Bridging the computer-user gap

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ABSTRACT

This paper deals with that portion of the computer-user interface comprising user manuals, training materials, and screen design. Several general principles are developed from learning theory including matching and schema, taxon and locale learning, and controlling the learning curve.

This paper develops more specific rules for applying these general principles to the interface. These rules cover manual design for the benefit of users, the role of typography in improving the design of any written materials, and the use of schema and matching to improve the computer screen/manual interface.

Further, the paper discusses rules particular to manuals concerning addressing different audience segments through sectioning, focusing on information, structuring the manual for each of two types of systems, and using sentence structure, graphics, and typography to improve the reference aspects of the manual. Finally, the principles of screen design which aid user acceptance, improve comprehension, and increase the rate of learning are set forth.
INTRODUCTION

The subject of user-computer interface is much too large to cover in a single paper. I focus on the user manual, training and learning materials, and screen design.

Personal computers have been a major force in improving these areas. Today, developers of hardware and software from mainframe to micro are beginning to understand that these issues can sell a product and make computerization acceptable for human consumption. The upstart world of personal computers has also attracted people with expertise from other disciplines which are important in application development such as training, learning theory, human/machine ergonomics, graphics design, and writing. Although such changes may have been addressed before, the personal computer has accelerated the process.

GENERAL PRINCIPLES

Several principles from the discipline of learning theory are vital to understanding and improving the computer-user interface.

The Human Mind

Both the computer and the brain suck up information in much the same way, but they process it differently. The computer has a very large volatile memory; the human mind has a very small one. The computer, subject to programmed rules, will store everything from volatile memory into permanent storage; the human mind is extremely picky and individualistic, and this is where the computer-user interface problem is centered.

Human volatile memory (short term memory or working memory) will hold about five of what experts call chunks for anywhere from 1/4 second to one hour—with practice. A chunk can be words, syllables, letter groupings, phrases, or ideas. Something in those chunks must connect with something already in long term memory in order for the chunks to make enough sense for the mind to process them further. Even then only one or two pieces may ever reach permanent storage in long term memory. The more the new material relates to information already stored, the faster learning occurs. To test this, try learning a foreign language without understanding either what the words mean or how to pronounce them. On the other hand, try learning BASIC after you already are proficient in COBOL, FORTRAN, and a database language; the learning time is significantly shorter than it is for a computer language novice. This process is called matching.

In addition, if the mind is given a schema for organizing these chunks in short term memory before the chunks are taken in, then these chunks can be processed even faster. It's like throwing objects at someone from behind a curtain. If a person knows what kinds of objects to expect, then he can catch more objects at a faster rate than can someone who has to learn by experience what to expect. The principles of matching and schema should lead developers to use language, screen design, and system design principles that will be familiar in some way to the intended audience (matching) and to tell them first how it is organized (schema).

The most accurate model of communication I have found is shown in Figure 1. This model explains how close relatives sometimes communicate very effectively in obscure phrases. It also says that no matter how hard you try, your knowledge base is going to bias both your communication and your comprehension of someone else's communication.

Two kinds of learning, taxon and locale, also apply. Taxon (rote) is easily lost unless it is practiced or used frequently, and it is usually taught by simple verbal repetition, much as dogs are taught tricks. Locale, on the other hand, is not lost as easily. It is understood learning and usually involves both verbal and visual stimulation in teaching. To promote total comprehension, the training impression must be as vivid as possible and may use as many kinds of sensory inputs and media as can be combined without creating confusion.1

Combining the model and the two learning methods, we can draw two principles: involve the user and utilize pictures, words, word pictures, demonstrations, user-centered exercises (utilizing user's own data), and any other types of media available in teaching the user about the system. Dale’s “Cone of Experience” lists 12 categories of ways which are roughly age related to stimulate learning. They include direct experience, simulation, and demonstration in the lowest age categories and visual and verbal symbols at the top (comparable to a sophisticated adult learning method). Pictures of all kinds are somewhere in the middle. These categories can also relate to the subject being communicated and to prior experience of the audience with that subject and with learning itself.6

Therefore, the combination of media that developers choose to present their applications and machines depend heavily on the intended audience. In addition, effective learning may be stimulated by categories lower on the scale, so that user-centered exercises and illustrations may be the most effective way to teach the system (successful with the highest percentage of the audience). But a visual and verbal analysis
of how the system works may be the most efficient (promoting locale learning and using fewer resources to create and absorb training). A hint: always provide a system diagram for tree structure menu systems. This is one of the hardest concepts for users to ferret out from the system itself; it essentially requires them to infer a three-dimensional structure from the various one-dimensional pieces—almost impossible.

The Learning Curve

The learning curve (see Figure 2) is very important in designing the user-computer interface. I am interested most in the tail because with it you can get more result for your efforts, and affect the rest of the curve.

This tail, depending what is to be learned, can be very long ( ) or very short ( ). The task of the computer-user interface is to make it short. A short tail can also affect the slope of the rest of the curve thus helping to achieve the entire learning process in less time by generating enthusiasm in users (something that has been shown to be a vital prerequisite for learning). The tail is most affected by the user manual's introductory or overview section which should give an overall understanding of the system: the easier it is for users to understand (that is, they should be provided with a schema and a basis for matching), the faster the learners will escape the tail. The tail is also strongly affected by the training materials and the approach to training. The slope will be most affected by the success with which users can find the section of the manual (or help text) they need to solve a particular problem and by the isolation of the answer from the general textual explanation of the problem (i.e., the reference aspects of the manual or help text). The slope is also affected by the screen design—the easier it is for users to relate screens to prior menus and other portions of the system, the faster (steeper) the actual learning process will be.

MANUALS AND SCREENS

Building on the general principles of learning theory as they apply to computer applications, this section provides specific design principles for the manual and the screen.

Patterns

Patterns are vital for reference materials and screen design. Visual images (patterns) can remain fixed in the eyes for several seconds; this physical ability can help users. When users look for something in the manual, they will probably have to deal with the instructions (once they find them) in two or more passes. The eyes will move from the book to the screen and back again to the book. If the writer/designer has used typeface, color, white space, and illustrations so that the page forms a visual pattern, there will be enough of the pattern remaining so that the eye will automatically return at least very close to where it left off.

In addition, by using exactly the same wording in the manual as is contained on the screen and as close as possible to the same typeface, the relationship between written material and screen wording is established much faster.

Typography

Boldface, underlines, color, uppercase, reverse video, italics, and type size, whether in written materials or in screen design, must be used—not abused. They serve to:

1. Call attention to warnings (bold and uppercase)
2. Set off sections of the text with headings and titles (underlining, uppercase, bold)
3. Emphasize (sparingly) text (underlining and italics)
4. Convey shorthand conventions for user input, screen output, and keytops (bold, uppercase, underlining, and italics)
5. Segregate ideas, illustrations, instructions, and reminders (boxes)

These typography graphics act as cues to memory and can improve recall as well as alert readers. They are also, of course, a part of the overall page pattern. If these aids are overused or used inconsistently (a particular problem in screen design), they will probably cause noise and hinder rather than help comprehension. Typography is therefore not purely cosmetic. But in addition to aiding learning as described, it also aids learning by generating enthusiasm, trust in the system (if the manual is professional looking, then the system is good), and the desire to learn—one of the more important components.

Overall Comprehension

Drawing on the principles of matching and increasing the slope of the learning curve, the best way to approach training materials is to plan the materials and explain the system top
down; approach the training bottom up. Give users the frame-
work of the system and the framework of the training ap-
proach. Then each step, beginning with the system base, will
have an increasing amount of prior knowledge in permanent
memory to match. Signal (by schema) all new material with
topic sentences, headings, pointers, objectives, and summary
statements. You can also display pictures of the system at
each step in the training to relate the new material to the
total system—kind of a "you are here" map. This can be
particularly effective with the tree structure menu type of
system.

MANUALS

Mainframe developers took their approach to manuals from
mythology: instead of 1001 tales, you get 1001 manuals. If the
single application is to be used only by users, there should
never be more than one user reference manual and one train-
ing manual. If data processing personnel are going to do some
technical manipulations before the users use it, then a tech-
nical (programming, installation, system adaptation) manual
and a users' manual should be available.

Simple installation (except when users accidentally erase
diskettes) will only be done once. Therefore, it is logical to
segregate the instructions from the main body of the manual.
For simple installation procedures, use a short installation
booklet or card. An overview giving the installation schema
should be included. If the installation manual is in the same
binder as the reference manual, it should be designed so it can
be removed after it has been used, because it, too, will be used
only once by each user. If the user has to refer to the training
manual for information that isn't in the reference manual,
then both manuals are badly done. Always adapt the training
materials from the reference materials.

1. The purpose of a user reference manual is to provide all
the information users need about a system if they are to
understand it and to use it in any way it could possibly be
used. The material must be organized for quick look-up,
easy comprehension, and easy access. The focus must be
on the information the user relies on from the system.

2. There are only two kinds of systems to use for manual
organization: command-driven (word processing, data-
base systems) and screen-driven (general ledger, order
types). This greatly simplifies developing the user manu-
al structure.

3. The purpose of a training manual (and other training
materials) is to teach the user the basic aspects of the
system. Focus should be on the 20 percent of the system
that is used 80 percent of the time. Also, more than one
medium should be used. Simulation programs should
never be relied upon to accomplish training; users must
be involved and engaged as much as possible.

Audience and Communication

Some writers of user manuals seem to have a problem with
the audience, particularly when a system is to be used by
users with different levels of knowledge (either differentiated
groups or groups with graduated degrees of expertise). For
example, accounting systems are used by accounting clerks for
data input and by accounting managers for analysis of reports.
In some businesses, however, the clerk and the manager may
be the same person. Complete business systems (such as those
used by doctors, lawyers, restaurants, and other verticals) are
often used by different groups of employees (e.g., accounting
personnel, managerial personnel, and "expert" personnel).
Don't make two manuals: handle these different readers' needs
by sectioning one manual properly. Clerks and man-
gers (even if they're the same person) aren't going to use the
same screen in two different ways. Why would you explain
managerial decision making when you are talking about what
data is entered in a particular input screen? You talk about
managerial decision making in sections on system structure
and system output.

A successful reference book integrates the structure and
output of the system, and segregates the instructions on how
to make it go. You talk to all groups about the structure; you
speak to each group separately through the segregated in-
structions covering the separate sections (input, reports) of
the system focusing on the purpose of that section.

If the same section is to be used by two different types of
readers, such as DP people and users, then write to the group
with most expertise and, using typeface graphics instead of
sections to segregate the information, include explanations of
any technical aspects for nontechnical people. See Figure 3 for
an example. Readers who understand subroutines are alerted
by a boldface and indented explanatory section to skip over
that part of the material. Readers who don't understand sub-
routines have the explanation available in the place where it's
needed. Boxes, asterisks—whatever typefaces and graphics
available—can be used to segregate detailed explanations.

Never write down to anyone. First, you might confuse in-
come levels for education (such as writing down to secretaries
rather than to executives), and second, most of the so-called
scientific methods previously used to write down have been
proven useless or even harmful. These include vocabulary
levels by school grades, and the infamous fog index.

You can use the specialized vocabulary of the reader wher-
ever appropriate, but leave out the computerese if you can
cosentially find an appropriate English language substitute.
"Enter" is perfectly acceptable, because that's what they are
doing; "file" is valid and it's an important concept to under-
stand; VSAM, bytes, RAM, open/close a file, spool, and
report image are some terms I would try to avoid.

Terminal keys are a particular problem. "Learning to Use
a Word Processor"9 contains a very amusing story about key-

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The CALL command allows you to call a subroutine.

Explanation: A subroutine is a.... It is
most often used...........

Figure 3—Example of a manual explanation segregating instructions for
different levels of user expertise.
top labeling. This happened in an experiment using only the training manual for training (wrong approach and obviously a bad manual as well as terrible keytop labeling). The novice word processing operator, wanting to remove a blank line that she had inserted in error between two text lines, used the "Required Return" key; this key was obviously the only one that might possibly have done the job since it seemed to be designed to require the bottom line to return to where it belonged. Had she first been given the basic computer file matching explanation—that there really are no such things as blanks in a computer; things that appear to be blanks are really caused by odd characters which the various keys insert into the file—she might have found her way to one of the delete or remove keys. Always remember this story when you review written materials for clarity, and remember that your readers are not programmers.

Do not write in the third person. Readers are reading this. They don’t like to be referred to in the third person as though they were invisible. Do not use passive voice and never, ever start a sentence with “It has” or “It is.” Users don’t like miracles. They want to control the system. Write the manual and training materials from this perspective.

Words, Sentences, Paragraphs, and Sections

Write simply—to everyone. Eye movement tests show that longer words and unfamiliar words take longer to process in short term memory. As the number of complete thoughts in a sentence (complexity of sentence) increases, so does the time to comprehend the sentence. However, the system overview section or general sections explaining concepts are designed for complete reading—not scanning. Therefore if words, sentences, and paragraphs are too simple, the reader may become bored and miss most of the material. For these expository sections, vary sentence lengths.

Other problems to watch for:

1. Be rigorous in checking spelling. Misspelled words can, if the context is not absolutely clear, increase fixation duration and interfere with learning.
2. Long distances between pronouns and referent nouns can also slow comprehension and perhaps even defeat it entirely.
3. The index should be comprehensive. If a user looks for a word in the index and doesn't find it referenced, whether it is system specific, task specific, or just plain English, then the index has failed.

Graphics and Typography

Again in the manual, diagrams and pictures should be used where appropriate to explain the system. Each illustration should be physically as close as possible to the text which relates to it. Repeat the chapter headings and subheadings exactly for the table of contents and take great care in choosing these words. The table of contents should give readers a word picture of the structure of the system as well as giving them the schema of the manual.

You can use call-outs in addition to summaries and key words as an aid to users in skimming and learning. Short explanations can be in footnotes, but in general, regard footnotes as a last resort. Too many writing amateurs will hide vital information in footnotes not realizing that it is vital.

To organize and present material succinctly, use numbered lists if things must be done in a specific sequence or have a hierarchy of importance; use bullets if listed items are of equal importance. Use rules, arrows, tabular format, examples set off from the text graphically, symbols, screen printouts—whatever you need to use in order to provide typographical and graphic clues to aid learning. Don’t get cute with symbolism—you are talking to adults after all. Remember the layout must be consistent throughout the manual. It is meant to be scanned, and inconsistency can cause any gain in learning speed to be lost to processing dissonance.

Some obvious things which should be mentioned: readability of typefaces* (e.g., choose a typeface which distinguishes the number one, the letter el, and capital letter I) and readability of copies (use carbon ribbon for direct printing or photocopying and a good printwheel).

Balanced pages (typography and illustrations) are much less disconcerting for people, and asymmetrical balancing is preferred over symmetrical. There are many rules for optimal typeface/reader comprehension. For example, wider columns require larger typefaces (10–12 words per line is optimal), and 9–12 point typeface (see Figure 4) is easiest to read. The goal is to reduce that learning curve and improve the user/computer interface.

In designing the manual, remember that form follows function; the manual design should come from the system design as perceived from the system/user interface. The user may use menu item 4 first, followed by item 2, then 1, and then 3; but the interface is 1, 2, 3, 4. Don’t try to put the manual in the same order as the user will use it. Don’t try to organize the manual to reflect the way the user will use the system. Design the system as the user would use it, and then take the manual from the system. Another problem with trying to design the manual to the user rather than to the interface is that different users will use the system differently. A manual designed for one user may completely confuse another.

This illustrates the difference in serif and sans serif typefaces. It is a 10 point typeface. 9 point is slightly smaller; 12 point is slightly larger.

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*In 1975, serif typeface was read 7 to 10 words faster per minute, but now that sans serif is more widely used, there may be no difference.
SCREEN DESIGN

The computer screen was designed to suit technology rather than human needs. White print on black background is the hardest for humans to read. Text in all uppercase letters takes more time to process and, to the average person, it signifies alarm. Yet many screen designers continue to use all uppercase, not only on input screens, but in screen instructions and in help text.

Color Problems

When given a choice between screens with text in white and one other color or text in white only, most users chose the white only as being easier to use. My opinion, based on color text studies, is that it was the choice of color and how it was used rather than the presence of color itself. People have different color preferences and needs. Yet most designers who develop for color screens continue to set the colors for the user rather than letting the user set them. Color can also be over-used, causing confusion about what is important.

Specialized Screen Typography

The worst mistake that designers make is with help text. A report by the American Institutes for Research says that it is 20% to 30% harder for users to read text on the screen than in a manual, yet developers insist on turing help text into a full-fledged dissertation. Keep it brief—reminders only.

Use windows rather than screen replacement. Since the brain can carry only a few chunks in short term memory, the act of reading text on a replacement screen replaces the chunks and creates a kind of “now why did I come into this room and what was I going to do with this thing in my hand?” feeling in the user. Use windows for help text and training instructions (either with or without borders and background color changes), and, if necessary, make the windows movable so that the user can comfortably examine both the problem and the solution together.

Many years of experimentation and study have gone into the effective design of today's newspapers so that readers can scan the entire page in seconds without missing a subject covered. These design principles can also apply to the computer screen. Use all the textual graphics available for designing screens, but don’t make clutter from comprehension aids. Use reverse video, large letters, high intensity, and underline just as you would on paper, but remember the computer screen has more limitations than paper.

1. The computer screen is, first, unnatural. People aren’t accustomed to text that is wider than it is long, so leave wide margins on text screens to make it appear longer.
2. Flashing letters are irritating, so use them only when you want to irritate—such as for a system crash warning.
3. All the typeface graphics call attention and pull the eye with varying intensity, so make certain you use the graphics to pull it in the general direction upper left to lower right. Don’t make users jump around on the screen to get the information.

4. When replacing part of the screen, leave it blank long enough for users to realize that it has been replaced. This is particularly important with novice users, as they tend to think that computers eat their input.
5. Don’t use animation on the same screen with text because it detracts from the text, and the text detracts from the animation.
6. Some users prefer vertical input screens; some don’t mind horizontal. However, line things up so users don’t have to search for the cursor. (It’s much easier to find the cursor on vertical screens.)

LAST WORDS

A user’s interest in a system centers on information—fast, logical, understandable, efficient processing of the user’s information. Users aren’t directly interested in efficient hash routines or wonderful file structures. They are interested in how these things affect their information. This is the user-computer interface. Make certain users can track their information from input to output—easily and completely—including every change the programs make to the information.

REFERENCES


