average total time

mance, dismissing the minimal manual as simply a shorter manual ignores many of its other features which directly addresses the characteristics of today's "typical users", such as their task oriented agenda and their tendency to make errors. Simply "slashing the verbiage" of the manual does not appear to be enough to improve user performance. In this study, the ability of the minimal manual users to avoid, recognize, and recover from errors appears to be the principle contributing factor to their superior performance. Several factors appear to be important in affecting error avoidance, recognition, and recovery. These include the organization of the manuals, the use of illustrations, and the inclusion of error recovery information in addition to the relative shortness of the manual. To determine the degree to which each of these factors is affecting performance, a subsequent study with more subjects is being conducted. This follow-up study focuses on the hypothesis that the inclusion of explicit error avoidance and recovery information is the key to improved user performance, particularly among novice and infrequent users.

Another effect of interest suggested by the data is that the performance differences between the two types of manuals were primarily among users who tend to shun the use of manuals, and that users who tend to use manuals for reference and learning were not as greatly affected by the type of manual. Participants who claimed to be accustomed to using manuals were relatively efficient in locating the information they needed and habitually referred to the manual in a sequential and systematic fashion before attempting each task. Thus, the shorter length and task-oriented organization of the minimal manual may have been of little consequence to such users. However, participants who were accustomed to using other methods for learning software may have used the manuals nearly as a last resort, becoming bogged down in (and eventually abandoning) the existing manual but successfully finding help in the minimal manual.

Some Additional Observations About Minimal Manuals

The results from this study suggest that a minimal manual for the software used in this study could be useful for training and reference in the field. Some additional observations based on this study are worth noting:

The design of a minimal manual is an iterative process. The development of a minimal manual is an iterative process fueled by usability testing with real users. The guidelines of Carroll, et al. (1986) have, for this study, helped produce a manual which on the first attempt has been demonstrated to improve learning performance for certain tasks with a small group of users. Perhaps just as valuable as the results from this study are the observations of previously uninventoried error patterns which provide the basis for the further refinement of the minimal manual. Feedback on other manual features may also result in modifications to the manual. The small group of participants which received the minimal manual in this study, then, served as usability testers for documentation, although we normally think of usability testing as applicable to the software itself and not necessarily the documentation.

Minimal manuals can shorten start-up times for novice and infrequent users. Because the minimal manual is smaller, task-oriented, and facilitates error recovery, it appears to be well suited for learners and for users who must only occasionally use a certain applications program to get a job done. For the specific software in this study, the use of such a manual could reduce the reliance of users on resource-intensive help mechanisms, such as telephone "hot-lines" or special workshops, as well as reducing the frustration often encountered in using a full-featured manual.

Minimal manuals can supplement the full-featured manual. For the particular software used in this study, the minimal manual is a supplement, not a replacement to the existing manual. Since the existing documentation features a full rendering of all the functions of the software and not just the most frequently used functions, it should not be viewed as entirely replaceable by the minimal manual. Certain users may need to learn the more obscure features of the software and may use it several hours a day. Perhaps some consideration should be given to re-documenting the infrequently used features in a manner like the minimal manual.

User aids of any kind should support error recognition and recovery. If minimal manuals are not adopted and some other forms of help are considered (such as an on-line help or tutorial system), then one of the functions of such help should be to assist users in avoiding, recognizing, and recovering from errors. Even the best designed interfaces will not completely prevent users from making errors. Help systems must recognize that users will make errors; more often than not, users access help systems when they realize they have made an error or are not accomplishing their intended goal.

Good documentation can minimize the effects of a flawed interface, but good interface design should not be ignored. If the user interface is overly flawed, several iterations of manual design may be required to capture all of the necessary error recovery patterns so that recovery procedures and appropriate warnings can be documented. If a minimal manual becomes overrun with error recovery procedures and warning messages, it can soon lose the advantage of being shorter in length, and the additional error avoidance and recovery information can become distracting. Software designers should continue to strive to create intuitive, user-friendly interfaces and not rely solely on documentation to "band-aid" or solve usability problems.

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OBJECT IDENTIFICATION BY LANGUAGE IN A USER INTERFACE USING LANGUAGE AND IMAGE INFORMATION

AKIRA HAKATA
TOMOICHI TAKAHASHI
YUKIO KOBAYASHI

1 INTRODUCTION

We propose an advanced user interface which can identify an object in a picture indicated by natural language, hand pointing or both.
"PUT-THAT-THERE" [1] is a well known system that allows users to access a pictured object by language, hand pointing or both. Here, object identification by language is done by using the words attached to each object in advance, for example: "rectangular" or "triangular" which indicate an object's shape.
Basic object identification mechanisms should be developed as it is almost impossible to attach adequate words to each object in all pictures [2],[3].
In this paper, we discuss the following:

(1) indicator words classification and a lexicon of spatial relationship words.

(2) object identification models using the words in the lexicon.

(3) IMAGE [Illustrated Map Guidance System (See Figure 1)] which adapts the above identification models, and its performance evaluation.

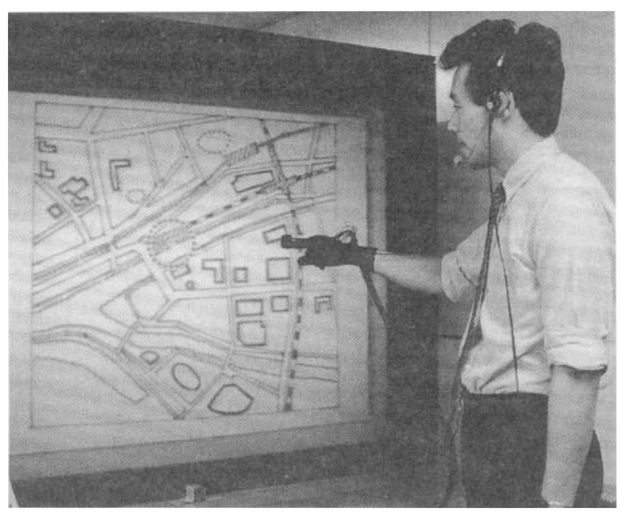

Figure 1: IMAGE [Illustrated Map Guidance System]

2 INDICATOR WORDS CLASSIFICATION

2.1 VISUAL AND SEMANTIC INFORMATION