# Intelligent User Interface Design for Interactive Television Applications

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## 1.0 INTRODUCTION

A generation ago, when mainframe computing was the workplace standard, a high priesthood of software engineers was necessary for programming functions, system maintenance needs, and general interface with users. In the late 1970s, when the personal computer was born, computer hardware underwent a decentralizing process as the digital revolution started shifting power to the individual. By the 1980s, application software had become the driving force of the PC industry as the realization grew that personal computers were simply lifeless boxes without popular software that could run a myriad applications, from word processing to presentation graphics to spreadsheets.

Early software applications for the PC were controlled primarily by arcane, keyboard-driven, text-based commands; this was the generation of the Apple-II, the first IBM PC, the Kaypro, the Osborne, the TRS-80, and other popular platforms. They were soon supplanted by PC systems that incorporated a "friendlier" user interface; first, the familiar Macintosh, and then Microsoft's Windows operating system that brought to the screen a graphical design based on a desktop metaphor using windows, icons, a mouse, and pull-down menus (the familiar WIMP factor). But not all software applications designed with a graphical user interface, or GUI, operated in the same way, and users had to cope with (and still do) an often complicated functionality that requires keyboard or function-key input. Moreover, while software applications have become "easier" to use, they are still relatively "dumb;" that is, they do not learn from user experience or user preference, and often cannot adjust or adapt to user styles. They may more aptly be termed "system interfaces" than "user interfaces."

Now the digital revolution is creating a powerful force called convergence, in which computing and television technologies are coming together to create new systems, new applications, and new markets. The interactive television industry (ITV) is on the threshold of widespread system deployment; by late 1995, dozens of major ITV testbeds and trials will be underway in the continental U.S. Efforts by cable TV providers (Major Systems Operators, or MSOs) and the regional Bell operating companies (RBOCs, or telcos) will dramatically alter the ways in which people use and watch television, bringing greater control, choice, and convenience to the consumer.

Utilizing powerful video server hardware, asynchronous transfer mode (ATM) transmission, and MPEG-encoded digital video compression, these new systems will create dynamic new services such as movies-on-demand, electronic banking, home shopping, and interactive games. But user interfaces designed for entertainment applications may be inadequate to support enhanced interactive video services such health and medical information, education, distance learning, or job training.

These ITV systems may at first be extraordinarily difficult to navigate by the average consumer. They will necessitate the storage of immense quantities of compressed digital video data in remote databases on servers at the system's head-end. Utilizing a standard NTSC television receiver with an addressable set-top box, they will have no keyboards, mice, pull-down menus, or other familiar input devices. The consumer must be able to navigate the new ITV systems using only a hand-held, "smart" infra-red remote-control. And at a normal viewing distance of 10 feet, NTSC screen resolution precludes the use of typical windows or computer icons that have become so familiar in a desktop environment where the user sits one-on-one 18 inches from the monitor. Latency is seldom addressed as a problem in the PC environment where users may tolerate an on-screen hourglass endlessly as they wait for the system to carry out its complex functions, but it is a critical problem for ITV. Viewers will insist on instantaneous system response to their commands.

Navigating a small video library of popular, first-run movies may seem undaunting on the surface, but when that collection expands to consist of 10,000 titles ranging from classics to comedy, new and more intelligent video database navigation tools will become necessary. Yet even that problem pales by comparison to a large video database of enhanced video information services that may consist of an

even larger collection of shorter video segments that necessitate interaction *within* the segments themselves. And this navigation issue becomes more critical still when we realize that the user is limited to a single command device (the remote control), which creates a special challenge for user interface design: how to display information on the screen (and what information to display), how to organize that information most effectively for the user, and how to incorporate intelligent agents in the user interface design that can learn from user preference and experience.

The Interactive Health Network, Inc., (HealthNet) is responding to this special challenge by developing an application that utilizes intelligent user interface design for enhanced video information services. Together with our technical alliances at Microsoft and the Cognetics Corporation, we have been working for the past year on appropriate user interface metaphors for enhanced video applications; researching mental models for con- sumers, including zero-trial learning with appropriate user testing through usability groups; experimenting with different user interface designs (including but not limited to text-only via attractive on-screen menus, TV icons ("bugs") only, icons with text, video-in-windows, and spatial navigators);configuring systems with minimal external controls; and conducting routine analysis of the relevance of video databases containing large numbers of short segments to the underlying user interface designs.

The system prototype developed by HealthNet and completed in late 1994 is intended to deliver critical health care information efficiently in video format to consumer and patient alike, which can greatly increase the quality of care provided and dramatically reduce burdensome tasks for the health care professional while lowering the overall cost of care. In institutional use, HealthNet's unique interactive video system can enable patients to access vital medical and health information to see pre-operative briefings, post-op therapies, and treatment protocols as well as video presentations on diet, nutrition, medication, fitness, and exercise. It has been estimated that nearly half of all doctor visits may be related to issues that do not require the costly attention of a skilled healthcare professional. A major benefit to the nation is that HealthNet's new interactive video system will support and enhance clinical pathways critical to both higher health care quality and lower health care costs. At the same time, it will contribute to innovative, high-skill job creation in the emerging interactive television industry. And it can help reduce the U.S. trade deficit by showing how America's high-tech service applications could be exported to ITV systems developers in other countries, notably western Europe and East Asia.

## 2.0 Background and Technical Approach

There are several forces at work today that require a new look at how user interface designs are created and deployed. One is the sheer explosion in software availability overall, driven in part by the continued decline in the cost of microprocessor power; as PC hardware becomes cheaper and more broadly available, so do the software applications designed to run on it. Functionality is increasingly controlled by ordinary end users, many (if not most) of whom even feel overwhelmed by the relatively simple interface demands of the VCR, which, despite numerous attempts to correct its design flaws, still blinks "12:00" in most homes. As hardware has become cheaper, it has also become more complex. Hewlett-Packard's first generation of laserjet printers, for example, contained about 25,000 lines of code. Today, they have ten times that amount, and the new models expected next year may contain a million lines of code. Users need more (and better) help learning how to use (and master) these products. Specialists in interface design are being challenged to do for new-generation systems like ITV what the telegraph did for messaging a century ago when it forced the obsolescence of the Pony Express. The simple migration of existing designs from computing to television will not be sufficient to do the job.

The digital revolution has also created virtually endless growth in communication services, especially for data. (Since mid-1992, AT&T's long-distance service has been dominated by data, not voice, transmission.) This in turn has dramatically expanded the number (and diversity) of people who use computers, software, modems, and online services in their daily work. As these communications technologies continue to grow and expand, so will the number of general users. This puts increasing pressure on user interface specialists to create simpler, more comfortable, easier-to-use designs that can make digital services more accessible to the general user. Nor is this a frivolous challenge: creating simple "up-front" designs that mask complex, intelligent "back-end" tasks implies a sea-change in attitudes, because designers can no longer afford to assume that users are primarily other computer-literate professionals.

The devices with which users use to interface with systems have also multiplied in recent years, leading to new efforts in speech recognition, gesture recognition, data-gloves, head-mounted displays, touch-screens, and virtual environments. Most of these are at best imperfect devices today, still in need of huge improvement before they can become accepted in the consumer marketplace; many -- the virtual reality interfaces -- further restrict system usage or benefit to one user at a time, which conflicts with the more open (and shared) television environment. And they all suffer from one major flaw, which is that they tend to be designed by experts for use by other experts, with very little attention to the general, non-technical user. As a result, the new challenge is to develop *user-centered* interface designs.

This challenge is all the more daunting for the successful and efficient navigation of enhanced video services such as medical and health information, distance learning, or job training. With the development and deployment of more effective, innovative, and intelligent user-centered interface designs, interactive television systems that distribute medical and health information can enable universal access to high-quality health care information so that the nation's best specialists will be available to rural residents and inner city patients alike.

HealthNet has focused its research specifically on user-centered interface design. Given the absence of traditional computer-based devices (such as windows, icons, mice, and pull-down menus) in a video environment, this approach has been predicated on the need for a simple, hand-held, remote-control device. HealthNet's work to date has researched several innovative, attractive, and easy-to-use "front-end" user interface designs that mask a more complex "back-end" intelligent functionality. We have tried working with several designs that incorporate these important elements, focusing in particular on two interface designs, one based on a conversational metaphor, the other on an "intelligent agent" metaphor,

In cooperation with Cognetics Corporation, HealthNet has worked on research, design, and demonstration through frequent usability testing of an innovative user interface and de minimis hand-held remote device that have optimum applicability to enhanced interactive video services such as medical and health information. HealthNet's technical approach has been structured around a multi-step process based on the QUE Design Methodology™ developed at Cognetics to facilitate the integration of usability engineering into new software designs, along the following lines:

- ◆ Develop the interface concept.
- ◆ Identify the functionality of each interface model.
- ◆ Identify the user population, an issue that is critical to effective usability engineering design.
- ◆ Identify high-level constraints, such as hardware architecture and system software compatibility.
- ◆ Create a storyboard sketch for each interface metaphor in development.
- ◆ Identify the usability goals for the interface.
- ◆ Plan the screen layout.
- ◆ Analyze the input device and design appropriate action sequences.
- ◆ Develop screen prototypes built around key screens that reflect the conceptual models, the tasks they will accomplish, and their look and feel.
- ◆ Iterate the designs and refine them, using a rapid prototyping tool like Visual Basic v.3.0 for Windows, iterated over four cycles:
- ◆ Final review and usability testing to determine an optimal interface design and de minimis remote control device.

## 3.0 HealthNet's Intelligent User Interface Design for Enhanced Video Services

HealthNet's Advisory Board suggests that it may be possible to cover a majority of common-interest health and medical subjects in about two-dozen basic video segments. We have been working to refine those choices, cross-reference the categories through keyword menus, and analyze other ways of representing the appropriate paths to them -- work that will be enhanced in future research.

But the navigation of a video database consisting of enhanced video services is orders of magnitude different from simply selecting a movie in a video-on-demand service or buying a product in a home shopping application. It is not necessarily more difficult, depending upon the user interface design, but it is clearly different.

Access to HealthNet's interactive video segments is enabled by means of drop-down "bugs" that are called onto the screen while the viewer is watching normal broadcast TV. [This effect is easily achieved through a function key on the remote

control.] These bugs, or icons, represent interactive services available on the viewer's system and might symbolize movies, games, shopping, sports, news, network reruns, education or reference services, financial markets, and health. When a viewer highlights and selects the HealthNet icon, he or she is switched immediately into the HealthNet video database and remains there until making a clear "exit" decision.

We are working on input of user profiles [name, age, height, weight, and brief medical history] that the system can retain based on which particular family member may be using the system. However, because most IR remote controls do not contain alpha keys and viewers are typically not comfortable using a remote control for data entry purposes, data input of this nature must be calibrated to the de minimus remote control and enabled by means of either numeric entries (age, height, weight) or entries in a fixed field ("1" equals yes, "0" means no).

HealthNet's main screen opens with video running in the background -- typically a talk show format with well known guests discussing current or controversial issues related to medicine and health. The HealthNet Navigator, consisting of large square icons arrayed horizontally across the bottom of the screen, is overlayed on top of the running video, with a generic Topics button in the lower right-hand corner and an Exit button in the lower left. The four Navigator icons graphically depict the principal demographic categories -- children, women, men, and seniors -- from which a viewer may choose to access the underlying subject (and video) of choice.

Highlighting and selecting the Women's icon, for example -- simply by pushing the appropriate direction arrows and then the "Select" key on the remote control -- takes the viewer into the Women's screen, which consists of a menu overlay containing six keywords centered vertically from top to bottom and easily readable from the normal viewing distance of 10-12 feet. Through an initial period of tests and trials, HealthNet has discovered the truism that one keyword is worth a thousand icons.

The six choices available on the Women's screen represent three areas of general interest (Updates, Fitness, and Nutrition) and three diseases or disorders specific to this demographic category (Breast Cancer, Menopause, and Stress). While this keyword list is clearly not exhaustive, it does represent convenient access to subjects of immediate interest to women. [A more complete list of choices is discussed under the Topics option, below.]

Highlighting and selecting the Nutrition option pops open a listbox showing a full range of keyword choices such as healthy snacks, high-fiber diets, low-cholesterol meals, low-fat meals, vitamins, etc, in alphabetical order. Selecting one of these options then opens a data form into which the viewer can enter salient statistics (such as age, height, and weight) if these have not been pre-determined earlier.

Highlighting and selecting the "OK" button on the data screen starts the video clip on the chosen subject -- high-fiber diets, for example -- with an 3-5 minute overview of the topic. As soon as any HealthNet segment begins, a separate overlay menu appears containing two sole options -- "Exit" to the lower left, "More" to the lower right. Selecting "Exit" immediately returns the viewer to the access screen -- in this case, the Women's screen -- if a mistake was made or if the viewer is done.

Highlighting and selecting "More" brings up a final overlay menu containing several keywords representing additional choices the viewer can make in order to interact within the video segment itself. For Nutrition, these choices are Recipes, Snacks, Quick Meals, Menus, Books, and Services. Selecting any one of these stops the current video segment and starts the chosen video, always with the "Exit" and "More" options at the bototm of the screen.

HealthNet has taken a similar approach in designing the user interface for video segments related to specific diseases or disorders. For example, from the Women's screen the viewer may choose "Breast Cancer," and be switched immeditely to that segment. From the Exit/More screen, selecting "More" brings up the overlay menu with six keyword choices, all while the overview segment is playing in the background.

These six keyword choices are Causes, Symptoms, Complications, Prevention, Treatment, and Services. Highlighting and selecting any one of these keywords starts the video segment relevant to that particular choice, thus enabling the viewer to navigate (or browse) the HealthNet content library quite easily.

HealthNet is currently working on an additional layer of material so that the viewer may be able to "drill down" one layer deeper into each of these six areas and watch more detailed video

presentations on each of them. Under "Breast Cancer," for example, once the viewer is in the "Treatment" segment, he or she may wish to access more specific segments that relate to primary treatment protocols such as Lumpectomy, Mastectomy, Mastectomy with Reconstruction, or Watchful Waiting. Each of these choices is again arrayed as a keyword option on the screen.

Highlighting and selecting the "Topics" button in the lower right-hand corner of the main HealthNet Navigator screen brings up another overlay menu containing six general keywords -- Nutrition, Fitness, Symptoms, Diseases, Injuries, and Services. Hightlighting and selecting any one of them pops open a listbox containing an alphabetical list of detailed choices relevant to that keyword selection.

Keywords are important in navigating health and medical information, we feel, because they most closely depict a conversational metaphor. Picking movies from a poster-like array of choices may be fine for entertainment, with catchy music and alluring previews built-in. Or having the screen resemble a colorful direct-mail catalogue like L. L. Bean or Land's End could work well for a clothing outlet. But access to important health and medical information in our view requires a "quiet corner" of the interactive services menu in order for consumers to benefit from and use an enhanced service like HealthNet effectively.

HealthNet has examined and surveyed a number of proposed user interface designs for other interactive services, such as movies on demand, interactive games, home shopping, and financial markets. Some of these user interface designs are attractive, innovative, and clever. But they are also daunting to the first-time user, and imply a familiarity with computers and pointing devices that the ordinary television viewer may not have.

"Video in Windows" is one popular example. Highlighting and selecting a choice on screen pops open a small window in which a video clip begins to play. Again, as a preview of full-length Hollywood movies this U/I approach is not without merit. But a screen containing four videos playing simultaneously in adjacent windows, as one design is currently structured, can be confusing to both the eye and the ear.

The combination of icons and text is another mistake often made when creating new user interface designs for interactive television. If the icons are too small, they are virtually unrecognizable on an NTSC monitor because of the poor resolution on the one hand and the greater viewing distance on the other. HealthNet has used only four oversized icons in its Navigator because they symbolize recognizable demographic categories -- children, women, men, seniors -- and sized at about 3" square, they are easily visible from a distance. But large icons also take up a lot of space on the screen, making it virtually impossible to use them together with text.

Text works best when used as keywords -- again, HealthNet's experience is that one keyword is worth a thousand icons. But too much text crammed onto a single screen makes it illegible for the same reasons that icons are hard to read -- poor resolution and greater viewing distance. In our experience, there is still much work that needs to be done in refining the keyword approach to video navigation, and our initial goal of keeping intermediate screens to a minimum may have to be revised. From the main screen to an underlying video segment, the viewer is never more than three layers removed from the targeted segment.

A final problem that will need attention is the multiplicity of different navigators planned for interactive video services around the country. While there have been frequent calls for a navigation standard to be developed so that the differences between system navigators can be minimized, we think it will be many years before one emerges -- just as it took more than a decade for Windows to become the accepted U/I for desktop computing. HealthNet is continuing to research these various ITV user issues.

## 4.0 References and Citations

Brouwer-Janse, Maddy D. (Moderator). Interfaces for Consumer Products: How to Camouflage the Computer? (Panel) SIGCHI '92. Conference Proceedings. ACM, New York, N. Y., 1992, pp. 287-290.

Buxton, Bill. The "Natural" Languages of Interaction: A Perspective on Nonverbal Dialogues. In Laurel, *The Art of Human-Computer Interface Design. Addison-Wesley, Reading, Mass., 1990, pp. 393-404.*

Curtis, Bill, and Bill Hefley. A WIMP No More: The Maturing of User Interface Engineering. *Interactions, January 1994, pp. 23-34.*

Erickson, Thomas D. Working with Interface Metaphors. In Laurel, *The Art of Human-Computer Interface Design. Addison-Wesley, Reading, Mass., 1990, pp. 65-74.*

Gillan, D. J., and Breedin, S. D. Designers' Models of the Human-Computer Interface. In Human Factors in Computing Systems: Proceedings of SIGCHI '90. ACM, New York, 1990.

Hefley, W. E., and Murray, D. Intelligent User Interfaces. In Proceedings of the 1993 ACM/AAI International Workshop on Intelligent User Interfaces. ACM, New York, 1993.

Johnson, Brian. TreeViz: Treeman Visualization of Hierarchically Structured Information. SIGCHI '92. Conference Proceedings. ACM, New York, N. Y., 1992, pp. 369-372.

Kreitzberg, Charles. Details on Demand: Hypertext Models for Coping with Information Overload. In *Interfaces for Information Retrieval and Online Systems: The State of the Art. Greenwood Press, New York, N. Y., 1991.*

Kreitzberg, Charles. Managing for Usability: The QUE Design Methodology. Monograph ©1994 by Cognetics Corporation, Princeton Junction, N. J. All Rights Reserved.

Kreitzberg, Charles. Supporting Peak Performance through Multimedia. In *Multimedia Review, Winter 1990, pp. 31-42.*

Laurel, Brenda. Interface Agents: Metaphors with Character. In Laurel, *The Art of Human-Computer Interface Design. Addison-Wesley, Reading, Mass., 1990, pp. 355-366.*

Marcus, Aaron. Metaphor Mayhem: Mismanaging Expectation and Surprise. Interactions, January 1994, pp. 41-43.

Mills, Michael, et.al. A Magnifier Tool for Video Data. SIGCHI '92, Conference Proceedings. ACM, New York, 1992, pp. 93-98.

Mountford, S. Joy (Moderator). When TVs are Computers are TVs (Panel). SIGCHI '92 Conference Proceedings. ACM, New York, 1992, pp. 227-230.

Myers, B. A., and Rosson, M. B. Survey on User Interface Programming. SIGCHI '92. Conference Proceedings. ACM, New York, 1992, pp. 195-202.

Norman, D. A.,and Draper, S. W., Eds. User-Center Design: New Perspectives on Human-Computer Interaction. Lawrence Erlbaum Associates, Hillsdale, N. J., 1986.

Norman, D. A. Things That Make Us Smart. Addison-Wesley, Reading, Mass., 1993.

Nygren, E., et. al. The Art of the Obvious. SIGCHI '92. Conference Proceedings. ACM, New York, N. Y. 1992, pp. 235-240.

Shneiderman, Ben, Ed. Sparks of Innovation in Human-Computer Interaction. Ablex Publishing Corp., Norwood, N. J., 1993.

Shneiderman, Ben. Designing the User Interface: Strategies for Effective Human-Computer Interaction (2d Edition). Addison-Wesley, Reading, Mass., 1989.

Shneiderman, Ben. Dynamic Queries: Database Searching by Direct Manipulation. SIGCHI '92. Conference Proceedings. ACM, New York, N. Y., 1992, pp. 669-670.

Vertelney, Laurie, Michael Arent, and Henry Lieberman. Two Disciplines in Search of an Interface: Reflections on a Design Problem. In Laurel, *The Art of Human-Computer Interface Design. Addison-Wesley, Reading, Mass.,* 1990, pp. 45-56.

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