Design Approaches for Developing User-Interfaces Accessible to Illiterate Users

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ABSTRACT

User-Interface Recommendations Supporting Universal Literacy Accessibility (URSULA) is a project to create user-interface guidelines for developers who are writing applications and websites that may be used by illiterate users. In particular, these guidelines would be useful for developers of devices for developing communities, such as the Simputer, a small information access device to be distributed in India. Because of low literacy levels among the target population for this device and the diversity of languages used throughout India, special consideration must be exercised when designing applications such that they are understandable by users who lack written language literacy. Interfaces that use speech and dialogue interaction, display non-linguistic graphics, adapt to the literacy level of the user, and accept input by microphone and touch screen would be well-suited to the domain. This paper traces the initial stages of URSULA work, and it demonstrates how a conceptual interface-design approach, Hypothetical User Design Scenarios (HUDS), can be used to drive the design process.

1. URSULA RESEARCH GOALS

The purpose of the User-Interface Recommendations in Support of Universal Literacy Accessibility (URSULA) project is to create a set of guidelines for developers of computer user interfaces who are interested in making systems accessible to illiterate users. Initially, user interface guidelines will be created for small devices like the Simputer, a handheld Internet device available in India [26] [11]. However, URSULA aims to produce guidelines useful for other form-factors and devices.

The purpose of this paper is to explain the initial stages of the URSULA project progress. Various approaches to interface design will be discussed, and a new design approach, Hypothetical User Design Scenarios (HUDS), will be proposed that suits the particular needs of the URSULA domain. Previous design work relevant to illiterate users will be reviewed, and an example HUDS design iteration will be performed (including an analysis of the target users, technology, applications, and environment). This paper will conclude with a discussion of the future directions of the project.

2. INTERFACE DESIGN APPROACHES

The Human-Computer Interaction and User-Interface Design literature have outlined several approaches designers can use when working on a project, many of which have been considered while designing the URSULA guidelines. Broadly, these approaches vary according to how much empirical information they require. Some design methods involve interaction with or observation of users of the system – a costly yet often worthwhile investment of resources. Other approaches are conceptual design processes which designers can follow to focus their ideas for an interface, think through potential problems, and harness their previous design expertise. For the URSULA project, such a conceptual tool was developed to drive development, namely the Hypothetical User Design Scenarios (HUDS) approach.

2.1 Experimental Approaches

Some user interface design approaches discussed in the literature require experimental or observational work in order to guide the interface design process: holding focus groups with potential users of the system, observing users of the system working in their current environment, organizing Wizard-of-Oz tests, or running usability experiments to find out if an interface prototype meets an established usability metric. While information gained from such studies is extremely compelling because it grounds design decisions in empirical findings, they can be costly and time-consuming to run. For a design project that is small in scope, has a limited number of specific issues to be decided, or whose intended users are easily accessible for experimentation, such empirical approaches are well suited. Such testing is poorly suited to interfaces for the developing world. Gaining access to target users, rural Indian villagers with literacy challenges, for experimentation would be challenging and costly. Also, the scope of URSULA is quite broad -- to establish guidelines for building interfaces for multiple handheld applications -- experimentally testing interface designs for such diverse applications would be impractical.

While gaining empirical data to guide the entire design process is not possible for URSULA, empirical methods can be employed if used in a limited context. Instead of running a trial experiment of every possible interface, limited experiments can be run after the broad shape of the interface has already been determined by less time-consuming approaches. Empirically based design methods can be employed to make fine-grained distinctions in the final interface or to help make choices at critical points in the project's development. Empirical methods can also play an important part in the usability evaluation process of an URSULA-produced user-interface.

2.2 Non-Experimental Approaches

Fortunately, the HCI and Design literature also offer many tools and approaches to designers who are looking for non-

experimental approaches to decide upon an interface. Many of the methods discussed below have been incorporated into larger HCI design frameworks, such as the User-Centered Design process of Gould and Lewis [13] or the Star Model of Hartson and Hix [14] [15]. Such broad frameworks help organize critical design tasks such as requirements gathering, conceptual design, functional analysis, prototyping, and implementation into an ordered process that can be followed by the creator of an interface.

In one approach, Task Analysis, the designer identifies and traces the tasks and subtasks which the user needs to accomplish in order to successfully interact with the interface [16]. As this analysis is performed, the designer enumerates the individual "objects" and "procedures" in the domain which the user will need to interact with conceptually. Important challenges that the user may face in a particular design are also brought to light.

In Structured Design, the designer composes a grammar for the interaction between the user and the interface [21]. These grammars which are created can take into account progressively finer levels of detail: the task itself, the semantics of the portions of the interaction, and syntax of these interaction steps, and the exact interaction steps performed. This design methodology often employs formalized grammar notations to capture the interaction in format that can be reused in later portions of the design process and easily communicated to others.

These first two approaches share some common disadvantages. They can lure the designer into making design commitments too quickly by forcing him or her to specify the interface at too fine level of detail early in the interface-creation process. This tendency may encourage the designer to make arbitrary or poorly motivated design choices merely to satisfy the degree of specification required by the methodology. Both of these techniques also require the designer to put forth a large amount of specification and cognitive analysis effort in order to develop a small portion of the final interface. For large projects, this ratio of effort to output might not be practical.

A third design approach often discussed in the literature is perhaps the most intuitive; in Visual or Holistic Design, the designer creates an initial mock-up, image, or idea of how the system will appear through visual sketches and brainstorming [21]. Several alternative designs are constructed and compared, and the designs are made available for others to examine and critique. Through this creative process and cycles of criticism, a final design will emerge. While some of the previous design approaches could be criticized for approaching the design task too obliquely, Holistic Design may tend too far in the other direction. Although it can be appealing to jump into the design process by creating some possible interfaces, without careful forethought poor initial decisions could become enshrined in the final design and important user issues could be ignored.

2.3 Hypothetical User Design Scenarios

In a HUDS, the design tool used for the URSULA project, the designer specifies a potential user of the system with a detailed information/application need and a particular set of environmental factors. All locations, organizations, individuals, and important issues that might impact how the designer should think about the interaction are identified and described. Next, the designer describes a situation which would motivate the user to use the system and constructs a script for the interaction between this user and the interface. As the designer crafts this interaction, he or she notes any issues which arise or open research questions which would need to be solved in order to create a high-quality interface. After the script is completed, the designer enumerates these open issues, discusses the approach he or she took to addressing them in the script, and then proposes a set of future research questions to be explored that would give greater clarity to the interface. This script-writing process can be iterated to consider a diverse set of applications and issues for the user-interface. Prior to writing the first script, the designer investigates the users, technology, applications, and usage environment of the system, and he or she performs a survey of previous user-interface research work relevant to his or her users.

The structure of the HUDS makes it easy for the designer to record the progress made during its creation and apply it to future stages of the design work. While there are many design techniques which incorporate scenario-writing approaches [4] [5] [22] [20], the value of the HUDS is the template it provides the designer for specifying information beyond that included in the scenario itself. The designer analyzes the problem space before writing the first scenario using a 'users, technology, work, & environment' structure discussed below. Insights into the user and the system environment are recorded at the beginning of each scenario in the "Entities and Characters" section. During the course of writing the interaction script, important design issues which arise are noted and recorded in the "Analysis of Issues in the Scenario" section. Most importantly to the future stages of the design process, the HUDS includes a section where the designer can record open research questions -- these can spark ideas for future experimental work to guide the design.

The HUDS is a working tool which allows the designer to flesh out potential interface issues that may have been previously overlooked, to encourage the designer to think about the interface in increasing detail, and to prompt discussion and comparison of ideas. The level of detail the scenario specifies about the user and his or her environment and situation may surprise readers unfamiliar with scenario-based design approaches; for example, the HUDS example in this paper carefully details the geography and economics of the town in which the hypothetical user lives. By making these aspects of the user's experience as concrete as possible, it's harder for the designer to gloss over potential problem areas in the interface and it is easier to discuss the design later with others. A HUDS-facilitated discussion with other designers would be more grounded in specifics, making it easier to critique and compare candidate approaches.

While a visual Holistic Design (HD) mock-up could also have facilitated sharing and criticism of a candidate design, the HUDS accomplishes this while overcoming some of the disadvantages of HD. Both HD and HUDS allow a designer to propose an approach to a user-interface problem and communicate this proposal to others. Both techniques encourage designers to think of their design with increasing degrees of detail as the proposal is drafted. However, the typically visual medium of HD may lure the designer into making some interface commitments too soon, may trap him or her into one view of how the system should operate, and may discourage criticism from others if the mock-up is presented too attractively. (It can be difficult to criticize something that looks visually appealing, especially when one does not have an equally attractive alternative design to offer in its

place.) Unlike HD, HUDS encourages the designer to think about the elements of the user interface as individual tasks or as an interaction script; in this way, it can incorporate thinking from a Task Analysis or Structured Design approach.

3. INITIAL PROBLEM ANALYSIS

At the beginning of the HUDS approach, the designer carefully investigates various aspects of the problem-space. In the model of Human Computer Interaction design laid out by Eason [10] and adapted by Preece et al. [21], there are four sets of project-specific issues that should be carefully considered at the start of a successful design process: the technology which it will employ, the work which it will help accomplish, the users of the system, and the environment in which it will be used. This conceptual framework will be used for the HUDS approach and it structures the discussion of the URSULA problem-space below.

3.1 The Technology: Tools and Devices

By better understanding the goals, specifications, and technology underlying the Simputer, the designer will be better able to anticipate how a user might interact with the device when writing the scenarios later in the design process.

The Simputer Trust is an organization founded by several Indian researchers to develop and market a low-cost hand-held Internet-accessible computing device to combat the growing digital divide in rural communities in India [26] [11]. Using SIM card technology from mobile telephones, a single Simputer could be personalized and shared: making it an affordable access device for online information. Advertisements for the Simputer discuss communication capabilities of the device and various online commercial and government services which it would help users access [11]. The device would have a form-factor similar to a Palm Pilot or Pocket PC with a touch-screen, microphone, speaker, and telephone modem port. The Trust is currently developing a mark-up language for Simputer-readable web pages, the Information Markup Language. IML would store pages with phonetic information that would facilitate the device's ability to read information aloud. Literate and illiterate speakers of multiple Indian languages should be able to use the device.

3.2 The Work: Important Applications

By considering which uses of information technology would be most valuable to the target population, the designer can ensure the interface developed supports the needs and requirements of these applications. Previous research into providing information technology to the developing world can help inform this application-selection process. The high-priority tasks identified below can be used as starting points for developing hypothetical situations for HUDS user-interaction scripts.

To combat the growth of the digital divide in the 1990s, many international organizations funded efforts to expand the reach of information technology to developing communities. The major approach taken by these groups was to establish "telecenters," small office-like spaces with telephones, computers, and good Internet connections in small communities throughout the world [9]. Sustainable Access in Rural India (SARI), a recent survey-based study on the feasibility and sustainability of telecenters, is the most recent and comprehensive work into information technology applications in rural India today [2]. The research team used focus groups and written surveys to identify a set of realistic applications for rural Indian information technology. Their goal was to find applications that would "enhance the social and economic development and be most valuable to the rural poor." [2] SARI identified the following high-priority information technology applications:

- Health Information Distribution
- Employment Listing Bulletin Boards
- Online Government Services
- Agriculture Reference and Seasonal Information

3.3 The Users: Two Kinds of Literacy

By studying the special needs of the target population, the designer can better anticipate the behavior of users when writing HUDS interaction scripts later in the design process. While URSULA's focus is combating language literacy barriers to technology, the typical Simputer user also faces technological literacy challenges.

3.3.1 Technological Literacy

A major challenge of telecenter projects is to educate their communities about the value of information and communication technologies [8]. While hygiene, sanitation, and safe drinking water is threatened in some areas, convincing these communities that their lives can be enriched through access to information and communication can be a challenge. Another challenge is technophobia. Considering that over half the world's population has never made a telephone call [7], using a computing device is an understandably alien prospect.

One aspect of modern technology has already infiltrated rural Indian communities – the television. The Indian government began a campaign to provide television sets located in central public locations in many towns and villages to increase access to news and information [23]. This is useful to know because it means that the target users already have some comfort level with three aspects of the Simputer interface paradigm:

- Going to a central community location to receive information from a shared electronic device.
- Viewing an electronic screen with visual information.
- Listening to audio information from an electronic device that compliments the visual on-screen information.

Even in those areas where television has not yet infiltrated, other forms of technology and communication channels have made inroads. Radio is available throughout several regions of the developing world where television has not yet reached. While lacking a screen, users of a radio would be acclimated to listening to information from an electronic device.

Although postal services may be available only sporadically throughout some countries, often rural residents can travel to a regional postal center to send written messages to people in other areas. At a basic level, this experience has prepared users for the e-mail paradigm which may be part of an URSULA interface.

3.3.2 Written Language Literacy

Modern definitions of literacy include such skills as reading, writing, and counting in one's primary language, taking advantage of information sources in this language, and being able to compose short meaningful statements [6] [25] [3]. Literacy is a major issue in India; according to the 2001 Indian census, 45% of

the adult population is illiterate, increasing to 51% in rural areas [1]. Rates of illiteracy for rural women are more alarming, with reports varying from 61% to 82% [6] [1]. With such a large portion of the population unable to read, previous telecenter approaches have been limited in their success at bringing information to communities. With standard PCs and Internet access, an illiterate user would not have the skills to read text on the screen, type required input, or use the keyboard to control the system. When telecenters provide literate volunteers to help these users navigate online, many may be too intimidated to ask for help. There is also potential for intermediaries to control or filter the information users would be given access to [2].

Literacy challenges pose many problems outside of the immediate realm of information technology access. A lack of literacy skills can affect a rural community member's confidence when asking health questions, dealing with government bureaucracy, breaking from harmful cultural customs and conventions, locating aid services, adopting advances in childcare practices and nutrition, discovering financial opportunities, understanding reproductive issues, preventing HIV infection, and communicating to family who have moved to urban centers for work [6]. Information technology and literacy education must be tied to immediate way-of-life benefits in order to make them enticing to these communities. The URSULA interface should encourage literacy learning while the user performs other desired tasks, and it should help users see how interface tasks might be made easier with additional literacy skills.

3.4 The Environment: Life and Language

Since HUDS interaction scenarios seek to anticipate how a user would interact with the system, understanding the setting and background of this usage will increase the accuracy of the simulation. Therefore, the rural way of life and the language diversity of India are considered below.

Rural Indian communities have traditionally led an agrarian life with time spent on the seasonal demands of subsistence and small-crop farming. Shrinking agricultural profits and unpredictable weather changes have forced many males to leave farms seeking employment in urban centers [6]. Many women are left to manage the household and farm, making them important target users of the Simputer. Given less access to education, rural women have lower literacy rates, making technology access a challenge. In addition to gender issues, sensitivity in the interface design will also be needed because of the diverse religious and cultural traditions, political movements, and social caste hierarchies which are part of Indian life.

The diversity of languages in use throughout India also poses challenges to users of information access devices. With dozens of major languages and hundreds of dialects, localizing the device into all of them would be impractical. Many people will need to interact with the Simputer using their non-primary language. Even if they are comfortable speaking these dialects, they may not be able to read them or use complex vocabulary. While most dialects run left to right and use one of a small set of scripts, there are languages which run the other direction and many that use scripts not yet included in Unicode or other character set standards -- thus complicating the design. Since not all of these languages have keyboard input standards, there is an additional incentive to employ speech-based input even for literate users. (Developing speech recognition and synthesis solutions for these diverse languages and dialects is another area of research of the Adaptive Speech Interfaces Group at UCD.)

4. SURVEY OF PREVIOUS WORK

4.1 Accessible Interface Design

In the field of Human-Computer Interaction, much recent attention has been paid to users with sensory or motor challenges. Some modern interfaces concentrate on finding ways to reformulate the output of the system to make it accessible to users with sensory difficulties. For users with hearing impairments, there has been research in captioning audio information or producing visual screen displays for audio events in the interface. A slightly more developed research area is interfaces that are accessible to users with visual disabilities.

Perhaps one of the most challenging user interface scenarios has been developing non-visual computer interfaces for blind or partially sighted users. There have been various approaches to adapting an interface for a user with visual impairments. Simple approaches merely read all portions of text on the screen, while more sophisticated techniques reorganize the interface into a hierarchal menu structure [18] or help the user understand the graphical layout of the screen [19]. Both of these interaction methods allow the user to develop a mental representation of the interface structure.

Other accessible interface researchers have considered input-related issues. User interfaces for the blind not only need to reformulate the system output into audio, but they also need to provide tools which allow the user to operate the machine predominately from the keyboard (since aiming an on-screen pointer with a mouse would prove difficult). Other work produced special typing or pointing hardware [17] or speech input methods [27] [24] for users with motor difficulties. The market for speech technology is broadening; people in hands-busy environments or with poor typing skills have become the new target markets for voice command and control and speech dictation software. Some popular products in this market include Dragon's Naturally Speaking and IBM's Viavoice.

4.2 Interfaces Targeted at Illiterate Users

There have unfortunately been few user-interfaces designed with illiterate users in mind. Some software on the periphery of this research area includes reading educational products like "Reader Rabbit" that teach literacy skills to their users. While these products are designed for a population with partial literacy skills, the amount of interface guidance that can be distilled from them for the URSULA project is limited. These programs are rarely designed with an adult population in mind, and they are not focused on helping the user accomplish non-educational life tasks. Two products which come closer to the design goals of URSULA include an accessible web browser and government information kiosk, discussed below.

Goetz and Strothottle [12] conducted research into constructing a web-browser that replaced individual words on the page with pictures representing their meaning. The system also allowed the user to click on a word to have it read aloud. A highlight of the approach was that the web pages needed no special encoding; so, users were not restricted to a subset of the WWW. However, the approach was impractical for several reasons. It is doubtful that

salient pictures could be chosen for all words in the user's vocabulary, nor could users be expected to memorize a picture language of thousands of images. The cognitive complexity of learning the picture language would likely be similar to that of learning to read written text, but by learning the picture language, the user would not have acquired a useful skill applicable outside of the browser. Also, the approach only addressed reading of text -- not how a user would input information for searching or other interactive applications.

The EZ Access Touch Screen Kiosk [17] was a device for delivering government services designed to provide access to the widest possible user base. While literacy was only a minor focus of the project (which also included accessibility features for a variety of sensory and motor disabilities), the system's approach for sight-impaired users was also applicable to illiterate ones. The interface included an easily identified button which would trigger the contents of the screen to be read to the user. Text was highlighted as read, and the user could also point to portions of the screen to have them read and explained. The system had two operating modes, a press-to-read mode, in which the system read aloud selected screen elements, and a press-to-activate mode, in which it would trigger an action if a button were pressed.

5. THE SCENARIOS: AN EXAMPLE

This section will demonstrate how the initial iteration of the HUDS development process was used to drive the URSULA interface design considerations. All HUDS interaction scripts would share the structure and top-level headings of this section.

5.1 Synopsis of Hypothetical Scenario

The World Health Organization has detected the early indications of a cholera outbreak in the Mahbubnagar district of Andhra Pradesh. The WHO needs to communicate important information about the disease to residents of this area so that they can take steps to avoid infection or to recognize symptoms of the disease to prevent dehydration.

5.2 Entities and Characters in the Scenario

5.2.1 World Health Organization

The World Health Organization is a non-governmental body that coordinates international health initiatives. The organization works to eradicate various contagious diseases, particularly in developing countries. In epidemic situations, the WHO coordinates with local government agencies and the broader health community to combat the spread of disease. One of the most valuable responses to these crises is to spread timely health information to the affected communities. The improved access to networked information afforded by the Simputer can provide another channel for this information.

5.2.2 Mahbubnagar

Mahbubnagar is a district in the west of Andhra Pradesh, a state on the east coast of the India peninsula. The district is on the boundary between a mountainous area to the north and a coastal plain with many rivers and creeks. The climate is typically hot and humid with an annual rainfall of over 125cm. The population is mostly Telegu-speaking with some Kanarese and Kannada speakers on the western edge of the district. Agriculture is the most important sector of the economy with rice as the most significant crop.

5.2.3 Cholera

Cholera is a severe intestinal infection caused by a bacterium called Vibrio cholerae often found in infected water or food. Large outbreaks of the disease can occur from a contaminated water supply; young children are particularly sensitive to infection. Symptoms of infection include diarrhoea and vomiting which can lead to severe dehydration and death without prompt treatment.

5.2.4 Jainder

Jainder is a farmer near the town of Gadwel in southern Mahbubnagar. His wife and three daughters live with him near a river. One of Jainder's daughters has become ill and it is important for him to learn of the epidemic. Also, his family's drinking water comes from this river and it may be contaminated. Jainder is able to speak but not read Telegu.

5.3 Hypothetical Scenario Interaction Script

There are three different types of proposed interaction styles discussed in parallel in this one scenario script. The script will jump between the three possibilities, and sections that correspond to each option (or to all) will be marked: Option A: Notification to User, Option B: Advertisement on Portal Screen, and Option C: Information Available for User Query.

Step 1: Background to the Scenario

For All Options

Jainder finishes his work for the day just before dusk, and he returns home to collect his SIM card. He travels to the local school building to use the community-owned Simputer. He arrives at the school, the attendant signs him into the logbook, and he inserts his SIM card into the Simputer. He turns on the device, and it connects to the Internet using a phone line and its internal modem. The Internet service knows that Jainder is a resident of Gadwel Township in the Mahbubnagar district because this information is stored on his SIM.

Step 2: Using the Device

Option A: Notification to User

Jainder is using the Simputer this evening because he needs to find an appropriate market to sell his goods next Saturday.

As soon as the device is connected, a loud tone sounds and a text box flashes onto the screen. The box fills the screen and it has a flashing border to draw attention. A voice reads the content of the message to Jainder: "Important health alert for your town!" There are two buttons on the screen – a circular one which says "More Information" and a square button which says "Ignore." The voice reads the content of each button, telling Jainder to press the circle if he wants to learn more and the square to continue with his work. As they are mentioned by the voice, the circle and square buttons are highlighted. Jainder chooses to touch the circle.

Option B: Advertisement on the Portal Screen

Jainder is using the Simputer this evening because he needs to find an appropriate market to sell his goods next Saturday.

When the device is connected, the usual "start screen" is displayed. This screen presents Jainder with a list of options he can perform using the device and its Internet connection. The screen is filled with picture/icon buttons that have small text captions below them. As Jainder watches the screen, each of the

button options is highlighted in turn and the Simputer voice reads aloud the name of the button and brief description of what it will do. Since Jainder has used the device several times before, he is already familiar with what the various icon buttons signify. By pressing on a button on the screen, Jainder can trigger a menu of options or a particular information retrieval task. He can also point to a special place on each button to ask the system to read it aloud instead of triggering an action.

At the top of the portal/start screen, new buttons, advertisements, or announcements are displayed. This portion of the screen is highlighted and read first since it contains previously unseen information. An announcement about the Cholera epidemic is currently at the top of Jainder's screen. This announcement has a special high-priority highlighting, and there is a special urgent tone / voice which is used for this announcement. Since the announcement sounds important, Jainder clicks on its button to learn more information.

Option C: Information Available on Query

Jainder is using the Simputer this evening because his daughter is ill. There are rumors in the town that a dangerous disease is spreading to young children. Jainder wants to find out if this is true, and he wants to find out how he can help his daughter.

After the device connects to the Internet, Jainder realizes that he is unsure of how to find out the information he needs. He doesn't know if he should search for a doctor, e-mail someone in a nearby town, read a local news report, or find out first-aid information for his daughter. As the options on the start portal page are read aloud, the "Health and Medicine" option catches Jainder's attention. He decides to look in this area. There are several options within: (1) "someone is sick," (2) "where is a doctor?," (3) "how do I stay healthy?," (4) "health news for my area," and several others. Jainder chooses "health news" so that he can find out if the rumors are true.

In the health news section, the device reads the headlines to Jainder. There is a story about a disease alert for Mahbubnagar; so, Jainder clicks on this option to hear more information.

Step 3: Reading the Health Information

For All Options

The screen fills with an animated image of a person drinking from a river, feeling ill, and then going to a doctor. On the screen, the text of an epidemic alert issued by the WHO about the cholera outbreak is displayed. The device's voice reads the text of the alert aloud to Jainder. The information says that there is a dangerous disease in his town, that it may spread through contaminated water, that people should go to a special center for treatment, and what the symptoms of the disease are.

Since there is a lot of information, it is broken into pages. At the end of each page being read, Jainder is presented with the option of going back, repeating, going forward, quitting, or asking for help. The device uses standard icons at the bottom of the screen for navigating the information; as each navigation option is read aloud, the corresponding button is highlighted on the screen. Whenever the device presents more than one page of information to a user, these same navigation icons are used. Jainder can either press the buttons on the screen, or he can say verbal commands such as "go back."

Sometimes, instead of progressing through the entire article, the system will ask the user a question to decide if it should read the next section of text or jump to another. The system asks Jainder if he might know someone with the symptoms of cholera. Since Jainder knows his daughter is sick, he answers "yes."

The system presents Jainder with a set of brief first aid directions for the sick person. It tells him to keep them hydrated and to bring them to the emergency cholera treatment center right away. As each of the directions is read aloud, a corresponding icon is highlighted on the screen. These icons represent the steps of the operation, and they help Jainder remember the sequence. Jainder can also point to any of the numbered items in the directions to have it repeated for him. For the directions to the health center, the system displays a map. Since the system knows that Jainder is from Gadwel, then it can give him personalized directions from where he is starting from.

Step 4: Leaving the Device

For All Options

The system offers to print a copy of the directions and map for Jainder to keep; he agrees. Although he will not be able to read all the instructions on the page, he can still be reminded of the steps by the icon images. Also, he may be able to show the instructions to someone else that can read them aloud for him later. When he tells the device that he would like to "quit" reading the cholera information, it offers to bookmark the information so that Jainder can easily find it again later. He agrees. Map and instructions in hand, Jainder turns off the device and quickly returns home to his daughter.

5.4 Analysis of Issues Raised by the Script

As the scenario script above was developed, various issues came to light which are critical to the successful design of this interface. Each of these issues is discussed as a topic below.

5.4.1 Making User Aware of Critical Information

When the system needs to communicate critical information to the user, there are several possible approaches. The system could send the user a notification which could appear on the screen when he or she signs on to the Internet, the system could advertise this information as a link on a starting Internet portal screen, or the system could allow the user to initiate a query and return information only if requested.

If information distribution techniques such as notification or portal advertisement will be used (as in options 1 and 2), then standards will be need to be established about what information is critical enough to be conveyed in these obtrusive manners. While advanced users might be comfortable with notifications and frequently changing portal pages, novice users could become confused. Whether personal information and user preferences will help determine announcement policies is an open question. Whether notification or prominent portal placement would also be used for commercial advertisements is another.

The design of the opening screen should anticipate as many common information retrieval tasks as possible. Expecting the user to navigate deeply and search for information (as done in option 3) may require an unreasonable level of computer literacy or luck. Allowing the device to control the initiative of the interaction would be best for most information retrieval tasks.

5.4.2 Expression of Urgent Information

URSULA will need to decide how a literacy-accessible interface should demarcate some information as more important than others. Forms of visual and aural highlighting that would be most effective for a population with limited computer and written-language literacy will be needed. Some standard forms of highlighting rely on cultural or reading conventions that would not have meaning to the target population of this device.

Highlighting or flashing is one way of drawing the user's attention to important information, but this type of marking might confuse the user. If another part of the screen is also highlighted because it is the current text being read, then the user may not understand what the device is doing. An aural form of importance-marking may be more appropriate. Perhaps tone of voice or an audio signal can be used to convey urgency.

5.4.3 Specifying Geographic Information

Users will need a way to communicate their geographic location to the device. While a home location could be stored on a SIM card, an approach is needed for other locations. If typing the names of locations is not possible, then using maps seems like a likely input option, but we might not be able to assume map literacy among the target population. If names of geographic locations are in dispute for cultural or political reasons, then the device would need to be sensitive to this.

5.4.4 Communicating Conditional Advice

The system may need to recommend different medical information according to the symptoms or questions of the user. This is a specific example of a general issue: the system will need to express different types of information to the user based on the user's current state or information needs. There are several ways in which this communication of state/needs could take place: the system could initiate a set of queries and await responses, the user could make one long query containing lots of state information, the system could present the user with a form, or the system could give the user a menu-like listing of all of the anticipated queries or information needs.

5.4.5 Communicating Sequenced Instructions

When a computer system presents sequenced instructions to a user in a written form, the numbered list format of the information helps to communicate the sequence of the items and acts as a reference for the user while enacting the instructions. The designer will need to decide how to provide the user with mnemonics to help him or her remember the sequence when the information is presented aurally. Perhaps non-linguistic graphical screen elements could be used as visual landmarks of the numbered instructional items.

5.4.6 Presentation of Health Information

If a high-priority information goal of the Simputer will be to distribute health-related information to the user, then the typical format of this information and its accessibility to an illiterate population needs to be considered. If pictures or diagrams are to be used to facilitate this presentation, then these images must be sensitive to the cultural attitudes of the target population. Facilities should also be provided for the user to ask for medical terminology to be defined and explained.

5.4.7 Taking Information Away From the Device

While illiterate users may be able to access information while it is presented on the device because of its reading capabilities, these users will have difficulty taking information away from the device. The ability to print information, store results, take notes, and bookmark pages would help address this problem. Pictures and graphics that can be copied or printed would also allow the user to take information away from the device.

5.4.8 Literacy Accessibility for Web Resources

Since many of the most exciting information access scenarios for the Simputer would entail internet connectivity, the URSULA project may need to consider the user interface design process as not just involving developers of applications but also websites. If so, then the user interface experience will be constantly developed and modified as new web sites are developed.

While application developers may be willing to invest large portions of time creating highly accessible, dialogue based, or speech friendly interfaces, web developers may be more concerned with generating content. While it will be important to consider innovative new interaction styles in the URSULA project, the guidelines produced should also offer simple screen-reading standards for accessing web resources that have not been designed with illiterate users in mind.

There is also potential for shared development of common web resources required by multiple services. Generating maps and directions for areas of India may be one of these potentially sharable capabilities. Many of the high-priority scenarios for the system involve the user looking for a geographic location at which to get medical attention, sell goods, or ask for work.

5.4.9 Helping Partially Literate and Return Users

Since speech-based user interfaces can sometimes lead to slower user interactions (because portions of the screen need to be read), the interface should be designed to take advantage of the skill of returning or partially literate users. The interface should have the ability to detect and adapt to the literacy level of the user. If the user is partially literate, then simple text captions could be used on screen to help the user jump to the right choice without waiting for a screen to be read. If the user already knows what icon to press to initiate an action, then he or she should be able to interrupt the reading of a list of options in order to trigger the desired behavior.

5.4.10 Screen-Reading Mode Interface Issues

While elements of the screen are being read or described, the user should be aware of what element the system is currently talking about. There will need to be some form of visual highlighting to help the user follow the audio captioning. This focus tracking will make it easier for the user to understand what element of the screen needs to be clicked in order to select an option that the system reads aloud. There should also be a facility for the user to click on objects in order to request that they be read or described – instead of triggering their default behavior.

5.5 Questions Raised by the Script

The user-interaction script and the discussion of critical design issues in this Hypothetical User Design Scenario have highlighted several open research questions. These issues could be explored through user-interface experimentation to further illuminate the design process for the URSULA interface.

- Do novice computer users understand how to deal with pop-up notifications? Does the wording of the notification affect their success?
- How do various forms of visual highlighting affect a user's success as identifying the intended piece of most important information? How long do various forms of highlighting take to draw a user's attention to important information?
- How successful are various forms of aural highlighting at helping a user find the intended piece of most important information? Are special sounds or voices effective at communicating importance or urgency?
- How successful are users at following aural geographic directions presented in various forms: with map, with turn-by-turn directions, by place names, by geographic features?
- Do illiterate users prefer to have written text appear on the screen and be highlighted as read? Or is it better for no text to appear and for the interface to be entirely speech based?
- How successful are various approaches for allowing the user to indicate portions of the screen that he or she would like to be read or explained by the device's voice?
- What set of visual navigation icons (go back, repeat, go forward, quit, help) are most intuitive for illiterate users?
- What forms of screen print-out are most effective at allowing users to remember long or complex directions? Numbered items with pictures? Maps and diagrams? Written text that can be read by a literate acquaintance?
- Which forms of user-querying are most effective for getting information from illiterate users? Open-ended queries? Yes/no or short-answer questions? Forms? Menu Options?

6. ADDITIONAL HUDS ITERATIONS

The HUDS approach provides a framework for continuing to drive the design process after the initial HUDS script is developed. After writing this initial scenario, the designer identifies new or unexplored issues from the background research. A new HUDS scenario can be constructed and developed to intersect and explore these issues. By creating new scenarios that explore diverse users, applications, and technologies, a clearer picture of the critical issues and requirements of the interface can be developed. In this way, the HUDS process can be iterated until the designer is satisfied with the amount of design guidance and analysis the approach has facilitated. A second HUDS script has already been developed for the URSULA project (using a bulletin-board employment searching scenario), and additional iterations may be performed as part of the interface design process.

7. FUTURE URSULA DIRECTIONS

Previous analysis consideration (of target users, technology, applications, and technology), creation of HUDS user-interaction scripts, and additional review of HCI literature on dialogue, speech, and natural language interfaces have suggested valuable design directions for a high-quality literacy-accessible user-interface. These recommendations will be distilled into a concise set of URSULA user-interface guidelines useful to application developers.

Since the HUDS suggested several open research questions that could be addressed by running user-interface experiments on prototype designs, pilot experiments will be run to investigate the feasibility of empirical studies and to suggest their structure. Further, it is anticipated that URSULA will grow beyond this initial project into a team within the Adaptive Speech Interfaces Group of University College Dublin and Media Lab Europe exploring the theoretical and implementation issues involved in the production of user-interfaces for illiterate users. This team may employ further scenario-based and experimental approaches to develop accessible user-interface guidelines.

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