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User Friendly Future: Applications of New Information Technology

What Is User Friendly?

This paper considers the clinic theme, "What Is User Friendly?" from a scientific and technical perspective. As Burch has observed in the introduction to a bibliography on computer ergonomics and user friendly design, the term *user friendly* is an anomaly as a technical term: "Most words borrowed from science enter the popular language stream long after their associated discoveries have become history. The term 'user friendly' is an exception to this rule; it became popular long *before* a scientific basis for 'user friendliness' had even been looked for."[1] The current emphasis on user friendliness is both market- and technology-driven. There is an interest in making computers more useful tools for people who are not computer specialists, thus expanding the potential user population; and there are new technological components that may be employed to make systems easier to use.

Definitions proposed for user friendly/friendliness range from brief dictionary definitions (e.g., "a system with which relatively untrained users can interact easily")[2] to lists of criteria (e.g., criteria for user friendliness proposed by Trenner and Buxton).[3] Although a review of these definitions and criteria is one means of providing a context within which to view new technological developments, this paper instead begins with a historical perspective, describing selected proposals for user friendly systems made over the past forty years.

Technology Forecasting: Techno-poetic Fantasies

In an essay introducing the technology section of *The New Encyclopaedia Britannica Propaedia,* Lord Ritchie-Calder remarks that: "From

earliest time and beginning with the simplest contrivances, every discovery and invention has depended on the fact that the human being is not only a perceptual but also a conceptual creature capable of observing, memorizing, and juxtaposing images. He can make a mental design, a techno-poetic fantasy, even when the means of actually producing it are not available."[4] In the domain of information system design, there have been a number of such techno-poetic fantasies, designs for user friendly systems not realizable with the technology available at the time they were proposed. Rheingold has recently surveyed several of these proposals and the people behind them.[5] Those described briefly in the following paragraphs originated with Bush, Licklider, Engelbart, Nelson, and Kay: memex, procognitive systems, the augmented knowledge workshop, hypertext, and dynabook.

Vannevar Bush's article, "As We May Think," in which he proposed memex and other devices, has frequently been cited in the library and information science literature since it first appeared in *Atlantic Monthly* in July 1945.[6] Less well known is the condensed and illustrated version which appeared in *Life* 10 September 1945, including illustrations of future information technology such as memex.[7] Memex, as envisioned by Bush, is a mechanized private file and library. It is "a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory."[8] Bush emphasized the value of organizing the contents using associative indexing, "whereby any item may be caused at will to select immediately and automatically another. This is the essential feature of the memex. The process of tying two items together is the important thing."[9]

In 1967 Bush had an opportunity to assess how much progress had been made toward the construction of memex.[10] He observed that: "Great progress...has been made in the last twenty years on all the elements necessary. Storage has been reduced in size, access has become more rapid. Transistors, video tape, television, high-speed electric circuits, have revolutionized the conditions under which we approach the problem."[11] However, Bush was not optimistic that a personal machine would be affordable in a short time. He did not foresee the rapid progress in integrated circuit technology which led to personal computers in the 1970s.

In 1965 J.C.R. Licklider published *Libraries of the Future* in which he described the likely characteristics of future computer-based information systems.[12] He coined the term *procognitive systems* to differentiate them from libraries, since the intent was that such systems "will extend farther into the process of generating, organizing, and using knowledge" through interaction among men, computers, and the body of knowledge.[13] Criteria to be met by procognitive systems include: converse or negotiate with the

user while he formulates his requests and while responding to them; adjust itself to the level of sophistication of the individual user, providing terse streamlined modes for experienced users working in their fields of expertness, and functioning as a teaching machine to guide and improve the efforts of neophytes; provide the flexibility, legibility, and convenience of the printed page at input and output and, at the same time, the dynamic quality and immediate responsiveness of the oscilloscope screen and light pen.[14]

In 1982 Licklider had an opportunity to reflect on developments since 1965.[15] Although he noted considerable advances in the technological infrastructure, such as increased storage capacity and the availability of networks for digital transmission of information, he remarked that "the practically important application of information technology by libraries has not been, the past eighteen years, on any direct path to the procognitive system I was trying to describe in *Libraries of the Future*."[16] Nevertheless, he concludes by suggesting that, by the year 2000, librarians will have two important roles: (1) contributing to the work of the online intellectual community involved in generating and using the body of knowledge, and (2) organizing and maintaining the body of knowledge which will exist in electronic form.

In 1963 a series entitled "Vistas in Information Handling" began with a volume devoted to *The Augmentation of Man's Intellect by Machine*.[17] The lead paper in that volume, prepared by Douglas C. Engelbart, presented a conceptual framework for the augmentation of man's intellect.[18] At the recent Association for Computing Machinery (ACM) Conference on the History of Personal Workstations, Engelbart reviewed research conducted in the intervening years toward realizing the "augmented knowledge workshop"—the place in which a person finds the data and tools with which he does his knowledge work, and through which he collaborates with similarly equipped workers.[19] Engelbart feels that human knowledge work capability can be enhanced through properly harnessing this new technology. Although many of the technologies, both hardware and software, originally developed by Engelbart's group have now made their way into commercial products, he concluded his conference presentation on a somewhat pessimistic note: "I still don't see clear perceptions about what we humans can gain in new capabilities, or about how this may come about. There are constant, echoing statements about how fast and smart the computers are going to be, but not about how the enhanced computer capabilities will be harnessed into the daily thinking and working life of our creative knowledge workers."[20]

At a colloquium on information retrieval held in 1966, Theodor H. Nelson argued that access to information may not be best accomplished either by indexing techniques (document retrieval) or queriable informa-

tion networks (content retrieval).[21] As an alternative, he suggested that digital text storage and display make possible the creation of hypertext or nonlinear text systems. Hypertext is the combination of natural language text with the computer's capacities for interactive, branching, or dynamic display; it "may differ from ordinary text in its sequencing (it may branch into trees and networks), its organization (it may have multiple levels of summary and detail), its mode of presentation (it may contain moving or manipulable illustrations, moving or flashing typography), and so on."[22] Nelson has been pursuing development of the technology required to support this concept, as reported in his book *Literary Machines*.[23]

The final techno-poetic fantasy noted here is the dynabook, proposed by researchers at the Xerox Palo Alto Research Center.[24] The dynabook would be "a personal dynamic medium the size of a notebook...which could be owned by everyone and could have the power to handle virtually all of its owner's information-related needs."[25] Alan Kay and Adele Goldberg describe what such a device would be:[26]

> Imagine having your own self-contained knowledge manipulator in a portable package the size and shape of an ordinary notebook. Suppose it had enough power to outrace your senses of sight and hearing, enough capacity to store for later retrieval thousands of page-equivalents of reference materials, poems, letters, recipes, records, drawings, animations, musical scores, waveforms, dynamic simulations, and anything else you would like to remember and change.

Although none of these authors used the term *user friendly* in characterizing the products of their imagination which are now at least partially realizable with available technology, a technologically based definition of the concept user friendly should include such visions of the future. In each case ease of interaction was taken as a given; instead the focus was on means of creating, organizing, searching, and using the contents of the knowledge base.

Technology Transfer: Information Technology

Before turning to a consideration of the technological components which will form the basis of user friendly systems in the future, it is appropriate to note the plethora of periodicals which have emerged in an effort to speed the transfer of technology into the library context. Titles include *Information Technology and Libraries, Program: News of Computers in Libraries, Small Computers in Libraries, Microcomputers in Information Management, Library Software Review, The Electronic Library, Electronic Publishing Review, Online, Online Review, Database, Library Hi Tech, Library Hi Tech News, Library Technology Reports, Information Retrieval and Library Automation, Advanced Technology/*

Libraries, and *Information Today*. Periodicals such as *Library Journal* and *Wilson Library Bulletin* also now have regular columns devoted to library uses of technology. Although sources in the computer science and engineering literature must be consulted to follow current research in information technology, possibilities for application are documented in a reasonably timely manner in the periodicals published for a library and information science audience. Given the rapidity with which new developments occur, the next section simply highlights some of the technological components currently available for design and construction of more user friendly systems.

Technological Components: Hardware and Software

Developments in hardware contribute to user friendliness by making many alternatives first feasible and then economical. Because users of most systems can be expected to be a heterogeneous group, choices in hardware allow alternative modes of access to be implemented for a given system. For example, microcomputers can be substituted for dumb terminals now that information processing technology has become relatively inexpensive. This enables the system to present alternative interfaces, such as one that is menu-driven rather than command-driven. Local processing also offers the possibility of implementing gateways to simplify access to multiple systems, masking differences which users may find hard to remember.

Telecommunications contributes to ease of interaction through the transmission speed which can be supported. New types of links using fiber optics can support higher speed and larger bandwidth so that more data can be transmitted at a faster rate. In addition there are now possibilities for integrating voice, text, image, and data communications.

New forms of storage media make possible local, self-contained information systems as an alternative to interactive access of remote databases. In particular the optical disks, such as CD-ROMs, offer large capacity storage for digital data as well as visual images. Because cost to use such systems is no longer a function of connect time to a remote computer, new types of interaction which would be too costly in systems charging for use by the minute are possible.

Input/output devices have the most direct impact on perceived user friendliness. Input is no longer confined to the QWERTY keyboard which anyone but the touch typist may find cumbersome to use. Touching (using touch screens) and pointing (using devices such as the mouse) can be used to indicate choices in menu-based systems. Output can use printers, plotters, and display screens with possibilities for different fonts, colors, windows, and graphics. Although not yet as common, limited voice input and

speech output allow the use of sound rather than tactile and visual means of recording and reporting.

Software is of course required to make all these hardware components operate. In judging user friendliness, one is concerned with what Shackel has termed the "cognitive and software interface."[27] Components include languages (e.g., use of command languages *v.* natural language), information organization, display format and layout, dialogue structure and design, error message design, and advanced interfaces (e.g., intelligent systems adaptive to the user). Tools are beginning to be available with which to design and build many of these components as identified, for example, in Bundy's *Catalogue of Artificial Intelligence Tools.*[28]

Given this wide range of technological components, the challenge is to combine elements to create more user friendly systems. As Smith notes, there are significant differences between designing hardware and software for the user interface.[29] Formal standards may be applicable to hardware design, but flexible design guidelines rather than standards are applicable to software design. For example, Rubinstein and Hersh present a well-developed set of guidelines for human-oriented design.[30] In general, more guideline information is available relating to the physical interface than to the cognitive interface.[31]

Technological Integration: Personal Workstations

Development of personal workstations represents the computing environment which will form the basis for user friendly systems in the future. The transition has been characterized by Perlis and White: "Twenty five years ago computing was stationary, ponderous and centralized. Its dominant role was to serve the critical needs and purposes of organizations and the sciences. Today matters are very different. Computation is personal, ubiquitous and expansive. Power is being supplied at and to the fingertips of the individual."[32] The workstation concept is sustained by four technologies: dedicated microprocessors, local area networks, local databases, and gateways to mainframes.[33] Various input/output devices are provided, depending on the tasks which the workstation is designed to support. The workstation is used to carry out both generic activities (e.g., calculation, word processing, mail) and profession-related activities (e.g., scientific or engineering analyses) with appropriate software support.

These computing and communication systems are already appearing in organizations of which libraries are a part, such as universities. At Carnegie-Mellon University, for example, a system named ANDREW is being developed with personal computers, raster graphics, high bandwidth communications, and time-sharing file systems as components.[34] The designers anticipate that ANDREW will affect university education in

four main areas: computer-assisted instruction, creation and use of new tools, communication, and information access. With respect to information access, the designers comment that "a mark of tomorrow's professional will be the ability to navigate in large information repositories" including the library's database, worldwide databases, and databases developed within the university.[35] Some predictions of how such systems will be used have already appeared. For example, Spinrad offers what he terms "vignettes" describing how a typical student, professor, and administrator would function in an electronic university,[36] and Lancaster describes how the scientist could use an electronic information system to create, transmit, and receive information.[37] Some of the "techno-poetic fantasies" cited earlier also suggest ways in which a personal workstation could be used.

Technology Assessment: An Appropriate Skepticism

To provide a balanced discussion of technology in support of user friendliness, it is necessary to interject what John Shelton Lawrence has termed "appropriate skepticism." In discussing the use of computers for word processing, he notes that: "Computer users often allow their exhilaration with hardware and productivity to displace the critical attention they formerly gave to their manually produced material....The physical appearance of the computer's output is seductive in this regard; because it prints absurdity as beautifully as the most carefully wrought expression, one is tempted not to look beneath its surface."[38] A similar danger exists in the context of user friendly catalogs and other information systems. Problems may arise if the following factors are not taken into consideration.

Comprehensibility. In a piece entitled "Black Box Blues," Dixon remarked that "the real danger of the microelectronic era is posed by what was called, even in the days of macroelectronics, the black box mentality: passive acceptance of the idea that more and more areas of life will be taken over by little black boxes whose mysterious workings are beyond our comprehension."[39] The algorithms followed by computers are not necessarily comprehensible to users. Yet by knowing the basis for system decisions, the user can more appropriately accept, reject, or modify them. Designers must determine the extent to which computer processes should be made explicit rather than hidden.

Scope of the system. A great deal of effort can be expended to no purpose if the user seeks information which in fact is not contained in the system. In order to use the system intelligently, a user needs to understand its scope—i.e., the broad class of questions to which the system is designed to respond.

Limitations of the system. The attempt to make human-computer dialogues more like human-human dialogues may lead to an overly

anthropomorphic interpretation of the computer system by users. Without a way to probe the limits of capabilities of a human-like system, the user is likely to attribute more power to it than it actually has.

Source of information. When information is sought from printed sources or from other people, the inquirer has some basis for judging the authoritativeness of the material or the response. By masking aspects of the search process from the user—such as database selection—and by presenting isolated responses—whether citations or facts—the inquirer has no basis for judging the domain covered or the reliability of the response.

Mastery of the system. In a piece entitled "Can Online Catalogs Be Too Easy?" Arret points out that user easy is not user friendly if progressive learning and system mastery are sacrificed.[40] If there is no way for the user to advance beyond the simple searches supported by the user friendly interface, then there is no way that the full power of the system can be exploited.

In the spirit of technology assessment, a discussion of the technology supporting user friendly systems must acknowledge these potential problems. Given the current limitations of user friendly systems, users must develop an appropriate skepticism and designers must explore approaches to deal with issues such as those enumerated earlier.

Halfway Technology Versus High Technology

In an essay on the technology of medicine written in 1971, Thomas introduced a distinction between what he termed "halfway technology" and "high technology."[41] He explained that halfway technology is characterized by things done after the fact in efforts to compensate for the incapacitating effects of certain diseases. He noted that the real high technology of medicine comes as the result of a genuine understanding of disease mechanisms, allowing prevention and/or effective treatment. Interpreting these concepts in the context of information technology, one could describe efforts to design more user friendly interfaces to existing systems as halfway technology, trying to improve access to systems not initially designed from the perspective of user needs. To achieve high technology, research is required to understand the needs of the user far better than is the case today. This theme is echoed by Chapanis who talks of "taming and civilizing computers" by discovering enough about human behavior to design computer systems for enhancement and enrichment,[42] and by Birnbaum who notes that the "domestication of microelectronics" will only be achieved by developing computer technology in the context of what the user wants to do.[43] At present the hardware is far ahead of theory and research in user customization. Fortunately, there is an increasing amount of interest and research activity in this area, drawing on behavioral scientists as well as computer scientists.

User Friendly Future

This discussion began with the observation that user friendly is an anomaly as a technical term. Nickerson has suggested a simple alternative which may prove more satisfying:[44]

> Whether "friendliness" is the right concept is perhaps a matter of taste. "Usability" strikes me as the more appropriate and completely adequate concept; in imputing the quality of friendliness to a machine, one is diluting the meaning of one of the most pleasant of words.

And Burch in turn offers a measure of usability:[45]

> *System transparency* is the ultimate, ideal measure of computer usability. It is achieved when a system's overall design is so compatible with the way the user thinks, talks, listens, remembers, perceives, processes information, asks questions, makes decisions, and solves problems, that the system itself requires none of the user's attention and, in effect, becomes invisible. It happens in the same way that a reader curled up with a good book becomes unaware of the paper, the typeface, the book itself, or the room around him.

The current concern for user friendliness can be viewed as an attempt to cope with halfway technology. Future attention to usability and usefulness may lead the way toward high technology.

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