DOCUMENT RESUME

ED 391 472 IR 017 620

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TITLE	Developing a User Interface for the Converged Information Future.
PUB DATE	Apr 95
NOTE	28p.; Paper presented at the Broadcast Education Association Annual Conference (Las Vegas, NV, April 7-11, 1995).
PUB TYPE	Reports - Evaluative/Feasibility (142) -- Speeches/Conference Papers (150)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Electronic Equipment; *Equipment Standards; *Futures (of Society); Information Dissemination; Information Technology; Investment; Models; *Telecommunications; *User Friendly Interface
IDENTIFIERS	Business Literature; Design Methodology; *Standardization

ABSTRACT

The future of telecommunications is at a very uncertain stage: how will information be delivered, with what hardware, and who will manage delivery and content? One thing is certain: the survival of new communication technologies will depend in part on user-friendly interfaces. In whatever form services arrive at the house, their interfaces will need to be uniform and easy to use. The first part of the paper chronicles cases of corporate investment in user-friendly design and summarizes arguments in the popular and academic literature about good interface design. The question of whether an interface is "standardizable" is addressed in part 2, including discussions of the possibility of standardizing at the point of delivery for a system that might be pluralistic or multiplatform, and of possible guidelines for standardizing an interface. Part 3 puts forward several models for creating such a standardized interface--a government model, a private industry/free market model, and a professional association model--and arrives at qualities needed in an optimal model. (Contains 45 references.) (Author/BEW)

Developing a User Interface for the Converged Information Future

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Presented to the Broadcast Education Association Annual Conference, Las Vegas, NV, April 7-11, 1995.

Abstract

The future of telecommunications is at a very uncertain stage; how will information technologies be delivered, with what hardware, and who will manage delivery and content? Whatever the future of telecommunications holds one thing is for certain, the survival of new communication technologies will depend in part on user friendly design of the interface. In whatever form it does arrive at the house, the interface to those services, entertainment options, etc., will need to be uniform and easy to use. These are keywords of user friendly design and they refer to the place where human and machine interact—at the interface.

This paper will: first, show the importance of user friendly design via cases of corporate investment in user friendly design, as well as arguments made in the popular and academic literature about good design; second, the question of whether an interface is "standardizable" will be addressed in two parts: a) the possibility of standardizing an interface for a system that may be pluralistic, multi-platform, etc., by standardizing at the point of delivery, and b) what some guidelines for standardizing an interface would include. The third part of this paper will address the mechanism for creating this interface by putting forward several possible models: a) a government model, b) a private industry/free market model, and c) a professional association model. The relative merits and demerits of each will be discussed ultimately arriving at an optimal model.

Developing a User Interface for the Converged Information Future

Whatever the future of computing, telecommunications, broadcasting, and cable holds, one thing is for certain, the successful development of new communication technologies will depend in part on user friendly design of the interface. But the future of telecommunications is also at a very uncertain stage; rapid changes, volatile markets, and corporate mergers have made the future difficult to discern. Thus arguing for user friendly design of an undefinable, perhaps multiple machine information delivery vehicle seems an academic exercise at best and a waste of time at worse. However there is one point where this discussion has a place—at the point of delivery.

There are many questions still to be answered about the converged information future. Known popularly as the National Information Infrastructure (NII) or the information superhighway, the "converged information future" is a description of what is to come in information technology. Regardless of how information is delivered, whether it is over fiber optic lines from the telephone or cable company, or sent over the air, or through some hybrid combination of fiber and coaxial cable, the information will likely be delivered to a converged hardware apparatus that performs similar functions as today's computers, televisions, and telephones. How will it be delivered? What hardware configurations will be employed? Who will manage delivery? Who will deliver content? No one has these answers today. What is known is that whatever its form, the interface to those services, entertainment options, etc., will need to be uniform, easy to navigate, easy to use, and consistent. These are all keywords of user friendly design and they refer to the place where human and machine interact—at the interface. Books are one example of this interface notion.

A book is a form of delivering the written word to the user (other forms include handwritten notes, email, etc.) and a book has a predictable, easy-to-use, consistent form and design (or interface). A book is predictable. When a reader picks up any book written in English, he or she expects to read it from left to right and top to bottom, and so will turn to the leftmost page to begin reading. A book is easy to use, one simply turns the pages. A book has a consistent, navigable structure through its tables of contents, chapters, and epilogues. A book is one way of delivering text to the reader and the reader has certain expectations of a book's design. In other words, the reader has certain expectations of the interface between him or herself and the text when using a book.

This paper will: first, show the importance of user friendly design via cases of corporate investment in user friendly design, as well as arguments made in the popular and academic literature about good design; second, the question of whether an interface is "standardizable" will be addressed in two parts: a) the possibility of standardizing an interface for a system that may be pluralistic, multi-platform, etc., by standardizing at the point of delivery, and b) what some guidelines for standardizing an interface would include. The third part of this paper will address the mechanism for creating this interface by putting forward several possible models: a) a government model, b) a private industry/free market model, and c) a professional association model. The relative merits and demerits of each will be discussed ultimately arriving at one conclusion which is a hybrid of these three.

Cases of corporate investment in user friendly design.

Intellectual arguments abound on the merits of user friendly or user-centered design. The slew of empirical evidence and academic literature is clearly one indication of user friendly design's perceived importance. However, the most telling indicator of the currently high value of user friendly design is dollars. Industry's willingness to spend substantial sums of money supporting human factors laboratories and user interface design teams suggests that user friendly design is more than just an academic exercise; it pays off in the market place. Yet, finding industry quotes on investment in user friendly design testing is close to impossible for no less than proprietary reasons. Wicklund (1994) addresses this issue of industry evidence with case studies of industry efforts in user friendly design. Although Wicklund provides no hard numbers, he makes clear the importance of user friendly design through seventeen case studies.

One point of support for the importance of user friendly design is simply the breadth of industries engaged in it. Wicklund demonstrates that consumer products companies, computer hardware and software companies, consumer software companies, on-line service companies, business software companies, and telecommunications hardware and software companies have all been making strides to incorporate user friendly design issues into product development. Three industries that apply particularly well to this paper include consumer products, computer hardware and software, and telecommunications hardware and software. These three industries are all heading towards the converged information future along with consumer software companies. Unlike consumer software companies, these industries are rather new to user friendly design issues. Their increasing concern with what consumer software companies have known for a while, "designing for the consumer," points to the native importance of user friendly design for the converged information future.

Thomson Consumer Electronics, a consumer products company, recently incorporated a user interface design group in February of 1992 (Logan, 1994). This design group plays a prominent role in the organization and is clearly important to upper management. The User Interface Design group reports directly to the Americas Design Group which reports directly to the chairman. The interface design team is "responsible for the overall user interface design and usability of the TCE [Thomson Consumer Electronics] Americas TV..., communications..., and audio ... products" (Logan, 1994, p. 64). They attend to five major aspects of user interface design: on-screen displays (e.g. menu systems, LED displays), hand units (e.g. remote controls), front panels (i.e. on TVs, VCRs, etc.), jack panels (to connect speakers and devices), and instruction manuals. Their design mission and responsibilities for interfaces include: research and design, prototypes, visual communication, and documentation. The User Interface Design group interacts with and improves on a wide range of products within Thomson.

The Human Factors Group at Compaq Computer Corporation, a computer hardware and software company, has a longer history (Purvis, Czerwinski, & Weiler, 1994). It officially began in March of 1989 under the auspices of Systems Engineering. It began as a small lab with short-term usability testing efforts and has since blossomed into a full-fledged interface design lab. This group is charged by Compaq with 1) "helping product development teams make better educated decisions about user interface trade-offs" (p. 112), and 2) "to provide robust data supporting user interface recommendations" (p. 112). The group's services now include user needs and task analysis, usability goals tables, user interface design, cognitive modeling tools, form factor studies, and field studies. Their services are available to all individuals and design teams with a human computer interface question.

Ameritech's efforts at incorporating user friendly design issues into product development represents a different perspective (Lund, 1994). For both Thomson and Compaq support for initiating a user friendly design group was from the top down, and both companies quickly took to the notions of user friendly design. Ameritech is a particularly useful case for the importance of user friendly design because of its dual attitude towards the concept. Although upper management supported both the creation and benefits of a Human Factors Department (March of 1989), this department had a long tradition of "human factors mistrust" to overcome. Ameritech obviously saw this department as important because it was made a core technical competency. However there was still difficulty with internal mistrust and the human factors group faced a continuing educational challenge with product development teams. Ameritech understood the fundamental role the department should play within the organization, "to develop requirements for human interfaces to Ameritech products and services, and the network systems and platforms that support them; and to support the implementation of the requirements" (p. 462), but had to overcome some internal barriers. What is most intriguing about this case study is that despite the internal culture, Ameritech forged ahead with a human factors department knowing its importance. This dedication proved successful with the Human Factors Department showing case studies of "20 to 100% increases in revenue after human factors involvement" (p. 462). With the current Ameritech reorganization, the Human Factors Department had new opportunities to educate the different business units about its services and build a more positive internal image of its department.

These three cases represent industry efforts at incorporating user friendly design into product development. They are significant because these companies are nontraditional users of usability testing and user friendly design, and yet they chose to invest in such departments. Consumer software companies, on the other hand, are the companies traditionally concerned with user friendly design. Two current consumer software products, Macintosh System 7.x and graphical World Wide Web browsers, will briefly demonstrate the importance of user friendly interface design for consumer software.

The debate between Macintosh, DOS, and Windows users concerning the merits of their respective systems is sometimes rather heated. While system configuration and memory allocation requirements could be included in the debate, this case will focus on user friendly design issues. The Macintosh operating system (System 7.x) continues to win hands down against the DOS (5.x and up) and Windows (3.x) operating systems on user friendliness. A Consumer Reports (1993) comparison of System 7.1, Windows 3.1, and DOS 5.0 placed the Macintosh interface at the lead. It received the highest ratings of the three systems due in part to its overall ease of use. Arthur D. Little, Inc. (1994) conducted an independent productivity comparison of Macintosh users versus Widows users. Macintosh users were significantly faster and more effective at the same, everyday tasks than Windows users. Although not a specific user friendliness comparison, task completion time and task accuracy are solid operationalizations of user friendliness. Lastly, Bernstein (1993) reports that a group of lawyers surveyed on the differences between Macintosh and Windows also found the Macintosh more user friendly. The continuing impact of user friendly design is significant. A review of Windows '95[1] reports that it borrows from the best of the user friendly Macintosh interface (Capen, 1994). Brisbin (1994) reports that the World Wide Web browser, Mosaic, also borrows from the Macintosh interface. Brisbin argues that one can "make the Internet more Mac-like with Mosiac" (p. 127).

In fact the Mosaic interface is the focus of much talk about the new user friendliness of the Internet. Mosaic, as do other World Wide Web browsers, provides a user friendly graphical interface to the Internet and it is currently public domain software. Rather than typing in command line instructions as users did in the early days of the Internet with UNIX, Mosaic employs the "point and click" style similar to the Macintosh interface. Mosaic was designed with non-technical Internet users in mind (Clark, 1994) and deliberately took a user friendly approach (Hof, 1994). This approach paid off. As word of the programs availability spread, nearly 2 million users acquired the software within its first year (Hood, 1994). Mosiac is only the start of a larger trend. "To sell effectively on the Net, most analysts believe the least that's needed is a rich graphical interface" (Stefanac, 1994, p. 61). Indeed the current on-line commercial services have been effected by the success of Mosaic's user friendly interface. America Online, Prodigy, and Compuserve have all redesigned their user screens, prompted in large part by "the unexpected popularity of Mosaic" (Steinert-Threlkeld, 1994).

Industry investment in user friendly design departments and laboratories, the success of the Macintosh interface, and the popularity of Mosaic all point to the growing importance of user friendly design. Significant dollar investments are being made to incorporate user friendly design into hardware and software products. This evidence suggests that user

[1]Windows '95 is the next generation of Microsoft's Windows operating system. It is also known as Chicago.

friendly design is important. In addition, the academic community strongly supports this notion of good design.

Academic literature arguments for user friendly design.

On its face, it seems only natural that an interface designed around the user will be easier to use than a cumbersome, poorly designed one. Not only is a good interface easier to use, but it can encourage both new and continued use of that product (Shneiderman, 1992). Bad interface design, at best, frustrates users and, at worst, drives them completely away from the product (Norman, 1988). In addition, Norman believes that these poor designs are pervasive. "The result is a world filled with frustration, with objects that cannot be understood, with devices that lead to error" (p. 2). In arguing for user friendly design, Nielson (1993) points out that a good interface can save money. In addition, he provides a solid argument for good interface design, quoting a 1992 study by Myers and Rosson. That study revealed that "software developed in recent years has been devoting an average of 48 percent of the code to the user interface." (p. ix). Not only does this figure provide an argument in favor of good design, it illustrates that programmers are starting to give greater attention and time to designing and programming the user interface. Brown (1989) believes that poor design will lead to unsuccessful products. Shneiderman (1992) also argues for user friendly interfaces to products by promoting transparency. "When an interactive system is well designed, the interface almost disappears, enabling users to concentrate on their work, exploration, or pleasure" (p. 9). Shneiderman also points to good interface design as a way to increase performance speed and user satisfaction while decreasing learning time and error rates. Apple (1987) views good interface design as that which puts the power of computing in the users' hands (p. xi). In a work written for teachers and designers of computer mediated learning products, Venezky and Osin (1991) make a common sense appeal to those persons and others involved in designing computer products. "Nobody will deny that students can learn from poorly written and ugly screens and that they may do so even if they have to endure headaches or stiff necks produced by wrongly designed terminals, but our task is to create an environment that will not only instruct and do so efficiently, but will also educate by example" (p. 207).

Popular literature arguments for user friendly design.

Another argument for good design comes through examination of some notable "market duds" whose difficulties are due in part to poor interface design. This type of argument is difficult to find in the literature as people are generally reluctant to report failures. Nonetheless, there are some examples. Almost anyone can relate to the concept of the flashing "12:00" on a video cassette recorder (VCR). It provides an excellent illustration of the frustration many people encounter when trying to program their VCRs. Times Mirror (1994) reports that VCRs are used more frequently for watching rented videos than for recording programs off the air. Fully one–third of VCR owners in the survey admitted they did not know how to program their VCR (p. 63). This frustration is embodied in a 1990 USA Today headline, "Hard to tell what's worse: quantum physics or VCR programming" (Cava, 1990, p. 1D). It is against this background that a new product revolutionized the VCR market. The VCR Plus allows users to enter a three to six digit code that corresponds to the show the user wishes to tape. The codes are listed in most newspaper television listings as well as TV Guide (Cava, 1990). Since its 1990 introduction, the VCR Plus has become a world standard for VCR recording, available in about 30 countries ("VCR Plus," 1994). The greatly simplified interface of the VCR Plus, pushing a few buttons in lieu of a complex, multi-step process, is what accounts for the product's success.

Another product whose interface may have been problematic is the Postal Buddy. Deployed in some test markets, the product was a talking vending machine that sold stamps, stationery, postcards, printed mailing labels, and collected and downloaded change of address information (McAllister, 1994). Being able to service customers during all hours of the day and allowing them to avoid slow moving lines was an appealing concept for the United States Postal Service. However, according to Adams (1993), "The Postal Buddy user interface made it seem as though it would take forever to finish a transaction. Why was it thought necessary to use those artsy–crafty slow wipes on the screen changes, instead of just moving along to the next menu screen immediately? Why were there so many unnecessary choices and delays to try to sell other merchandise? These machines were slower than the most incompetent postal clerk" (p. 24). The postal service recently ended the Postal Buddy experiment.[2]

Standardizing at the point of delivery.

Having made the argument for good interface design, the next question is whether it is possible to standardize an interface for a system that is pluralistic, multi–platform, multi–vendor, and largely unknown. The answer is a qualified "yes." The qualification is that the system is standardizable at the point of delivery, the interface. Just as every automatic teller machine (ATM) has some standardized components at its interface, so should the interface to the converged information future. While ATMs may offer some different features (deposits, loans), every ATM's interface requires the user to insert a card, enter a personal identification number, and then choose a banking function. The point of delivery, or interface, for the converged information future is that point at which the end user interacts with the plethora of available options and information.

There are several precedents for a standardized point of delivery in modern society. The standard telephone book leads the list. Anywhere in the United States, a user looking in the phone book expects to find residential listings on white pages and in alphabetical order. Commercial listings are on yellow pages. In some areas, government listings are

[2]There is some controversy surrounding the recent action of the postal service. For a detailed discussion of the relevant issues, see McAllister, B. (1994, September 18). Bright idea delivered to wrong address: Huge claim filed for quashed invention. The Washington Post, p. A1.

on blue pages. Of course, the main reason the phone book has a uniform look is that the regional bell operating companies (RBOC) publish the books and those companies were part of AT&T before the divestiture. Nonetheless, since the modified final judgment, each of the RBOCs has been free to make its own decisions regarding the look of its own phone books (Shooshan, 1984). Each company has chosen to keep a uniform look.

Another example is traffic lights. Lights interact with drivers to maintain order and safety on the roads. The simple interface consists of three colored lights: red means stop, yellow means caution, and green means go. Traffic lights provide an interesting case study of a uniform delivery point. It is a state responsibility to construct and maintain traffic lights. As a state duty, there is the potential that the U.S. could have 50 different traffic light standards. In other words, each state could use unique colors as their traffic light interface. Of course, that would be disastrous. Fortunately, for drivers, the states have decided that a uniform, easy to understand interface is the way to go.

The case of standardization that most closely parallels the converged information future is that of the standard QWERTY keyboard. Any computer, whether it is an IBM, Macintosh, Next, etc., has the same keyboard. Any typewriter or specialized word processor also has the QWERTY keyboard. In addition, there are third party vendors who only sell keyboards. The keyboard industry is a pluralistic, multi–platform, multi–vendor environment. Yet, these different industries all deliver a similar keyboard to the consumer. In fact the keys on each manufacturer's keyboard may interact with individual machines in different ways, but the standard layout and look of the keyboard remain constant.

These examples, telephone books, traffic lights, and keyboards are but three of the many illustrations of a standardization in a multi–vendor environment. Despite having multiple vendors, each with different interests and goals, these interfaces have remained the same. Having made a case for good design, and arguing for a standard design interface, the next set of questions centers on the principles of good design.

User friendly interface design guidelines.

Many of the authors that made arguments in the previous section for good design also provide some fundamental design principles. Shneiderman (1992) has "eight golden rules of dialog design" (p. 72). Brown (1989) also lays out eight principles. Apple (1987) has 10 general design principles. Nielson (1993) proposes 10 usability guidelines and five usability attributes. Norman (1988) discusses four design principles and seven stages of design questions. In addition, he describes seven principles for transforming difficult tasks into simple ones (p. 188). In many cases, these authors' ideas overlap. The following eight design guidelines are a synthesis of the interface literature.

1. Consistency. Shneiderman (1992) calls for consistent terminology, prompts, menus and sequences of action. Nielson (1993) echoes Shneiderman, writing that words and actions should always have the same meaning. Apple (1987) insists on consistency within and among applications. Consistent design also makes good intuitive sense. The user will be confused if the same words or actions have different meanings at different times. Also, if the layout of screens changes randomly, it will likely disorient the user. Consider a network of roads and highways as an example. Imagine trying to drive to work everyday and having to find a new way each day because the roads on which you normally drive change each day. A similar confusion would result if road maps and actual roads did not correspond. Drivers would be frustrated and eventually just give up.

2. Feedback. Norman (1988) wants full and continuous feedback concerning the results of actions. Shneiderman (1992) calls for informative feedback for every operator action. Apple (1987) believes in keeping the user informed with immediate feedback. Nielson (1993) supports the notion of frequently telling the user what is happening. Again, this criterion makes intuitive sense. A user who does not know what is happening is a tentative, confused user. This is no different from good management principles. A good manager will frequently evaluate employees, providing both positive and encouraging feedback. That feedback in turn helps to motivate the employee to continue working hard.

Similarly, frequent and helpful feedback will encourage a user to continue working and exploring.

3. Metaphors, expectations, and stereotypes. Apple's (1987) first design guideline is to use metaphors from the real world. Metaphors should be plain so that users can apply a common set of expectations to the computer environment. Apple also suggests using audio and video, where appropriate, to reinforce the metaphor. Brown (1989) advocates using familiar expectations and stereotypes. For example, use the color red to indicate stop, green to indicate go, and yellow to indicate caution. Also, he calls for physical analogies, such as a word processor being similar to a typewriter. Norman (1988) encourages designers to use knowledge in the world and knowledge in the head. One of the benefits of using simple metaphors and analogies is that it can make a system easier to learn. Both Brown (1989) and Nielson (1993) support the notion of easy learning and the ability of a new user to quickly begin productive work.

4. User centered control. Shneiderman (1992) refers to this concept as an "internal locus of control." Apple (1987) calls for both user control and direct manipulation, allowing the user to be in charge of the computer's action. The intuition for this criterion is one of reducing anxiety for the user. The user will be more comfortable and willing to work and explore if the user has control over the environment and the actions of the computer or other devices. Without user centered control, the user may feel as if the computer is taking over and the user will then become frustrated and inclined to quit.

5. Reduced memory load. Nielson (1993) believes that minimizing the amount of information that a user needs to memorize will lead to a more efficient operation and provide encouragement for the intermittent user to keep coming back. Apple (1987) calls for a "see and point" system rather than a "remember and type" system. It says that a user should never have to remember information that the computer already knows.

6. Shortcuts. Brown (1989) calls for multiple paths for accomplishing the same task. He believes in providing the user with the ability to bypass menus and create macros to

automate repetitive functions. Nielson (1993) points out that shortcuts allow for good interaction for both novice and expert users. Again this is a common sense criterion. Advanced users want to cut through some of the steps that are necessary to make a product easily accessible to new users. Without shortcuts to accomplish this task, the power user would become frustrated and eventually quit using the product.

7. Error. The first rule here is to create designs that minimize or eliminate errors (Nielson, 1993; Norman, 1988; Shneiderman, 1992). Short of eliminating all errors, a designer must provide simple instructions to help the user fix the error (Apple, 1987; Shneiderman, 1992). A corollary principle is to allow easy reversibility of user actions. (Apple, 1987; Nielson, 1993; Norman, 1988; Shneiderman, 1992). Being able to "undo" an action will allow the user to feel more comfortable with the product. The interactions will not be intimidating for the user. Another way to ease a user into a new design is to avoid excess functionality (Brown, 1989). Too many bells and whistles can overwhelm even a frequent user. The more functions a program tries to incorporate, the more opportunities arise for the designer or the end user to create error. In addition, a program should have "clearly marked exits" (Nielson, 1993). A user's level of anxiety is greatly increased if there is no obvious way to quit working on a program or quit using a product.

8. Good dialogue. Shneiderman (1992) believes that any dialogue should yield closure. There should be a beginning, a middle, and an end to each dialogue with the user. This structure will provide the user with a sense of satisfaction and prepare the user for the next action. Nielson (1993) implores designers to speak the users' language. Dialogue should avoid 'engineeringese' or 'technospeak.' In addition, Nielson points out the importance of help and documentation. Designers should write help screens in simple, natural dialogue. The ability to search a help section is also useful (Nielson, 1993).

The argument to this point has been for a common, easy-to-use interface to what will likely be a complex, multi-platform, multi-vendor information environment. An interface with so many different delivery systems will need to be more than standardized; it will also need to be interoperable. Regardless of who delivers the converged information future in what box and with what proprietary elements, the front end of that system should look the same for all users. For this system to work, the interface must be more than standard, it must have a mandate of openness and interoperability with other systems.[3] In this way, vendors and manufacturers could maintain proprietary technical secrets for both hardware and software, and still use a common interface.[4]

Mechanisms for creating a standard interface.

This paper now turns to a discussion of the mechanisms by which to standardize the interface for the converged information future. There are several possible models for accomplishing this task, government, free market, and professional associations.

The first model relies primarily on government. The federal government has a number of options from which to choose to bring about standardization. One approach for the government is to mandate a standard. Under this scenario, the government simply decides what the standard will be. It takes little or no input on this decision from outside agencies like consortia or standard setting bodies. Rather, the government relies on its own fact finding ability. The FCC used this scenario with the first color television system (Besen and Johnson, 1986). After months of hearings and field tests, the Commission selected the CBS standard. The CBS standard was incompatible with the existing black and white standard. Nonetheless, the FCC proceeded with the standard and CBS began broadcasting color programming for several hours during the weekdays. CBS also began to manufacture color sets compatible with the new standard. The government eventually prohibited the production of the new sets as a result of the Korean war. At that time, CBS ceased broadcasting color programming and the standard died in short order. (Besen and

[3]It is beyond the scope of this paper to provide a discussion of open systems however, Senn (1995) provides an excellent overview of openness and interoperability as they apply to computer applications.
[4]The OSI-ISO reference model is a good example of the importance of mandating not only a standard, but also an interoperable standard. Although the government mandated migration to the OSI reference model, many different versions of the OSI Common Management Information Protocol have proliferated due to lack of interoperability (Horwitt, 1992).

Johnson, 1986, p. 91). Realizing the mistake, the FCC moved toward the adoption of the National Television Standards Committee (NTSC) color television standard that is in use today. Economists would argue that the strengths of this model are that government can set a standard faster than the market, and that a government mandated standard removes uncertainty for the consumer of buying the wrong technology (Besen & Johnson, 1986). The weakness of this model is obvious for the color television example. The government can select the wrong standard, which results in slowing the deployment of the technology.

Another option for the government is to put forth a policy that outlines broad goals, and then allows the market to implement those goals with enforcement from the government. With this model, the government articulates the 'big picture' and leaves the details to those companies and persons who are directly involved in a particular industry. This is the basic model the FCC used with cellular phone service. According to Besen and Johnson (1986), "The FCC's clear goal was to enable mobile telephone users to communicate with one another regardless of which firms design and manufacture the equipment" (p. 126). After authorizing two cellular test projects in the mid 1970's, the Commission began the rulemaking proceedings for cellular service in 1980 (Besen and Johnson, 1986). The decisions about standards came easily, while those about how many cellular systems to authorize and the role of the traditional phone companies created great controversy. The reason for the easy standard setting process was the FCC's decision to adopt, with some modifications, the standards put forth in an Electronic Industries Association (EIA) working paper (Besen and Johnson, 1986, p. 127). The substance of the working paper came largely from the two test cites the Commission had authorized in 1976. Essentially, those companies most involved in trying to bring cellular service to the market had a large say in the standard setting process. Under this government model, the FCC outlined the broad policy goal, allowed those companies most closely involved with the product to develop the standards, and then mandated those standards. The result is that the cellular phone market has experienced rapid growth since its introduction in the 1980's. The advantages to this approach are that the standard is quickly and widely accepted by those firms most affected by the standard. The drawback here is that only a small number of firms participated in the standard setting discussion. This model favors the early innovators, not necessarily those with the best technology.

A third government approach is to sponsor a government agency which could support standards research. A commercial enterprise could then develop products based on the standards work supported by the agency. This is similar to the way the Defense Advanced Research Projects Agency (DARPA) operates as an arm of the Department of Defense. The NSF (National Science Foundation) is another government funded entity that supports technological research. DARPA is funded solely by federal dollars and its primary mission is "developing the seedbed of military technologies critical for national security systems" (Robertson, 1992, p. 9). It has no labs of its own but rather directs research into key defense areas through military contracts ("The government's guiding hand," 1991). DARPA's strength lies in its efficiency. "[It] is not subject to the layers of bureaucracy that impact most contracting activities, and its procurement staff works very hard to keep non-essential red tape to a minimum" (Galatowitch, 1991, p. 23). A weakness of turning to such an organization is lack of external input. The organization alone decides which and for how much it will fund external research.

The second model is the private industry/free market model. The first type of this model is simply the marketplace or laissez–faire approach. Using this model, the government does not mandate a standard, rather it allows the marketplace itself to select the standard. The Federal Communications Commission (FCC) used this approach with AM Stereo (Klopfenstein and Sedman, 1990). With that technology the FCC refused to choose among the five competing standards and decided the market would be the best decision maker. According to Klopfenstein and Sedman, "the adoption and diffusion of AM stereo has been retarded by the FCC's decision in 1982 to not establish a technical standard. The marketplace did not perform as the FCC predicted" (p. 175). Because the market was unable to pick a standard, the FCC finally mandated a standard in October 1993 (Scully, 1993). On the surface, this model appears to be a good idea. The government identifies the technological contenders and then allows the market to select a winner. The problem with this model, as demonstrated by this case, is that the market can be reluctant to choose. Both end users and broadcasters were afraid they would select the wrong standard. Without a clear government mandate or a consensus market choice, it took over 10 years to establish a standard.

The private industry/free market model also includes cooperative research and development efforts on the part of industry. In 1983, ten of the United States' largest computer corporations formed the Microelectronics and Computer Technology Corporation (MCC). In 1984, with the passage of the National Cooperative Research Act, MCC could pursue cooperative research and development without anti-trust concerns. MCC was formed as a for-profit technology research corporation where "The member firms collaborate on the pre-competitive development of technology. Once that technology research reaches the point of 'proof of concept,' the consortium ceases to develop it and turns it over to the member companies who pursue specific applications and market opportunities" (Avery & Smilor, 1990, p. 94). In 1990, MCC's research agenda included chip packaging and interconnection, advanced computer technology, software technology, computer-aided design, and high-temperature superconductivity (Avery & Smilor). MCC faced its biggest challenge in attempting to conduct near-proprietary research and product development in a supposedly open research environment. When corporate paranoia concerning proprietary research became too problematic, MCC refocused towards more generic research efforts whose benefits would be industry-wide rather than company specific (Burrows, 1992).

Industry control over the research agenda and standard setting process is the primary benefit of this type of private industry/free market model. This model requires no government intervention and no bureaucracy, thus speeding the research process. Another benefit of research consortia are their ability to pool funds, reduce duplication, and reduce risk to individual companies (Avery & Smilor, 1990). This would be particularly important if industry sought to develop a standard on its own. However, there are down sides to this model. The research agenda for the organization is directed, for good or ill, by upper management's vision. In the case of MCC, Craig Fields made decisions about research directions that ultimately forced his departure (Burrows, 1994). This internal dynamic could negatively impact the rapid development of a standard. In addition, as MCC experienced, companies find it difficult to cooperate when research borders on competitive product development. The companies involved would have to be attuned to effectively managing proprietary concerns of member companies.

A third type of the private industry/free market model is a collaborative industry research effort funded in part by government. The Semiconductor Manufacturing Technology Institute (Sematech) was formed in 1987 in response to the sudden and rapid dominance of the Japanese in the dynamic random-access memory market (Auster, 1990). Sematech's members are, obviously, several semiconductor manufacturers. In 1992, funding for Sematech came from both industry (50%) and government (50%) (Goldman, 1992). Despite doubts about Sematech's success, it has been partially credited with the U.S. resurgence in and current dominance of the global semiconductor market (Kennedy, 1994). Clearly Sematech is a positive example of government supported industry collaboration. The downside is what follows when the original research goals are met. Sematech states that it will cut government funding. In 1994, Sematech announced that by 1997 it would attempt to operate without government support altogether (McCartney, 1994). However, this does not mean that it will not compete for federal grants to continue funding its research. Such an organization has the potential to live forever in some fashion or another. With its new more vague, and less goal-directed research agenda, "tackling projects too risky for a single company to undertake" ("Uncle Sam's", 1994, p. 70), an eternal life is more likely.

The last model is to allow professional associations to propose standards. Two organizations represent this effort, the Internet Engineering Task Force (IETF) and the Institute of Electrical and Electronics Engineers. The Internet Engineering Task Force is "a loosely self-organized group of people who make technical and other contributions to the engineering and evolution of the Internet and its technologies" (Malkin, 1993, p. 1). This volunteer organization is the primary body engaged in standard setting for the Internet as well as addressing future development issues. The task force meets to address concerns in an informal conference environment and produces recommendations which are formalized and then approved. The IETF's development of the extremely popular Internet protocol standard TCP/IP is evidence of its efficiency (Dern, 1994).

Another organization is the Institute of Electrical and Electronics Engineers (IEEE). This technical, professional membership organization is the world's largest ("The IEEE is...," 1993). Members in the organization can play a role in the IEEE Standards program which "has responsibility for all standards development and approval for which the IEEE is ultimately responsible" ("IEEE Standards Board Bylaws," 1993, p. 1). The IEEE addresses standards in electrical engineering, electronics, radio, and in allied branches of engineering, arts, and sciences. The Standards program focuses on consensus-building among engineers from all concerned areas. The standards ultimately published are held to be the best agreement and compromise achievable for all parties involved. Both associations, IETF and IEEE, demonstrate the strength of bringing professionals together outside of a government or industry environment. These groups focus on consensus building in a timely manner. When concerned engineers and researchers collaborate on technical questions the results are generally quick and positive. The downside to collaboration is also consensus-building. On occasion participants can labor for long periods of time to reach consensus, thus allowing some other de facto standard to arise. Another downside to this approach is lack of an enforcement method. Compliance with association standards is ultimately voluntary and not enforceable. Although many companies will comply to compete, it is not required.

The optimal model.

The optimal model must be one that is anticipatory rather than reactionary. As the converged information future continues to approach, there must be more sophisticated and complex standard setting and policy making mechanisms in place to handle the growth. The optimal model, then, would involve a number of participants. Government, standard setting bodies, consortia, and industry members would all play a role. First, the government would begin by appointing a task force (probably under the direction of the NTIA) that, with the guidance of professional associations, would articulate the need for a standard interface as well as some preliminary interface design considerations. Next, the task force would develop a request for proposals concerning the interface design to which any interested parties such as consortia, standard setting bodies, and individual companies could respond. Each of these bodies could then individually or in tandem develop possible interfaces and interoperability guidelines. After receiving proposals, the task force could then conduct usability testing on the submitted interfaces to determine the best design and guidelines. Based on that testing, the task force would recommend that the NTIA formally adopt both a standard and interoperability guidelines and mandate them for any participant in the converged information future. Finally, the NTIA should mandate an annual review of the product and compliance with the interoperability guidelines. With an annual review, the task of keeping the standard flexible and enforcing the interoperability guidelines would be more manageable. By keeping the responsibilities for oversight of these rules within the NTIA, this model allows for flexibility and quick response. Members of the NTIA task force would be more closely involved with the industries responsible for the converged information future than individuals in other government agencies and thus acutely aware of the issues. This awareness leads to shorter and more thorough education about the issues as well as greater sensitivity to the industry's needs. On the other hand other governmental agencies, like the FCC, must deal with industries as diverse as cellular telephone and direct broadcast satellite, and personal communications systems.

This model ultimately proposes a change in the status quo of telecommunications standards. Although the future of telecommunications is at a very uncertain stage, user friendly design of computer interfaces will be critical to the success and growth of the converged information future. Because a standardized interface makes a product more accessible to more people and because the issue of user friendly design is so closely tied to growth and success of a product, the need for a standard interface is clear. By adopting and following this optimal model, the government and industry will be able to deliver a standard interface and thus meet the needs of end users in the converged information future.

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