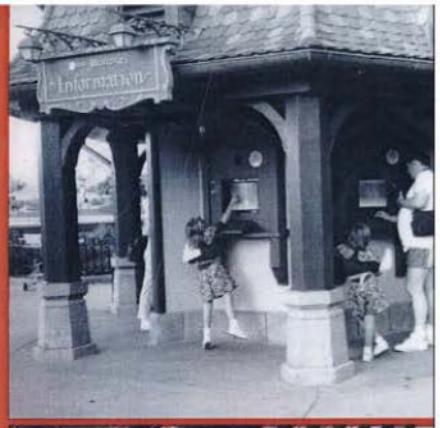
Public Access Systems

Bringing Computer Power to the People







Greg Kearsley

Public Access Systems:
Bringing Computer Power to the People

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INTRODUCTION

This chapter provides an overview of public access computing applications including Automated Transaction Machines (ATMs), Point of Sale (POS) units, electronic message systems (EMS), information kiosks, online catalogs, exhibits, and game/entertainment systems (see Figure 1-1). The purpose of the chapter is to introduce the design, development and implementation issues discussed in later chapters as well as the various hardware and software technologies involved in public access computing systems.

As Figure 1-1 illustrates, public access systems encompass three main functions: providing services, information, or entertainment. Some types of systems provide more than one function, for example, information kiosks can dispense coupons or tickets (usually a POS chacteristic), and interactive exhibits can have entertainment as well as information value (so-called *infotainment*). In fact, there is a general trend to design systems that have multiple functions. However, the broader the functions offered by a system, the more complex and expensive it becomes. For this reason, many public access systems are designed only to perform one function-and to do it as cost-effectively as possible.

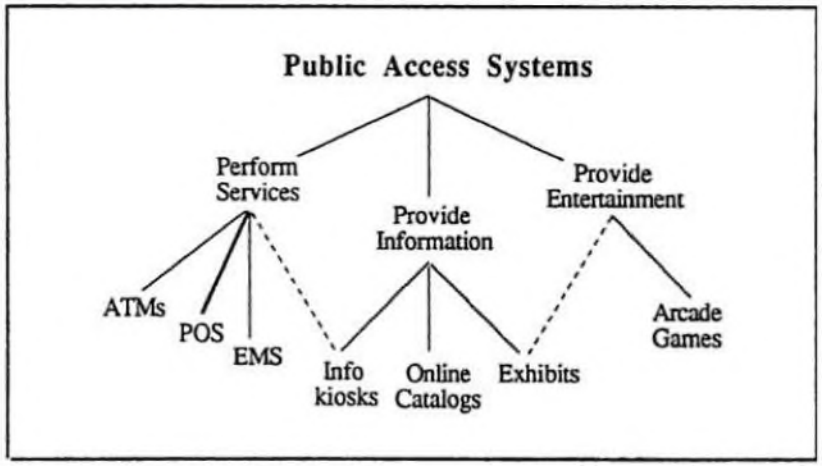


Figure 1-1. Major types of public access systems.

CHARACTERISTICS OF PUBLIC ACCESS SYSTEMS

All types of public access systems share similar characteristics:

- The delivery stations are located in open public areas rather than private spaces such as offices, classrooms, or homes.
- There is no training associated with the use of a public access system; you simply walk up and use it.
- Public access systems are typically used standing up rather than sitting down, and the interval of use is relatively brief (e.g., a few minutes).
- They can be used by anybody (although authorization may be required).
- Usage is unlimited and unsupervised.
- They are capable of responding to user input (i.e., interactive).

This set of characteristics distinguishes public access systems from other computer systems found in offices, homes, schools, or factories. Most computer applications are designed for a particular category of user, require training (sometimes lengthy), and are often used for long durations. Because public access systems are located in public spaces, can be used by (almost) anybody, and must be usable immediately, they present new and different design challenges. While many of the capabilities of public access systems can (and already have) be extended to private usage, they represent quite a different kind of computing environment from a system developer's perspective.

Incidently, the last characteristic listed above (i.e., interactivity) differentiates public access systems from their less sophisticated cousins, vending machines Vending machines are not capable of true interaction, although they can display very short messages and accept simple input. Because they lack full microprocessor and storage capability, they cannot run programs and hence perform the functions of a computer system. In addition, vending machines dispense merchandise, whereas public access systems usually provide information or services that require access to a database. On the other hand, public access systems may replace vending machines in the future.[1]

AUTOMATED TRANSACTION MACHINES (ATMS)

In a little more than a decade, Automated Transaction Machines (ATMs) have significantly changed the nature of banking. For example, in 1979, there were approximately 10,000 ATMs installed in the United States; by 1990 there were almost 100,000. Today, most major banks provide ATM services to their customers allowing 24 hour, 7 days a week banking. The American Banking Association estimates that 71% of all adults in the United States have ATM cards (149 million cards) and that 35% of all households use ATMs regularly. For many people, ATMs represent their first and only ongoing encounter with a computer system. ATMs are also becoming widespread in grocery and convenience stores, shopping malls, schools, hospitals, and airports, allowing customers access to cash without the need to visit their bank.

Most ATMs use a full-size display screen, although some use 1-4 line displays. Input is via control keys on a keypad located beside or below the display. ATMs also have a magnetic card reader, a cash dispenser, a deposit slot, and a receipt dispenser. In some cases, the cash and receipt dispenser are combined. If the ATM is located in a retail environment, it may not have a deposit slot. Some ATMs also have a security shield that covers the transaction area until a valid card is inserted into the card reader.

[1] *It is interesting to note that vending machines represent the industrial age in which transactions involve money and goods whereas public access systems typify the information age based on credit cards (electronic funds transfer) and services.*

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In addition to breaking down time and distance barriers to banking, ATMs have also gone a long way toward extending the reach of banks across the country and world. Most ATMs are part of nationwide networks (e.g., STAR, Cashflow, PLUS) that allow bank cards issued by a bank in one state to be used in ATMs belonging to banks in other states or countries. ATMs also accept major credit cards for withdrawals (provided that the customer has requested this option). In fact, the major banking networks are owned by credit card companies.

ATMs belonging to American Express go even further in this regard than those of domestic banks. American Express ATMs are located in airports and major shopping areas all over the world. These ATMs offer a choice of six languages in which transactions can be conducted (see Figure 1-3). Secondly, they allow cash or traveller's checks to be withdrawn in the local currency and automatically charged to the customer's home account, with the prevailing exchange rate applied. It's no wonder that the location of the nearest American Express ATM is an important piece of information for frequent travellers!



Figure 1-2. This ATM dispenses subway farecards as well as performs the usual banking functions.



Figure 1-3. American Express ATMs provide instructions in six languages.

ATMs can also be used for ticketing transactions. Many airlines have experimented with ATMs to dispense tickets and boarding passes at airports. These ATMs look and work much like bank ATMs, except they dispense tickets instead of cash. Such ATMs must be connected into the airline reservation system in order to make seat assignments correctly. In general these systems have not been as successful as the ATMs used in banking, primarily due to the complexities of airline ticketing relative to banking transactions. However, from the customer's perspective, they are very convenient, because they eliminate the need to stand in lines to buy tickets or obtain boarding passes.[2]

ATMs can do more than dispense cash or tickets. For example, the *R. Stevens Express* provides automated photo processing. The customer drops off their film, specifies what kind of processing they want, pays by cash or credit card, and picks up their photos from the unit the next day. The *Postal Buddy* is an automated mailing station developed for the U.S. Postal Service (see Figure 1-5). The Postal Buddy weighs packages, provides stamps, and accepts bank or credit cards for postage. Both of these POS units have been fielded in grocery stores. At recently built service stations in the United States, many of the gas pumps allow payment by credit card directly at the pump; each unit includes a printing unit that provides a receipt for the transaction. While these ATMs are still performing a service function, they are doing so in a retail environment and hence are similar to POS systems.

[2]*The classic example is a bank office where there is a line-up at the ATM outside but there are no customers inside the bank.*

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Figure 1-4. Amtrack's self-serve ticketing kiosk.



Figure 1-5. USPS Postal Buddy does custom printing as well as dispenses postage.

One of the major characteristics of ATMs is that they extend to the customers' computer systems that are already in use. In the case of banks, tellers use the same system to process transactions for customers-ATMs simply make it possible for the customers to do it themselves. Similarly, with ATMs used for ticketing, the underlying system has been in use by reservation clerks and travel agents for a long time. From the companies' point of view, ATMs are a way of reducing employee workload and shifting it to the customer. From the customer's perspective, ATMs provide the convenience of banking or obtaining tickets when and where they want. However, there are costs on both sides. Companies must install and maintain ATMs which is expensive and requires specially trained staff. Also, customers must learn to use ATMs and live with their limitations.

POINT OF SALE (POS)

Point of Sale (also called Point of Purchase) systems are primarily designed to increase sales in a retail environment and represent a form of electronic merchandising. In many cases, they simply provide information about products or services. However, some POS systems also take customer orders and deliver goods. POS systems can also collect information for subsequent sales follow-up or marketing analysis.

According to the Point of Purchase Advertising Institute, 53% of all chain drugstores and 38% of all mass merchandisers have used POS technology. One common POS application is coupon dispensing. POS terminals will print out discount coupons for products selected by the customer. For example, Advanced Interactive

Video Inc. developed a kiosk for Phar-Mor drug stores that offers shoppers coupons and prints them out on request. Evaluation data indicated that coupons generated by the kiosk were used much more frequently than coupons distributed in print. Besides generating coupons, the system can also display a store directory, store policy information, and a video version of the store's printed advertising circular. When not being used by a customer, the system displays advertisements and product promotions.

Many POS systems are intended to help the customer select the appropriate product or service. For example, the *DesignCenter* kiosk created by Innovis Interactive Technologies allows the customer to design wood decks using a touch screen and then prints out a listing of all materials needed. The *Mannington Floors Premiere Theatre* shows customers what different rooms of a house would look like with the flooring styles they select. Sears developed the *Electric Home Lighting Center* that allows customers to choose from hundreds of lighting fixtures. Florsheim Shoes developed a kiosk called *Florsheim Express* that allows the customer to examine the entire product line and place orders directly (see Figure 1-6). Intellimation created a kiosk called *Courseware On Site* that allows potential buyers of educational software for the Apple Macintosh to preview programs they are interested in. The Intellimation kiosks are located in college bookstores and instructional resource centers.

Not all POS systems take the form of a free-standing kiosk. For example, the *Mannington Premiere Theatre* mentioned above consists of a touch-screen monitor that is embedded in the middle of a flooring materials display wall, allowing customers to look at samples in conjunction with the use of the program. Information Resources Inc. developed *VideOcart*, a computer display mounted on a grocery store shopping cart (see Figure 1-7). *VideOcart* displays store specials, coupons, recipes, nutrition information, and an item locator. As shoppers move through the supermarket, triggering devices tell the cart where it is so that it can display messages relevant to that aisle. When the cart reaches the cash register, it can communicate an electronic record of what the shopper selected and their through the store for later analysis of customer shopping patterns.



Figure 1-6. Florsheim Express kiosk located in the shoe department of a Sears store.

Most of the POS applications discussed above use either videodisc or CD-ROM to store video and photographic information. However, it is also possible to build POS systems using only magnetic storage. For example, the *HomeVue* system is a POS kiosk for real estate that stores photographs of properties for sale in compressed digital format on a hard disk contained in the kiosk. This digital rather than optical storage of images makes it possible to update the photographs and listings on a daily basis by downloading them from a host computer using telecommunications (Carper, 1989).

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Figure 1-7. VideOcart brings POS to grocery shoppers.



Figure 1-8. California lottery kiosk located in a grocery store.

All of these POS systems have a common goal: to increase the buying behavior of the customer. They can deliver advertising to the spot where purchasing decisions are made (i.e., in the store or shopping mall) and help the customer make product choices. POS systems provide the same kind of advantages to the company and customer as ATMs: They eliminate the need for a salesperson, and they put complete control of the purchase in the hands of the customer. However, they go one step further than ATMs: The visual presentation is intended to sell not merely perform a specified transaction.

INFORMATION KIOSKS

One of the most popular forms of public access computing systems are information kiosks. Such kiosks may be found in airports, tourist centers, shopping malls, hotels/resorts, convention centers, and corporate headquarters. The following examples illustrate the diverse range of these applications:

- The Florida *Touch Guide* system, located at tourist information centers and rest stops along the Florida turnpike, provides information on restaurants, hotels, beaches, entertainment facilities, and other attractions. The kiosks include a printer and special cooling features that allow them to operate continuously in the hot Florida climate. The *Touch Guide* system uses DVI technology and was developed by Network Technology Corp.
- A kiosk at Smugglers' Notch Ski Area & Resort in Vermont developed by Terrajim Inc. features "Sherpa"-an animated guide-and provides information about dining, entertainment, child care, and local attractions.
- Kiosks at the Jacob Javits Convention Center in New York provide the "Video Guide to New York," a visitor information database, and the "Product Locator," information about current trade shows being held. The kiosks were developed by Nynex Information Resources Company.
- The Chicago Mercantile Exchange has placed four kiosks in its visitors' center that overlook the trading floor. The kiosks explain how the trading works with examples of buying and selling that the visitor can try out. The system uses interactive videodiscs.
- The Marriott Corporation has placed "Exploring the World of Marriott" kiosks in the college recruiting offices of a number of universities around the United States. The kiosk presents information about the company in full multimedia form, answers student questions, and collects recruiting data.
- The Arlington International Racecourse has placed three kiosks in its visitor area (called "The Starting") that provides information about the history of horse

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racing, interviews with famous jockeys, profiles of great racehorses, and how to place a wager.

- The Shell Canada *InfoCentre* located on Highway 401 near Toronto is a "service station of the future" that combines a gas station, restaurant, business, and information center (see Figure 1-9). The InfoTouch system features seven touchscreen units that provide information on travel, food, hotels, and attractions in the Toronto area as well as a large video display. The system was developed by Magnus Multimedia.

Information kiosks designed to provide tourist or visitor information are often subsidized by advertising revenue. For example, the *Discover Atlanta* system developed by TouchTel Inc. had 46 kiosks located throughout the city in 1990. The system allows users to find out about and make reservations at hotels and restaurants; each advertiser pays a monthly charge (ranging from $100 to $3,500 depending on the nature of the information displayed) to be included in the system. Is it worth the cost? Advertisers report a 10-20% increase in reservations due to use of the system. The system is accessed in excess of 200,000 times and can result in more than 50,000 phone calls per month. The *Las Vegas Teleguide* system which involves 70 kiosks in the convention center, hotels, and casinos generated 1.4 million inquiries per month in 1990. Advertisers report hundreds of sales leads each month from users of the system; they pay approximately $50 per screen per month plus additional fees for printed summaries and market analysis of usage data.



Figure 1-9. Visitor at Shell InfoCenter (Courtesy, Shell Canada Ltd.)

Some information kiosks provide "self-help" or social service functions. For example, the Virgina Cooperative Extension program, based at the Virgina Polytechnic Institute and State University, has placed kiosks providing information on health, nutrition, horticulture, consumer law, and other topics in libraries and shopping malls around the state. The *Courtguide* system developed by the Law Foundation and Attorney General's Department of New South Wales, Australia, provides information on how courts operate, penalties and fines, procedures for witnesses, advice on handling disputes, and a community service directory. The

Courtguide kiosks are located in courtrooms across New South Wales. The U.S. Employment Services and New York State Department of Labor developed the Automated Labor Exchange (ALEX) kiosk which allows people to search for jobs according to occupational categories. The database includes nationwide as well as regional job opportunities and links federal and state employment agencies.

The *Chemical Bank Information Center* combines the functions of an information kiosk and an ATM. In addition to the routine banking transactions of cash withdrawals, account transfers, and deposits, the system also allows customers to examine their bank records to see if checks have cleared or deposits have been made as well as prints out a statement for the past 30 days. The Information Center also provides information about all of the bank's financial services including account options, interest rates, IRAs, and loans. This information can be linked to customers' current accounts so they can see how the different offerings might apply to them. The system also has a message function that lets customers request more information about a topic via telephone follow-up or mail.

One characteristic of most information kiosks is the use of the touch screen for user input and the avoidance of any type of keyboard or keypad. This is driven by the desire to make such kiosks easy to use by all age groups and to minimize maintenance or vandalism problems. Because information kiosks are often located in areas in which there is no supervision, reliability and ruggedness are two critical design attributes.

MUSEUM EXHIBITS

Interactive exhibits at museums or trade shows are another popular form of public access computing, that are usually in the form of free-standing kiosks, but sometimes are components of larger displays. A number of new technology centers have been designed specifically to feature interactive exhibits. Examples include:



Figure 1-10. Information kiosk at Epcot Center.

- AT&T Infoquest Center in New York features over 40 interactive exhibits focusing on telecommunications technology.
- EPCOT Center at Walt Disney World in Orlando, FL is the largest public installation of interactive videodisc systems in the world. There are over 80 different programs running on 300 stations.
- The Tech 2000 museum in Washington, DC is a showcase for the interactive multimedia industry and has dozens of exhibits and systems covering art, entertainment, and education.
- The Franklin Institute Science museum in Philadelphia, PA created a "Futures Center" that includes a number of interactive exhibits on environmental topics and life sciences.
- The Hall of Life at the Denver Museum of Natural History features exhibits that keep track of each visitor's interaction on a "LifeCard" and can print out a health evaluation at the end of the visit.
- The Living World Education Center at the St. Louis Zoo provides interactive workstations that allow students and teachers to study a broad range of animals and related topics
- VideoPlace is a "virtual reality" exhibit in the Connecticut State Museum that allows visitors to experience various virtual reality applications.

Interactive exhibits are popular attractions at science centers and children's museums around the country. Many art museums are also actively exploring the use of interactive systems for exhibits and orientation. The Museum Education Consortium, which is comprised of seven major art museums, has developed a multimedia exhibit on Impressionism and Post-Impressionism that will be used by all of the partipating institutions. The Minneapolis Institute of the Arts has placed interactive kiosks in their lobby to provide an orientation to the museum for visitors.

The U.S. National Park Service has started to use interactive kiosks extensively at historic sites and park information centers to provide visitor orientations. Small regional and local museums are also beginning to use interactive exhibits. For example, the Yugtarvik Eskimo Museum in Bethel, AK, in conjunction with the University of Alaska-Fairbanks, has implemented a hypercard based exhibit intended to teach people about traditional Eskimo culture (Sponder & Schall, 1990). Heller (1991) describes the design process for interactive exhibits at the U.S. Holocaust Memorial Museum. A survey of interactive videodisc applications in museums is provided by Binder (1992).

Interactive exhibits (as well as POS and information kiosks) share some common design characteristics. One common feature is an "attract" sequence intended to capture the attention of passersby. These sequences repeat until someone touches the screen and starts the program or brings up the main menu. Another common design feature is a time-out test that goes to the attract sequence if there is no user response for a specified time period (assuming the user has abandoned the system). Provision for multiple languages is also an important aspect of museum exhibits, because visitors are often from other countries.

ENTERTAINMENT

The entertainment world represents an active area for public access computing systems, which includes video game arcades, entertainment parks (e.g., EPCOT), and home products. While the latter category is not strictly public access, it typically has close ties to arcade games and toy departments in stores. Some examples include:



Figure 1-11. Interactive exhibits at EPCOT.

- The *Power Glove,* a product sold by Mattel, which allows kids to play Nintendo games using direct hand movements;
- A series of "Sesame Street" Nintendo game cartridges developed by Children's Television Workshop for young children;
- American Interactive Multimedia developed a series of educational games to be marketed with its new CD/I systems; and
- A number of companies provide interactive television services that allow people to play games or control programs that are broadcast via cable or satellite. For example, viewers might be able to control camera angles or request specific types of information.

Video game arcades often represent the cutting edge of public access computing systems. Video game makers were one of the first groups to put interactive videodisc systems into use (e.g., *Dragon's Lair)* and continually push the state-of-the-art in computer graphics and animation. For example, the *Hologram Time Traveler,* developed by Sega, is the first arcade game to produce three-dimensional action images that appear suspended in free space (see Figure 1-12). The game uses video footage of live actors stored on videodisc and a mirror to reflect the images off a monitor into the viewing area. In an interesting cross between a video game and a POS unit, Nintendo created Game Boy counter displays that allow potential customers to play with the game unit which is part of the display. They also created POS kiosks that are full-size working replicas of the Game Boy and Nintendo (Figure 1-13).

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Figure 1-12. Sega Time Travel holographic arcade game.



Figure 1-13. Nintendo Game Boy POS kiosk. (Courtesy, NCC Sales Inc.)

Interactive videodisc systems also have applications in sports and recreation. A number of companies developed exercise bicycles that show video sequences with the pedaling effort linked to the nature of the terrain displayed. A variety of different trips with varying levels of difficulty can be selected. MIR Inc. developed the *Power Alley Batting Cage* which provides batting practice in the context of a realistic ball game and stadium setting. The batter faces a 9' x 9' video screen that displays the pitcher and surrounding ball park and contains a ball chute that delivers the pitch at speeds up to 90 mph. The batter can select the particular pitcher desired and is shown a summary of that pitcher's strengths and weaknesses. The company plans to develop similar systems for other sports such as tennis, soccer, and cricket.

One of the most important design characteristics of arcade games is fast response time; hence, a lot of emphasis is placed on system performance. Sound is another important design characteristic of games that is not emphasized very much in other forms of public access systems. Unlike other kinds of public access systems, arcade games tend to rely on joysticks and hand controllers for input rather than touch screens. In addition, game kiosks often have unusual shapes to match their theme, including units that are intended to be sat in or on (see Figure 1-14). The design of entertainment systems is similar in many respects to that of museums, except that

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some games can be strictly for enjoyment with no informational value.

ONLINE LIBRARY CATALOGS

Online library catalogs probably represent the most researched and oldest form of public access systems (e.g., Crawford, 1987; Fayen, 1983; Hilbreth, 1982; Mathews, 1985). First developed and implemented in university libraries in the 1970s, they are now common in most public and school libraries (see Figure 1-15). While online catalogs are usually networked systems that involve terminals connected to a host computer (usually via a local area network), some consist of personal computers and CD-ROM players. The latter configuration tends to be used for outside databases (e.g., ERIC, Medline, Psych Abstracts, etc.), while the former is used for the library's own collection.



Figure 1-14. Form follows function in a motorcyle racer arcade game.



Figure 1-15. Online catalogs are common in libraries of all sizes.

One of the distinctive characteristics of current library catalog systems is that the information is exclusively text in nature. This means that the display and storage of multimedia information (graphics, sound, video) is not currently a consideration for this type of public access system.[3] Even color is not a common characteristic of librarys' catalog systems. However, screen design and layout is of upmost importance in online catalogs, because a lot of information is presented to the user, and it is essential to provide it in the best manner possible.

[3]*However, in the future, cataloging information may take multimedia form including photographic and audio components.*

The primary operation conducted with an online catalog is searching. This has a number of system design implications. For one thing, it makes a keyboard necessary in order to type in search expressions. While it is possible to enter this information via touch panels and other direct manipulation devices, keyboards are much easier to use for this type of operation. Secondly, a great deal of attention must be focused on the design of the user interface, especially search commands and error handling, because search requests can be complex to formulate, and people often make

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mistakes. Because users are typing their input (rather than selecting options from menus or touching buttons), there are lots of opportunities for keyboard and syntax errors.

Probably the most significant characteristic of online catalogs is that they involve relatively large databases and highly structured information. Because users expect a quick response from a search request, system performance is critical, and databases must be organized so that they permit rapid access. They must also be organized so that they can be updated easily, because new information is being added constantly. Furthermore, many online catalogs are integrated with circulation databases that indicate the current status of holdings (e.g., checked out, on the shelf, lost, etc.). Needless to say, the design of databases for library catalogs is a complicated undertaking.

MESSAGING SYSTEMS

The last category of public access computing systems to be discussed in this chapter are messaging systems for conferences and special events. Such systems allow participants to make contact with each other over the course of the conference or event as well as be informed of program changes and news. They can be considered a special case of general-purpose electronic message systems that are used for electronic mail and computer conferencing (e.g., Kerr & Hiltz, 1982; Vallee, 1984).

An interesting example is the Olympic Message System used at the 1984 Olympic games in Los Angeles (Gould et al. 1987). The system provided 24-hour voice-mail capabilities to thousands of athletes and officials in 12 different languages. In addition, the system could be used to exchange telephone messages with family and friends not at the games. Kiosks were located in the Olympic village and contained a visual display listing individuals who had messages as well as a videodisc-based presentation by a mime showing how to use the system (see Figure 1-16).

Another interesting example of a public messaging system has been developed by Cognetics Corporation for the Society for Worldwide Interbank Financial Telecommunication and used at the annual SIBOS conferences. This system allows participants to write their message on paper, which is then digitized by a video camera and saved as a screen image. This technique permits messages to be written in any language as well as the inclusion of sketches or special symbols, two important considerations at an international technical conference. All interaction with the system is by means of a touch screen; no keyboard is used. Large monitors on the top of the kiosk list the names of individuals who have pending messages. The Cognetics system also includes a registration component that prints name badges and creates a participant database that is the basis for the messaging system.



Figure 1-16. OMS kiosk used in 1984 Olympics (Courtesy, IBM Corp.)

Messaging systems frequently share a design characteristic with ATMs that is not present in other forms of public access systems: the need for user ids and passwords to ensure privacy of information. Most messaging systems ask the user to select a password the first time they use the system. However, some messaging systems do not use passwords, allowing people to access all messages if they choose. The password issue has to do with the underlying metaphor of the system-whether it is a public bulletin board or a private mailbox.

SUMMARY

As will be clear from this introduction, public access computing covers a broad domain of applications. Most public access computer systems take the form of stand-alone kiosks. They are used by people of all ages who may have no previous exposure to computers. They can be located in shopping malls, stores, libraries, museums,

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airports, hotels, hospitals, convention or visitor centers, office buildings, and street corners. The driving forces behind the use of public access systems are increased convenience to the end user (e.g., 24-hour access to services or information) and lower operating costs to the system provider (e.g., reduced labor or facility expenses).

There are many design characteristics shared by the different types of public access systems. The use of attract sequences and time-out loops are common in many systems. Most systems require some sort of graphics or animation-in the case of interactive exhibits or arcade games, the graphics and animation can be very sophisticated. ATMs and messaging systems normally require user ids or passwords and are linked into extensive databases. POS and information kiosks can also be linked to databases of product or consumer information, although they typically operate in a completely stand-alone mode. On the other hand, ATMs, online library catalogs, and message systems almost always involve a network and shared database.

One of the fundamental questions in designing a public access system is: Will people use it? Many systems are highly successful (e.g., ATMs, online library catalogs), whereas others are less so (e.g., ticket dispensing machines, POS kiosks). In some cases, information or POS kiosks are almost completely ignored by their intended users. To be successful, a system must provide information or services quickly and reliably-and do so better than other available alternatives. For example, if a kiosk is located beside or near a counter that is staffed, most people will wait for human service rather than use a machine-unless the system is clearly superior in the quality of service provided. Furthermore, the information provided must be complete and up to date; consequently, a great deal of attention needs to be focused on database maintenance. There are many design and implementation factors that determine whether a public access system will be used and successful.

Designing and implementing a public access computer system presents many choices to the system developer. This includes the choice of specific storage, input and display technologies, the nature of the user interface, the organization and format of the information to be presented, the physical characteristics of the kiosk or delivery station, and the role of telecommunications or networks. Each of these choices involves cost-effectiveness decisions. The rest of this book considers these issues.

THE TECHNOLOGY

Public access systems involve a variety of different hardware components: microprocessors, displays, input/output mechanisms, storage devices, and network connections. Software components include operating systems, utility programs, and authoring tools. To design a public access system, it is necessary to make decisions about each of these components. Furthermore, the decisions made about hardware and software components affect many of the other characteristics of a system, including the nature of the user interface, database structures, and system performance or reliability. While decisions about hardware and software will not usually determine the success or failure of a system, they place constraints on what is possible and what is not.

MICROPROCESSORS

At the heart of all public access systems is the microprocessor which makes up the central processing unit (cpu) of a computer. The key characteristics of a microprocessor are word size and processing speed. *Word size* refers to the length of instructions or data fields, measured in bits. The larger the word size, the more data that can be processed per time unit. *Speed,* measured in cycles per second (hertz), indicates how many instructions can be processed in a single instant. The microprocessors in the first generation of personal computers featured 4- or 8-bit word sizes and ran at less than 5 megahertz. Today, most personal computers contain microprocessors with a word size of 32 bits and a processing speed of 20-30 megahertz. The next generation will use 64-bit words and have processing speeds at least twice as high.

ROM/RAM

Important elements of the cpu are the Read-Only Memory (ROM) and Random Access Memory (RAM). ROM provides permanent storage and is used to store critical loading and input/output routines; RAM is temporary storage used to hold programs and data while they are being processed. For example, if you were using a telecommunications program to transmit files, both the telecommunications program and the immediate data to be transmitted would be stored in RAM. Because the amount of RAM determines how large a program or data file can be processed at one time, it affects the power of the cpu. The capacity of RAM (and ROM) is measured in bytes-kilobytes (K) and megabytes (M).[1] The first generation of personal computers had 8K-16K bytes of RAM; current machines have between 1-4 megabytes of RAM. In contrast, the size of ROM is usually not that important, because operating system programs are typically small and do not require a lot of memory. Some computers use ROM "chips" to store application programs, thereby freeing up more RAM memory for processing functions.

What does all this mean for the designers and developers of public access systems? It means that personal computers have evolved into very powerful computing systems capable of running complex programs and manipulating large amounts of data. Public access systems often involve color graphics displays with animation or multimedia sequences. A tremendous amount of speed and memory is required to produce these displays and sequences. One of the critical performance characteristics of a public access system is quick response-people usually expect the system to respond in less than a second. This will only happen if the microprocessor is fast and has ample memory. The exact speed and amount of memory needed for an application will need to be determined from prototypes and field testing, although an experienced system developer can estimate based on the nature of the interaction and displays involved. As a general rule, system developers tend to select the most recent and powerful computer that can be afforded, even if a less powerful machine would do. This ensures that the program will respond to user input as quickly as possible.

[1] *A byte usually consists of 8 bits and is equivalent to a single character of data.*

DISPLAYS

While microprocessors may be the "engine" that powers a public access system, they are hidden to the user. Displays are the component that people see[2] and the primary means for providing information and feedback. There are a wide variety of display types and variables to be considered in the design of a public access system. These variables include resolution, size, graphics, and color.

Display Types

The three most common types of computer displays in use today are LED (Light Emiting Diodes), LCD (Liquid Crystal Display), and CRT (Cathode Ray Tube). In an LED display, rows of small diodes are turned on or off to produce characters (see Figure 2-1). Because all characters must be made up from combinations of on/off diodes, they tend be jagged and somewhat difficult to recognize. The characters in an LCD display are usually preformed and hence are much more distinct than an LED. CRTs are the type of displays used for television and computer monitors; characters are formed by turning on/off individual picture elements (pixels) in rows across the screen. Every second hundreds of lines are written on the screen. This process is called *refreshing,* and the speed of writing lines is the scan rate of the display. For example, the television monitors used in North America have a scan rate of 525 lines per second.

The practical significance of the type of display used is the resolution possible and the amount of computer processing needed.[3] LED displays can only show simple character displays (e.g., letters and numbers), but they require very little processing capability. LCDs are capable of more elaborate character and graphic displays, but also require more computer processing power. CRTs can display any type of characters or graphics, but require a great deal of processing power. There is also a difference in electrical power requirements-CRTs require more electricity than LCDs

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which require more than LEDs. If the device is portable and must run off batteries, the amount of electricity needed for the display becomes very important. Most laptop computers use LCD displays to minimize the power requirements (as well as to have flat screen displays-something not possible with traditional CRT units).

[2] *Unless they are visually handicapped. See discussion of designing for the handicapped in the Appendix.*

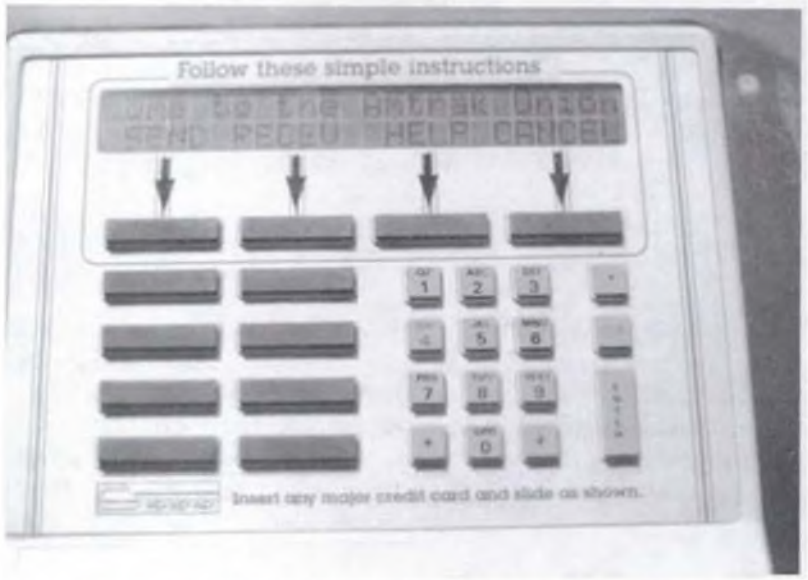


Figure 2-1. Keypad with "soft keys" and two line LED display.

In addition to monitors, video images can be projected on a screen from the front or rear. There are a large variety of video projectors commercially available that connect directly to computers or videodisc players. Video projectors are typically used when a large image is needed for group viewing. However, projectors can also be used when an irregular shape is desired. For example, the animated exhibits often seen at amusement parks (e.g., Disney World) are created by projecting video images on 3D forms.

[3] *One other practical aspect of display type is the level of electromagnetic radiation they emit. Because LED and LCD displays do not use a refresh method (which produces the radiation), they emit almost no radiation compared to CRTs. However, given the very brief exposure times involved in public access systems, this safety consideration does not seem very significant.*

Resolution

Resolution refers to the amount of detail that can be displayed on a screen. The higher the resolution of the display, the better the text, graphics, and images will look when displayed. The most common method for describing screen resolution is in terms of *pixels* (an abbreviation for picture elements) which refers to the total number of addressable points on the screen. For example, most current personal computer monitors display approximately 500 x 500 pixels, although newer generations of monitors are capable of 1000 x 1000 pixels. This latter resolution gives a level of detail comparable to printed pages. Because each pixel corresponds to a "bit" of information (more in a color display), more memory and processing power is needed as the resolution increases.

Display Size

Computer screens come in a wide variety of sizes, although a rectangular 13-inch display is probably the most common monitor size for personal computers. Many ATMs and POS systems use small displays that only show 2 or 3 lines of information. The primary factor determining the size of displays for public access systems is viewing distance. For example, in ATMs the viewing distance is typically less than 1 foot, so a small display is satisfactory. On the other hand, a museum exhibit or POS screen may be viewed from a distance of 5-10 feet and require a large display screen. Some exhibits use wall-sized displays that consist of multiple monitors, each of which shows a component of the full image. In addition to creating large displays, "video walls" can be programmed for a variety of special effects (see Simpson, 1991).

Note that there is usually a tradeoff between screen size and resolution: the higher the resolution, the smaller the display can be.

Graphics/Color

The type of graphics and color possible depend on the type of display and the processing capability of the computer. The current generation of personal computers are usually capable of displaying high-resolution graphics and at least 256 different colors. While it is possible to have ultra-high-resolution graphics and more colors, this makes the system expensive and is seldom needed for public access systems. The major problem is having sufficient processing power and RAM to display graphics quickly. Many computers have special microprocessors dedicated to displaying graphics or images, particularly when compression is used. Other considerations include compatability of different graphics formats and design guidelines for the use of color (discussed further in the next chapter).

INPUT MECHANISMS

The way input is handled is critical to the usability of a system. Furthermore, this is the feature that distinguishes interactive systems from presentation media such as television or computer animation. Without some form of input, a user cannot interact with the system.

Keypads

The most common input device for computers is the standard "QWERTY" keyboard originally introduced on typewriters. However, the standard keyboard is not found in many public access systems, because it violates too many basic design considerations:

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it requires skill to use, it is prone to break down, it allows the user to make mistakes, and it makes input too slow or inconvenient. On the other hand, keypads (either numerical or labeled) are often used in public access systems. A typical keypad is laid out in a 3x3 or 4x4 matrix. Keys may be the raised mechanical type that move when pushed or the flat recessed (membrane) type that depress slightly when touched. It is also common to position "soft keys" (unlabeled buttons) at the side or below the display; their function is defined by the current screen (see Figures 2-1 and 2-2).

There are some typical problems that occur with keypad-type input mechanisms. If the keys are of the mechanical type, they are prone to wear out quickly and get stuck or jammed. If the keycaps have some sort of plastic or paper labels on them, these labels will wear off after a while, making the key unidentifiable. If the keypad is not well illuminated, people may have trouble finding or seeing the keys. People with limited manual dexterity may have trouble pressing keys, especially if the keys are small and too close together. All of these factors need to be taken into account in keypad design.



Figure 2-2. A numeric keypad and "soft keys" on either side of the monitor.

Some systems, especially ATMs and information/exhibit kiosks, use a keypad consisting only of 3 or 4 keys which are quite large in size (i.e., 1-2 inches in diameter). Usually such keys are color-coded and have their functions (e.g., yes, no, withdrawal, deposit, next, back, cancel) embossed in big letters on the key. Obviously over sized keys minimize the complexity of the user response and any problems finding or pressing the keys.

Touch Screens

Touch screens are often used as input mechanisms for public access systems and have many advantages. Most people find the capability to indicate a response by touching the screen to be more "friendly" (as well as faster) than pressing keys. Response areas can be irregular in shape and easily changed or updated by reprogramming the screen. Touch screens can eliminate the need for keyboards/ keypads and hence reduce the space needed for the work station. Because there are no moving parts, the touch screen does not wear out or break like keys.

However, touch screens have some limitations. Depending on the particular technology used, they can lose their calibration and not indicate the location of input properly (or at all). There are a number of different ways of building touch screens, including those that use infrared or ultrasound beams to detect input as well as some varieties that embed tiny detectors in the screen. Some types and brands work better than others (see Pickering, 1986; Sears, Plaisant, & Shneiderman, 1991).

If the touch screen is mounted vertically, the user may experience arm fatigue after using the system for a brief period. Fatigue can be reduced or eliminated by providing an arm rest below the screen, mounting the monitor at a 30- to 45- degree angle, or placing the monitor lower (e.g., waist height). Touch screens also reduce the amount of light transmitted which affects the clarity of the display and color quality. This reduction can range from 10-30% depending on the type of touch screen involved.

There is also a problem of precision with touch input. If the screen target is too small, people will have trouble touching it accurately. Depending on the angle of the screen and the type of touch technology used, there may be parallax problems that cause people to misjudge the target location. People often touch the screen too quickly or move their hand as they touch, resulting in response errors. There are design techniques that can virtually eliminate these types of problems, however. For example, if the finger produces a cross-hair on the screen that gives the user feedback on location, and the system does not process a response until the finger is lifted from the display (rather than the initial detection), far fewer errors are made (Potter, Weldon, & Shneiderman, 1988). Designing the response areas so that they are big and stand out well from the background also makes a big difference in the accuracy of response.

Other Pointing Devices

There are many other forms of input that might be found in a public access system. Most computer workstations today have some type of pointing device such as a mouse, trackball, joystick, or graphics pen/tablet. These devices provide a means to control the input location on the screen by hand movements. While this capability can be provided with arrow keys that move up/down and right/left, pointing devices make it much easier and faster to move to a specific screen location. In addition, graphics pens allow handwritten input which accommodates any language or notation. However, with the exception of joysticks and trackballs in computer games (see Figure 2-3), pointing devices have not been used extensively in public access systems. Durability of these devices is certainly one of the factors limiting their use (although they can be made rugged if necessary-consider computer games). In most

applications where this kind of input is needed, touch screens have been used instead.

Magnetic Cards

An input mechanism that is important for some types of public access systems is magnetic card readers. Bank cards for ATMs are the most common use of this type of input as well as POS kiosks that accept credit cards (see Figure 2-4). In this context, cards serve a security function and contains the user's account number. The same function could be performed without the card by asking people to type in their account number and password. However, cards can also contain information stored in the magnetic strip that provides information such as credit limits, expiry date, birthday, or even clothing sizes. So-called "smart cards" that include a microprocessor chip embedded in the card are capable of more sophisticated functions such as keeping track of purchases or usage data. Such cards make it possible to store more information on the card and be less dependent on a network and online databases for processing of transactions.



Figure 2-3. Joysticks provide direct manipulation capability in arcade games.

Magnetic cards are also becoming popular in museum applications. By having the visitor identify information about themselves or their interests, it is possible to personalize exhibits. For example, in the Hall of Life at the Denver Museum of Natural History, personal data such as age, weight, height, medical history, eating habits, exercise regime, and other characteristics are recorded on the visitor's "LifeCard" as they interact with the exhibits. At the end of their visit, they can print out a health evaluation. Furthermore, visitors have the option of keeping their card for future visits; exhibits can display the results from previous visits for comparisons. Another possibility is that information on the card determines which version of a exhibit is shown to a visitor based on their background or interests (Motiska, 1991).



Figure 2-4. This automated gas pump includes a magnetic card reader, single-line display, keypad, and printer receipt printer.

Card readers are relatively reliable and pose few usability problems. Putting cards in the wrong way is the major user problem, and this can be minimized by putting arrows on the card and diagrams showing the correct orientation near the card slot (see Figure 2-4). Card readers have to be able to recognize that the card is inserted correctly and reject it otherwise. Alternatively, cards can be designed with an irregular shape or with grooves so that they can only be inserted the correct way. Another problem that occurs is that the magnetic strip becomes worn or damaged rendering the card nonfunctional. It is also possible for the reader to lose its alignment and not be able to read cards properly.

Speech Input

Another form of input that could ultimately be very important to public access systems is speech recognition. Clearly, the ability of people to respond to a system by talking is highly desirable. Despite considerable research and development over many years (e.g., Bolt, 1984; Fallside & Woods, 1985; Martin, 1989), the accuracy of speech recognition systems for normal conversational discourse is not very good. Speech recognition systems can reliably recognize isolated words, but they are easily distracted by background noise, accents, and irrelevant utterances. In order for a speech recognition system to be highly accurate, it must be "trained" to the

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pronunciation of a specific individual - something not very practical for public access systems. Furthermore, for speech systems to be robust, they must understand the nature of the conversation which requires the use of artificial intelligence techniques. An additional practical consideration is that speech input reduces the privacy of the interaction.

Motion Detectors

Some public access systems feature a sonic or infrared motion detector that determines when a person steps in front of or within range of the kiosk and starts the program. This prevents the system from playing continuously when no one is around which could diminish its novelty, make it annoying, or increase wear on the hardware. The motion detector can also be used to identify when a person abandons the kiosk, terminating the program and returning it to the opening screen or attact loop. Some sit-down kiosks include a pressure sensor in the seat that indicates when someone sits or abandons the kiosk.

Gestures

Finally, researchers today are investigating the potential of gestural input, that is, responses signified by body movements such as the hand or head. In the field of research known as *virtual reality*, systems have been built that allow people to control objects on the screen by moving their hands while wearing "data gloves" or passing them through sensor arrays (see Helsel & Roth, 1990; Krueger, 1991; Rheingold, 1991). This produces an experience of three-dimensional involvement. While this input mode is likely to have relevance to game design and the entertainment area, its impact on public access systems in the near future is likely to be minimal due to the complexity of the hardware and software required.

OUTPUT MECHANISMS

We already discussed the most important output mechanism for computer systems (i.e., screen displays), however, there are at least two other forms that should be mentioned: printing and sound. Both of these forms are often used in public access systems.

Printing

The most common form of printed output in a public access system is a receipt such as the ones generated by ATMs documenting the transaction. Other forms of printed output include: tickets, coupons, travel directions, inquiry results, or information about products or services. This information is printed out to provide the user with a permanent record so that the information can be taken with them. Some users may find their interactive experience more valuable if they receive a printed summary.

The primary consideration in the design of any printing device that is part of a public access system is reliability. Because printers involve moving parts and paper reloading, they are prone to failure. There are a number of different types of printing technologies, all of which involve tradeoffs for use in public access systems. Laser and ink-jet printers are fast and produce high-quality output, but require frequent replacement of toner or ink. Dot-matrix and thermal type printers are smaller, less expensive, and require less attention, but their output quality can be poor. One critical feature in the design of printing output is to ensure that the paper is either precut forms or automatically cut by the system. If users have to tear off their own output, the printer is likely to jam frequently.

Clearly any public access system that involves printed output will require regular servicing to reload paper, replace ribbons or toner, and check print quality. Because of the propensity of printers to fail, their inclusion also jeopardizes the reliability of the system. For this reason, the decision to include printing capability in a system should be considered very carefully. Unless it is absolutely vital to the function of the system, it should probably be left out. In any event, the system should be designed so that it can work properly, even if the printer is disabled, perhaps with reduced effectiveness.

Sound

Sound is another popular output capability of many public access systems, either in the form of music, sound effects, or voice messages. Current forms of digital storage media such as CD-ROM and videodisc (see below) make it possible to have large sound libraries available. Sound output has many uses: it can capture the attention of passersby; it can explain or expand on information displayed on the screen; and it can make the presentation or interaction more realistic or pleasant through sound effects and music. Sound is valuable because it can convey information when lighting is poor (or nonexistent) and visual displays cannot be easily read. It can also be used to mask ambient noise by providing sound that makes the public access system stand out. Sound has been shown to actually improve performance in video games (Buxton, 1991).

However, the use of sound in public access systems can be problematic. First of all, it is likely to annoy anyone who works within hearing range of the system-often to the point that they insist it be removed. It also may embarrass some users, because it draws attention to them. In the case of voice output, there may be problems with intelligibility unless the volume is relatively loud or the speakers are well placed. Sound is very instrusive; repetitive sounds become tiresome very quickly. There is also the consideration that hearing-impaired users may not be able to understand anything presented this way. (On the other hand, it makes information available to the visually handicapped.)

Because of these considerations, sound should only be used as a redundant information channel in public access systems. It could be used to enhance presentations or interaction that is already presented visually. Furthermore, it should be easy to turn the sound off (at the user level) so that it could be disabled if it causes problems.

STORAGE MEDIA

There are many different ways of storing information, and to some extent the type of storage media used determines what kind of displays and functions a public access system can perform. The most common form of storage media is the magnetic disk

(so-called "floppy" or "hard" disks), but optical storage media such as laser discs and CD-ROM are becoming popular, especially when multimedia information is involved.

Magnetic Storage

Magnetic storage devices represent information in digital form as a series of on/off (binary) signals. A floppy disk (which is removable) typically contains 720K-1.4 M bytes of data, while hard disks (which are not removable) contain anywhere from 20M-600M bytes. Because a single character (i.e., letter or number) equates roughly to a byte, a floppy disk could store 720,000-1,400,000 characters or about 1,500-3,000 pages of text, and a hard disk could store 20-600 times more.

While this may seem like a lot of storage capacity, for large online systems that involve records for millions of transactions daily (such as banking or reservation systems), it is not. Such systems tend to use a series of high-capacity hard disk drives that are linked to one or more mainframe computers. Furthermore, graphic and sound information takes much more space than text. For example, a full-screen color illustration or photograph might take up to 200K bytes of disk storage. So a 20M hard disk could only store 100 such graphics. If the application is a product catalog or travel information kiosk, this would not allow very much information to be stored. Digitized sound can also take up considerable space. A 10-second spoken message could require 100k bytes to store on disk. On a 20M hard disk, this would allow room for only 200 such messages. While this might seem ample, if sound is used extensively in an application, it would not take long to run out of disk space.

Optical Storage

When we consider the storage of dynamic images such as video or animation, the magnetic disk becomes inadequate except for very brief sequences. For example, video presents 30 picture frames per second. If each of those frames requires 200K bytes to store, one second of video image will need 6M bytes of disk storage. An animation running at 10 frames per second would require 2M bytes. Because of these large storage requirements, optical storage media are essential for the presentation of dynamic images. Full-size videodiscs can store 54,000 picture frames per side (including audio). Thus, up to half an hour of video or animation at 30 frames per second can be stored on each side of a videodisc. Obviously, videodisc is also well suited to large graphic databases as well as patent illustrations, architectural drawings, real estate photographs, product catalogs, or medical records.[4]

Like videodisc, CD-ROM (Compact Disc-Read-Only Memory) stores information in an optical format that is read by a laser beam. However, CD-ROMs store information in digital form, while videodiscs use analog form. CD-ROMs have a storage capacity of be

[4]It is also possible to store information in digital form on a videodisc. For example, Fast-Trax Digital Technologies has developed a format (VD-I) that allows up to 300 hours of audio or 1.768 gigabytes of data to be stored on a standard 12 CAV videodisc.*

tween 600-700M bytes. While this capacity is sufficient to store a large amount of text, sound, and still graphics, it suffers the same limitation as the magnetic disk when it comes to dynamic information. However, information stored on CD-ROMs and magnetic disks can be compressed and then "unpacked" when it is displayed. For example, a 200K-byte graphic might only take 20K bytes when stored in a compressed format. Compression allows a lot more graphic information to be stored on CD-ROMs and magnetic media than is normally possible. In the case of dynamic images, compressing the picture frames allows longer sequences to be stored. For example, a compression technology called DVI (Digital Video Interactive) marketed by Intel allows 72 minutes of full-screen motion video to be stored on CD-ROMs.

There are currently a number of CD-ROM formats which vary in their capabilities (see Table 2-1). The format of text-only CD-ROM is specified by an international standard, ISO-9660, that all optical disk drives and manufacturing facilities adhere to. Microsoft Corporation created a format called CD-ROM/XA (Extended Architecture) that allows text, graphics, and audio to be stored on standard CD-ROMs. CD-I and CDTV are formats developed primarily for the home consumer market, and they support text, graphics, and audio as well as some degree of motion video . While DVI involves a special interface card to connect the CD-ROM player to the computer, CD-I and CDTV are self-contained units that contain a microprocessor and connect directly to a television or monitor.

Choice of Storage Media

The choice of what kind of storage media to use in a public access system depends on the amount and nature of the information to be presented. If the information is primarily text with a small number of graphics, magnetic media are suitable. On the other hand, if the information involves a lot of graphic information or motion sequences, videodisc or CD-ROM is needed. Other factors to be considered are speed, cost, and updating. Retrieval times for CD ROM tend to be much slower than magnetic discs or videodiscs. If a quick response is desired, CD-ROM is probably not a good choice. Videodisc and CD-ROM add extra system costs for players and interfaces (e.g., $500-$1000 per unit). Updating the information on videodisc or CD-ROM involves physicially replacing it; whereas information on a magnetic disc can be downloaded from a network via telecommunications (see the discussion in the next section).

Table 2-1
CD-ROM Formats

CD-ROM	ISO 9660	Text
CD-ROM/XA	Microsoft	Text, graphics, audio
CD-I	Philips/Sony	Text, graphics, audio, video
CDTV	Commodore	Text, graphics, audio, video
DVI	Intel	Text, graphics, audio, video

At the present time, optical media are, for practical purposes, read-only. There are videodisc and CD-ROM players that allow recording, but they are expensive and not very common. This makes optical media a good method for publishing multimedia information, because the discs cannot be copied or altered. For certain kinds of public

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access systems such as information kiosks, museum exhibits, or games and entertainment units, this works fine. On the other hand, some types of applications will require frequent updating and optical media may not be suitable, even though it provides the kind of multimedia storage capability needed. For example, the use of optical media to present real estate properties would not be a good idea for most types of homes or commercial offerings, because this information changes frequently. On the other hand, it might make sense for very expensive properties that turn over more slowly and justify the cost of a multimedia system.

One new form of storage media that may play an important role in the future is the optical memory card (see Figure 2-5). Such cards resemble a standard credit card, but are covered by an optical recording strip that stores information in digital format. For example, the prototype Drexler LaserCard stores 2.5 megabytes of data. Such cards are essentially rectangular CD-ROMs and hence capable of storing any form of multimedia programs or data that we currently use CD-ROMs for. It is easy to envision optical memory cards replacing magnetic media (i.e., floppy disks), once this technology becomes more mature.

NETWORKS

Sharing information across different locations is one thing that computers can do well. Public access systems that involve access to an online database (such as ATMs, library catalogs, message systems) depend on networking capabilities. Any POS system that accepts credit cards for payment will need to have a telecommunications link in order to verify the card and process the transaction. On the other hand, systems such as information kiosks or games may be completely self-contained and not involve any networking. As time goes on, most public access systems are likely to involve networks due to economic, updating, and data recording factors.



Figure 2-5. Three forms of optical storage media (videodisc, CD-ROM, and LaserCard).

Telecommunications

Networks that involve sharing of information over large distances (often called wide-area networks) use telecommunications channels (e.g., public telephone lines, private leased data lines) for data transmission. Devices called *modems* (modulator-demodulators) are used to convert data from digital to analog format so it can be transmitted over the same telephone lines used for voice communication. Use of switched digital channels (i.e., ISDN) involving fiber optic cables or satellites does not require the use of modems; however, a device called a *codec* (compressor-decompressor) may be needed if a lot of data are to be transmitted (such as video).

Local Networks

Local networks involve the sharing of information within a building or around a campus and do require the use of telecommunications. All machines in the network are connected to a cable (either fiber optics or coaxial) that allows them to share data. Usually one machine on the network is designated as the "file server" and is dedicated to network management functions and data storage. Information that is available to all network users is typically stored on the file server machine, although in some systems it is possible to access information stored on one machine from any other machine. When information is accessed on a network, you may only be able to read or write to a file stored on another machine, or you may be able to copy or transfer the original file to your machine. Transfering a file (either the original or a

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copy) from one machine to another is usually called downloading or uploading.[5]

Network Interconnection

Both wide-area and local networks have many applications in public access systems. As already mentioned, banking, reservation, message, and cataloging systems depend on remote access to a single database in order to work. In these systems, the ATM unit or terminal is always connected to the main computer by a telecommunications link (usually a private data line) so that transactions can be processed immediately. Local networks are used for information or message kiosks within a museum, convention center, office building, or shopping mall. Wide-area and local networks can also be interconnected, allowing a series of local networks to share information with a large national network via a telecommunications link. In this situation, one of the workstations (the server) in the local network is usually dedicated to linking with wide-area networks and sharing information with the other units in the local network. Figure 2-6 illustrates a typical wideband local network interconnection in a bank branch setting.

[5]*While the distinction is not always followed, uploading denotes loading a file from another computer whereas downloading refers to sending a file to another computer.*

Information Updating

One important reason to use a network is to allow information to be updated easily. If changes are made to information stored in a central database, they are immediately available throughout the system. Thus, if a system displays product information and the price changes or the product goes out of stock, this can be seen the next time the information is accessed. However, if the information was stored at the terminal (either in magnetic or optical form), it would not be changed until that unit is updated-which might not be for weeks. A compromise situation involves downloading new data from a network on a daily basis. This can be done automatically by the system when the units are not in use (e.g., late at night). At the present time, this will only work if magnetic storage is used, although eventually it will be possible for optical media as well. Note that programs as well as data could be uploaded via a network, allowing the interface as well as the content to be changed remotely.

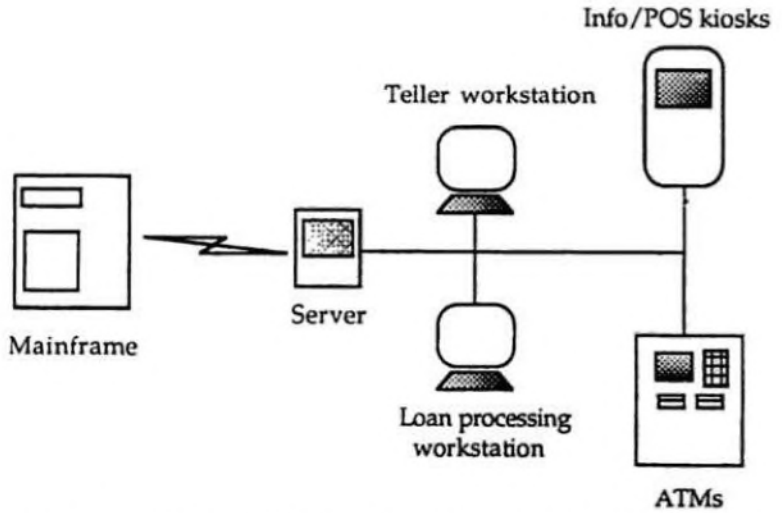


Figure 2-6. Bank network involving telecommunications links between mainframe/central database and local networks at branches.

Data Recording

Data recording is another important aspect of networks. Every time any form of input is made by the user, this can be recorded. Usage statistics can be generated from these data that indicate what aspects of the system are used and how often. In POS systems, this information identifies purchasing decisions; in information kiosks it reflects what people want to know about. However, unless the system is part of a network, the data collected cannot be aggregated easily because it resides on each separate unit. Furthermore, being part of a network allows the functioning of units to be monitored. For example, a unit can signal when there is a malfunction so it can be serviced.

Network Limitations

There are some limitations to the use of networks in terms of the kinds of information that can be shared. Because graphics files are usually large, they can take a long time (i.e., a few seconds) to transmit over a network and produce slow system response to user requests. Transmiting compressed files that are unpacked for display can speed things up but still may result in unacceptable delays. Sending dynamic images such as video or animation over a network requires high-speed channels such as fiber-optic cables or satellite transmission that are relatively expensive. For this reason, the sharing of dynamic images is more practical for a local network than a wide-area network.

In general, public access systems that involve extensive use of graphics or dynamic images use self-contained units rather than networks. It is possible to use graphics or images stored on a videodisc or CD-ROM player with text downloaded from a network. For example, a kiosk system used at the Smithsonian Information Center

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provides pictures and video sequences from videodisc units in each kiosk but displays text messages about current events downloaded daily from a local network.

A great deal has been learned about the use of networks in public access environments from attempts to implement videotex systems (e.g., Alber, 1985; Chorafas, 1984; Gecsei, 1983; Martin, 1982; Noll, 1986). Almost all of these systems failed due to inadequate technology, poor usability, unacceptable reliability, and lack of stable economic support. On the other hand, electronic mail and computer conferencing systems have been relatively successful (e.g., Mason & Kaye, 1989; Quarterman, 1990)-largely because they are restricted to text information and hence avoid the complications associated with transmitting graphics and images.

SOFTWARE

There are a variety of different types of software that may be involved in a public access system. Three primary types are operating systems, application/utility programs, and authoring tools.

Operating Systems

The software that takes care of all system functions (e.g., accessing memory, reading/writing files, accepting input, etc.) is called the operating system. This software is normally loaded into memory (RAM) when the computer is turned on and automatically handles all system functions. Furthermore, the operating system is specific to a particular type or model of computer. For example, the original IBM PC uses DOS (Disk Operating System), whereas the current PS/2 runs OS/2 or Microsoft Windows. The Apple Macintosh has a distinctly different operating system. The only operating system that runs on a number of different types of machines is Unix (developed by AT&T).[6] Not only does Unix run on a variety of workstations, but versions are also available for IBM and Apple computers.

Operating systems are accessed using a command language, menu options, or manipulation of graphic icons. For example, to remove files from a disk that are no longer needed, a command such as "Delete filename(s)" would be typed in. Alternatively, the option "Delete" could be chosen from a menu and the file(s) to be removed could be selected from a directory listing shown on the screen. In a graphically oriented system such as the Macintosh or Windows, the icon representing one or more files could be "dragged" using a mouse and placed over the icon of a trash can.

[6] *Another important characteristic of Unix is that it is a multi-tasking operating system that allows multiple users to share resources (essential in a networked environment).*

There is no operating system specifically designed for public access applications. To the extent that most public access systems involve personal computers, the operating systems that come with these computers are the ones that are usually found in public access systems. In applications such as ATMs, online catalogs, and electronic message systems, large mainframe computers are often involved, and they have their own operating systems and command languages. For a more detailed discussion of operating system software, see Davis (1992), Deitel (1990), or Tanenbaum (1987).

Application/Utility Programs

Although there are no operating systems specifically designed for public access applications, there are programs available for specific types of applications. For example, financial institutions have developed programs for controlling ATM networks, libraries have developed online catalog software, and companies have developed programs for the POS or exhibit systems they sell. These programs are usually designed and marketed for a certain hardware configuration and operating system. Given the high cost of developing and testing software, it is highly desirable to buy such a "packaged" system.

One category of software that is particularly important for public access systems is utility programs. Such programs allow the control of external devices (such as videodisc/CD-ROM players), the conversion of file formats, virus protection, compression/decompression of programs or files, enlarged text or text-speech conversion (see the discussion of design for handicapped users in the Appendix), retrieval of deleted files or damaged disks, and many other specialized functions. Utility programs provide solutions to specific problems or needs and extend the capability provided in applications programs or operating systems.

One of the primary concerns in selecting an application or utility program is its flexibility. Even when a program meets initial needs, requirements almost always change as a system is implemented and used. It is critical that the parameters of a program can be changed as needed without a major disruption to the system or replacement software. For example, suppose a videodisc or CD ROM player in a kiosk is to be replaced by a different model. It should be possible to reconfigure the control program simply by selecting the new player from a menu. Or, imagine that all the storage space on the hard disk is used up - does the system generate a warning and make it easy to delete unwanted data or transfer files to another disk? If a second kiosk is added, can it easily be connected to the existing system or is a whole new program needed? Flexibility in a program is achieved by foreseeing possible changes or problems and providing options to accommodate them. Unfortunately, many programs lack such flexibility.

Authoring Tools

Authoring software is used to develop interactive programs (including those that involve optical media such as videodisc or CD ROM). Authoring systems allow you to create screen displays, input and response sequences, animation, and various types of user controls. There are many authoring systems available for personal computers, each of which has its particular strengths and weaknesses (see Anderson & Veljkov, 1990; Barker, 1989; Crowell, 1988). HyperCard for the Apple Macintosh is probably one of the most widely used (and most imitated) authoring systems. It is very easy to use, but also quite powerful because of its underlying programming language called HyperTalk (see Apple, 1988; Goodman, 1990). In addition to full-fledged authoring systems, most developers also make extensive use of other special-purpose programs

to create graphics, animation, sound sequences, and scanned images.

Whereas authoring tools make it possible to develop very sophisticated interactive programs, they depend on the skill and expertise of the designer. A great deal of knowledge and experience is needed to design effective interactive programs. The next chapter discusses some of the most important concepts in user interface design-the essence of any interactive program.

SUMMARY

The design of a public access system involves a variety of different hardware and software components. Hardware include: microprocessors, displays, input and output mechanisms, storage media, and networks. Software consist of operating systems, application/ utility programs, and authoring tools. Decisions about each of these components determines the capabilities and nature of a public access system. For example, the type of graphics (especially photographics images and animation) possible is a function of the microprocessor and the display used, as well as the graphics creation software. The input and output mechanisms chosen affect the usability and reliability of a system; the operating system often determines what input and output is possible. Storage media can be magnetic or optical (i.e., videodisc or CD-ROM); magnetic media are fast and less expensive, but optical media will be needed if the information is video or animation sequences. Finally, networks will be needed if the information must be kept in a central database or updated frequently.

Selection of particular components is usually a tradeoff between costs and capability. For example, high-resolution screens are to be preferred because they increase the legibility and quality of the display; however, they make the system more expensive. Similarly, use of touch screens will likely make a system easier to use but also raises reliability and maintenance problems. Sophisticated authoring tools can be expensive, but they provide more design options. Networks bring many benefits to a system, but they raise the overall costs. The system designer must pick the capabilities needed within the cost range of the project. We discuss this tradeoff further in Chapter 7.

3

User Interface Design

For many years, computer systems were designed by, and for, technical people. System designers and programers decided how things would work; that was that. However, with the advent of personal computers in the early 1980s, "ordinary" people started to use computers in large numbers, and this led to a major change in the way software was designed. It became necessary to make computers easy to use (i.e., "user-friendly") which meant a great deal of attention was paid to the user interface. Public access systems take this one step further, because they literally open up the use of computers to people on the street.

In the past decade, a considerable amount of research and analysis has focused on user interface design. There have been many books written on the subject (e.g., Dumas, 1988; Heckel, 1984; Laurel, 1990; Nickerson, 1986; Rubinstein & Hersh, 1984; Shneiderman, 1992), and there are a number of scholarly journals devoted to user interface studies. Human-computer interaction has become a major focus of cognitive psychology (e.g., Card, Moran, & Newell, 1983; Carroll, 1987; Norman & Draper, 1986). There is also a special interest group of the Association for Computing Machinery (ACM) on human computer interaction (SIGCHI) that has thousands of members.

In this chapter, we examine user interface design principles as they apply to public access systems. It should be pointed out that although these principles derive from a solid body of research and experience, their application to a particular project depends on the specific circumstances involved. Furthermore, as technology changes, the principles tend to evolve to keep up with new capabilities. While the key focus of user interface design is usability (i.e., making the system easy to use), in the context of public access systems, it is also necessary to take into account aesthetics (i.e., making the system pleasing to use). So principles of user interface design for public access systems must address both usability and aesthetics.

SOME GENERAL PRINCIPLES

The following are some of the most important principles of user interface design.

Provide a Model or Metaphor

When people use a computer system of any kind they build a "mental model" of the system to understand and predict how it works. This is akin to creating a mental map of a building or city in order to get around or the conception we have of an automobile or sailboat in order to operate it. Such mental models allow people to feel more confortable with complex equipment and environments. Of course, the extent to which a model is useful depends on how accurately it describes how a system actually functions.

The system designer can enhance this modeling process by adopting a single metaphor in the design of the system. For example, the dominant metaphor in personal computer systems at present is the "desktop," that is, the idea that interacting with the computer resembles moving things to and from a desk in an office (see Figure 3-1).[1] Information is stored in *files* which can be collected *in file folders*. Files are visually represented by icons that resemble documents and physical objects. Information can be deleted by throwing it away in a trash basket.

Another popular design metaphor is that of a house or building containing rooms and doorways. Information is stored in different rooms and accessed through doors. Figure 3-2 shows a menu screen developed for a product information program that uses a showroom metaphor. A library metaphor can be used in which information is stored on shelves or racks and found by looking in a catalog. The encyclopedia metaphor assumes that information is organized alphabetically; a timeline metaphor indicates that it is accessed chronologically. Some programs use a "rolodex" metaphor that simulates a spiral bound set of tabbed-cards that can be flipped through. Also common is the "control panel" metaphor that presents a row of buttons that resemble those on a VCR or television.

[1] *See Apple (1987) for a detailed specification of a desktop interface.*

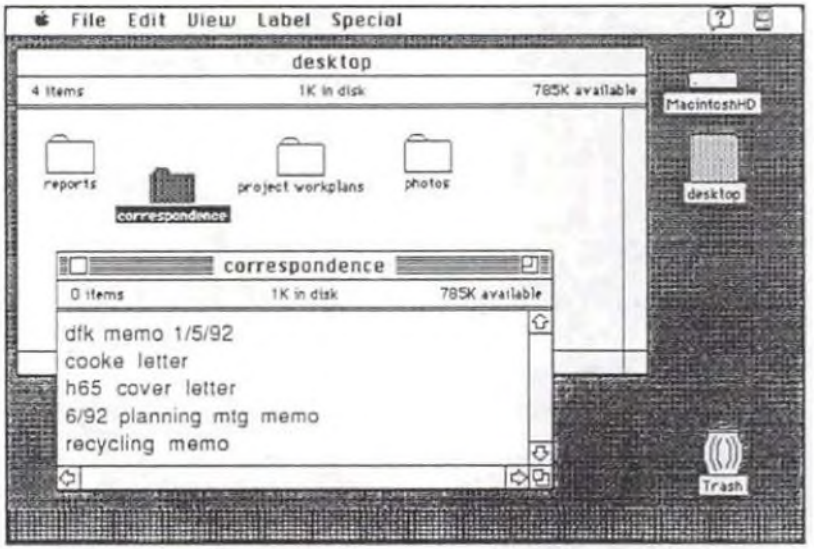


Figure 3–1. The Apple Macintosh interface uses a desktop metaphor.

Metaphors do not convey all of the functions of a system, but they provide enough of a foundation for the user to build a useful mental model. For example, in the desktop metaphor, moving a file from one disk to another typically produces a copy of the file. This doesn't resemble reality (which requires selecting a copy function), but it simplifies the copying operation and is an extension of the metaphor. Similarly, the concept of windows simulates the ability to have different perspectives of a scene, but in real life we can't move and resize the windows.

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Be Consistent

Users want things to work in the same way throughout a program. For example, if options in a menu become highlighted or turn color when selected, they should do this in all menus. Otherwise, people conclude that the menus work differently or that some menus are not working properly (e.g., the ones in which options don't highlight). If pressing the escape key quits the current operation, it should do this throughout the program. If the system "beeps" when an error is made, it should always "beep" when errors are made. And so on. The point is that people expect programs to behave in a consistent manner and become puzzled or annoyed when they don't.

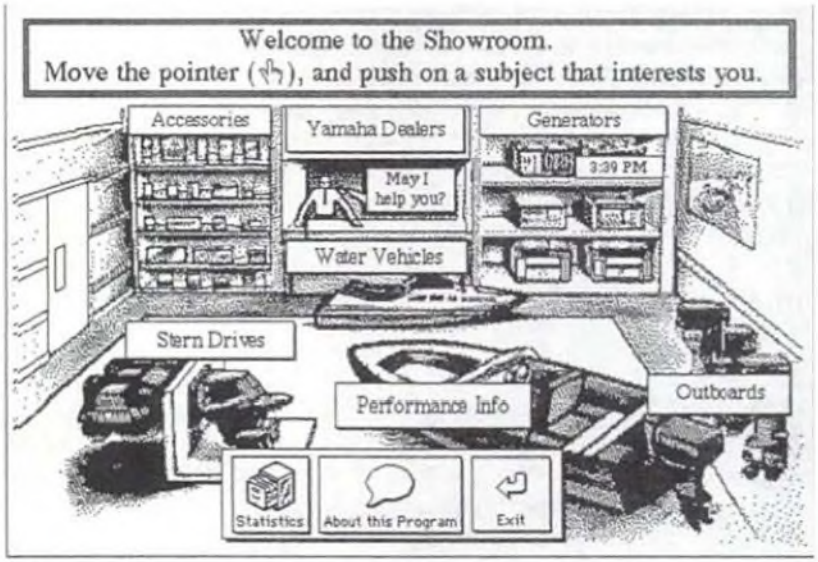


Figure 3-2. Showroom metaphor (developed by North Communications for Yamaha USA).

A corollary of this rule is: If you want something to stand out, make it behave differently from other similar aspects of the program. For example, selecting a menu option which is currently inactive should not produce any highlighting (better yet, the option is greyed out to signify it is inactive). If a certain arrangement of fields or windows are used in a program, you might change this arrangement in one section to indicate that it is different. The size of a screen button might be made bigger or smaller to indicate that it is the default or the recommended action. In other words, don't change something unless you want the user to take notice of it.

What about changing things just to introduce a little variety or "spice of life" into a program? Don't do it. This is the siren song of capricious interface design. Whenever you change the screen layout or organization, the user will stop to figure out why. If there is no reason, you will have disrupted the "flow" of the program and leave the user puzzled. Variety should be introduced by changes in the content not functional elements. Different typestyles, colors, illustrations, or sound effects can be used to create variety without affecting the functionality.

Minimize Navigation

Users shouldn't have to exert a lot of mental effort to move around or progress through a system.[2] Indeed, the goal of good interface design should be to make the transition from one activity to another completely transparent to the user. The usual method of selecting options in today's computer systems is to present a menu of options, typically in the form of a menu bar with pull-down menus. However, this type of user control mechanism is inappropriate for a public access system, because it requires too much knowledge and effort on the part of the user. Instead, control options should be presented in the form of "buttons" (either text or icons) that are explicitly displayed on the screen (see Figure 3-3). Unlike menu options which can number in the hundreds, only a limited number of buttons (2-10) can be displayed on the screen at one time. This serves to simplify the number of choices available to the user and minimize navigation problems.

There are some standard options that should always be available on every screen: cancel/undo, go back, index/contents, and quit. *Cancel* means either stop the current transaction or undo the most recent selection. It is common practice to ask people to confirm any choice that cannot be easily undone (such as erasing information or placing an order). Go *back* allows a user to return to the preceding screen or activity. This requires that the system keep track of what the user does. *Selecting the index or contents* should take the user to a screen that lists or shows all the major components in the program and allows the user to access them directly. *Quit* lets the user end the session and return the system to its opening sequence. By providing these options, the user always has control of the program-a critical human interface consideration (see below).

[2] *This is even true for applications where the purpose is to have an adventure (such as a game or entertainment setting.). The substance of the program, not the interface, should provide the puzzle.*

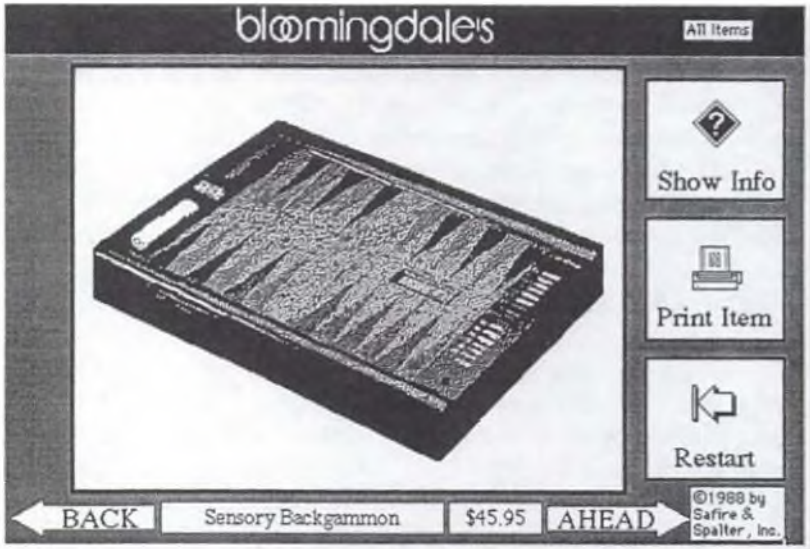


Figure 3-3. Screen with five buttons: show info, print item, restart, back, and ahead (developed by Safire & Spalter, Inc).

One of the fundamental ideas in minimizing navigation is to bring the options to the user, instead of requiring the user to go searching for them (Tognazzini, 1990). All options should be plainly displayed and not hidden from the user (although they might be greyed out if inactive). Control should be clearly recognized as such (e.g., giving all buttons a beveled edge so they literally stand out). Ideally the user is confronted with a single interface that stays the same across all activities. Windows can be opened within this interface to allow different types of displays or transactions, but the main interface should always be recognizable and active. Presenting a different interface with different options in different locations is bound to frustrate and confuse users. The design concept to strive for is that everything happens in one place, something like a town square or "mission central."

While most interfaces rely on spatial layouts of buttons, it is possible to use temporal spacing as well. Wyke-Smith (1991) describes a "one-button" interface developed for a product information kiosk. The main menu consisted of a circle divided into six sectors that would highlight in sequence the instructions "To learn more, click when your choice highlights." When the user clicked the mouse, the program would present information corresponding to the highlighted section. Each section highlighted for just under 2 seconds, allowing a full cycle of options every 10 seconds. Not only did this temporal menu provide for a single-button response, but it also provided an eye-catching title screen to attract users to the kiosk.

Users Should Always Have Control

One of the most critical (and most frequently violated) rules of designing any interactive system is that the user should always be in control, not vice versa. This means that the user should choose what is presented, how its presented, and when its presented. An interactive system is not television, that is, a medium intended for passive viewing. There is a great temptation to design lively animated sequences that involve no user interaction. While such sequences are often needed to attract attention to the system, they should be rare in a program (and always under user control). For example, if a motion or animated sequence demonstrates a product or procedure, it should only be presented if selected by the user. Furthermore, the user should be able to stop the sequence at any point and make another selection. Ideally, the user should be able to specify variables that affect the nature of the sequence shown.

The dilemma that designers often face when considering this principle is whether it is ok to let a user "flounder around" instead of following an optimal path. For example, in the design of a POS or information system, it might be obvious to the system designers that a certain presentation sequence makes the most sense, and allowing users to select their own sequences may often result in confusion. However, designers must accept the fact that people need to explore a system in their own fashion, even if it results in suboptimal choices. User acceptance of a system is usually more important than efficient use in most public access systems.

It is essential that users control the pace of the interaction. This means they should decide when to view another screen or how long it should take for a transaction to be completed. People read at different speeds or may need to interrupt the transaction for a few seconds. A screen that displays for a fixed time interval is likely to be too brief for some users and too long for others. Similarly, an input field that only allows a brief time period for the user to make a response is going to cause problems. Allowing the user to indicate when they are ready to go on by pressing a key or touching the screen is a much better technique than a fixed time interval. Of course, most public access systems need to have a time-out capability in the event the user abandons the system. However, this time-out period should be set well beyond the duration of reading a single screen or completing one transaction (e.g., 4-5 minutes).

User Response Should Always Be Acknowledged

It is important to think about human-computer interaction as a conversation or dialog between person and system. The same rules of etiquette apply to both. One such rule is acknowledging what another person has said or done. To be good conversational partners, computer systems must always acknowledge a response or action taken by a user-even if it is just by touching the screen or pressing the next button. This can be accomplished by highlighting the button or making some sort of noise (such as a beep or tone). In most cases a user response will result in new information or a new screen displayed.

The consequences of not doing this are frustration and annoyance on the part of the user. If a person makes some kind of response and the system does nothing perceptable, the person is not sure that the response was received and will likely repeat it (or assume the system is broken and walk away). Furthermore, the acknowledgment of response must be immediate. If the processing of a response could take more than a few seconds, some sort of acknowledgment should be

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provided initially (such as a feedback message or the screen changes). Some systems display an "in-progress" icon such as a clock or spinning circle to indicate that the system is processing a response.

GUIDELINES FOR DISPLAYS

As we mentioned in the previous chapter, the design of displays is a critical aspect of a public access system, because this is the component that people see and interact with. So even though there is much to consider in the development of a public access system, screen design tends to get an inordinate amount of attention, because it is the tip of the iceberg that is above water. The following are some guidelines for the design of screen displays (see Artwick, 1985, and Galitz, 1985, for further discussion).

Don't Clutter the Screen

Probably the most important rule about screen design is to avoid crowding the display with too much information, such as too much text or graphics, or too many options. This rule has both a psychological and aesthetic basis. A very well-known principle of memory is that people can only process a limited amount of information at one time-in the order of 5-9 "chunks" (Miller, 1956). Studies have shown that user performance degrades as the density of a screen display increases (Tullis, 1983). So if the display presents more than this number of concepts or ideas in any form, the person is likely to suffer information overload. From an aesthetic perspective, empty space contributes to balance and helps to accentuate what is presented. In the same way that a printed page looks better if there are wide margins and plenty of "white space," a screen display is improved by a limiting the amount of information.

There are a number of ways to minimize screen clutter. The overall objective is to minimize the information presented in each display. This can be done by using wide margins, doublespaced text, columns, and smaller type fonts (provided they are legible). Windows can also be used to hide or reduce the size of information. For example, a lot of text can be presented in a window that scrolls or pages so that only a small amount is presented at one time. Similarly, a window can be used to scale down the size of a graphic or image so that it takes up less space on the screen but is still recognizable.[3]

Make Sure Displays Are Legible

Legibility means that information displayed on the screen (text, graphics, images) is easy to read in the usual viewing conditions. Although this rule sounds trivial, the displays of many public access systems are difficult to read at a distance of 2-3 feet with poor lighting or glare, a fairly typical viewing condition.[4] This is caused by type sizes or graphics that are too small, too ornate, or poorly organized on the screen. Poor use of color can also be a problem contributing to legibility problems (see below). Putting all text in captial letters can also degrade legibility, because it is harder to read than upper and lower case.

3 of course, opening too many windows at the same time can clutter up the screen. However, if the user can control the opening/closing of windows and their location on the screen, this is not a problem.

Poor legibility may result in slower or incorrect perception of information presented. It may also mean that people lose interest quickly in viewing the display and hence using the system. Legibility is something that has to be considered in general for the particular hardware and software being used as well as on a screen-by-screen basis. In addition, the age and reading ability of the anticipated user population needs to be considered-older, less literate, and visually handicapped individuals will need larger text or graphics.

Obviously, the characteristics of the display monitor such as size, brightness, contrast, and resolution play a major role in legibility. For example, the higher the screen resolution, the smaller the text font that can be used. However, well-designed screens should be legible on a broad range of monitors. It is better to achieve legibility through good screen design than to count on the quality of a particular monitor which makes the system very hardware dependent.

Use Color and Attentional Features Carefully

There are a number of ways to capture attention in screen design including the use of color and attentional features such as blinking, highlighting, or animation. Many of the design guidelines for the use of color and attentional features in print and video media apply to screen displays, although there are some additional considerations. A great deal of research has been conducted on the use of color in computer displays (e.g., Durrett, 1981; Travis, 1991) as well as guidelines from graphics designers (e.g., Norman, 1990; White, 1990).

[4]Clearly, this has implications for the design of the delivery station and where it is situated-factors that are discussed in Chapter 5.

Color can be used to draw attention to a display, to highlight information, or to convey realism in graphics and images. The size of objects and depth can be affected by the choice of colors. For example, warm colors (e.g., red) appear larger than cool colors (e.g., blue). Colors in the center of the spectrum (yellow, green, white) are more easily perceived than those at the extremes (red, blue). In general, blue is not a good color to use for text, lines, or small objects, although it is good for backgrounds. It is also important to avoid using too many colors simultaneously, especially if they are highly saturated, because this makes it hard for the eye to focus. For example, color pairs such as red/blue or yellow/purple are hard to look at, whereas color pairs such as red/green or yellow/blue are aesthetically pleasing to most people.

For people with visual limitations (e.g., color blindness), the extensive use of color to highlight or cue information creates problems. Therefore, it is highly recommended that color always be a redundant characteristic, and labels or other attentional features be used in conjunction with color. For example, if color is used in a graph or chart to signify different variables, the variables should also be

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identified by different types of lines or shapes. In other words, color should be used to capture attention, but it should not be relied on exclusively.

The key idea in the use of attentional features is to use them sparingly, or else they cease to capture attention. For example, blinking annoys people if it is continuous and distracts them from seeing other information on the screen. Highlighting loses its effectiveness if more than a small proportion (about 10%) of the screen is highlighted. In general, attentional features should be used to draw attention to something on the screen (such as the selected response) and then be turned off.

Use Headings and Numbering

Although computer screens are a completely different way of presenting information than print media, there are some aspects of document design that still apply. One is the use of headings and titles. Titles and headings make it easier for users to interpret the information they are viewing. They are also helpful in determining location in a system. Providing a heading in a screen gives it an identity that distinguishes it from other screens. Similarly, numbering of screens or pages in a window helps people have a sense of how much information is available and where they are.

Both of these techniques play an important role in helping the user organize the information presented. One of the biggest challenges in designing screen displays is arranging the information in each screen so that it is self-contained and does not depend on the user remembering something from a previous screen. Windows can be used to allow people to see several screens of information simultaneously. However, in most systems, it is necessary for the user to work with a number of different screens. Headings and numbering help people discriminate one screen from another as well as build up a conceptual map of the database.

GUIDELINES FOR RESPONSE PROCESSING

If screen displays represent the tip of the iceberg, then response processing represents the rest of it. Response processing refers to the actions that a program takes depending on what the user does, that is, the "interactivity" of a computer system. The following are some principles that pertain to the design of response processing features.

State Instructions Clearly

A lot of user frustration and problems can be eliminated by careful wording of instructions and directions. It is common to find that the usability of a program can be improved significantly by rewriting all directions using simpler wording. Instructions should be worded so that the expected action is clear-cut. In some cases, an example may be needed to illustrate the instructions. For example, consider the classic request: "Enter today's date." This is a highly ambiquous instruction given there are so many ways to express dates. However, the instruction: "Enter today's date (mm/dd/yy):" indicates the desired format (although it still leaves some questions).

Confusion over the nature of the response required can be minimized by presenting input fields that identify the exact format desired. For example, "Enter today's date (mm/dd/yy): _ _ / _ _ / _ _ provides an input field that only allows the user to enter data in the correct format and checks that the entries are numerical and in the correct range.

Many problems with instructions are caused by making incorrect assumptions about what users know (see Norman, 1983). For example, programs that use functions keys provide directions such as "Press Fl to get Help." However, novice computer users not familar with the function keys often pressed the F key followed by, or simultaneously with, the 1 key. Another common mistake is to tell users to press the Enter or Return key when this is not labeled as such on the keyboard/keypad. Many of these kinds of problems can be eliminated by using direct manipulation interfaces (e.g., touch input) that do not involve the use of the keyboard or a keypad. However, all programs provide some sort of directions to the user, so there is always the potential for ambiguity and misunderstanding. In a public access system, it is not possible to make any assumptions about the computer literacy of the user. For example, refering to the menu explicitly (i.e., "Select this option to return to the main menu") assumes that users know what a menu is; calling it the list of topics or contents is better.

Provide Default Options

To make it easier and faster for users to respond, every option should have a default action. If the user does not make a new choice, the default action will be taken. In most cases, the default action will be "Next" or "Continue." When a specific response is required, the default action can be the most common or recommended selection. For example, if the user is being asked if they want to save their current settings or selections, the default should be *"yes,"* because in most cases this is the appropriate action. If the system is a bank ATM and the person is given a choice of withdrawal amounts, the lowest amount would be the default. In this case, the default is likely to be the first option in a list of choices. However, once a person has made a choice among a set of options, this choice should become the default until the user changes it.

Another way to implement defaults is special "short-cut" options or keys. For example, many bank ATMs have an "express" withdrawal option that processes a transaction for a prespecified amount of money (e.g. $40), skipping some of the usual steps such as specifying the mix of bills or which account to use. Similarly, online catalog or electronic message systems may provide very simple search or sending options that streamline those activities but do not allow full functionality. This technique is a way to accommodate variations in user experience or requirements.

Default options should always be indicated by highlighting, color, or shape of the button, and this should be consistent throughout the program. In cases in which the choices are arbitrary, make the first option the default as a convention. The major advantage of defaults is that they allow people to get through a program without having to understand what all the options mean. This minimizes the amount of effort or ability required to use it which can be especially important with certain audiences

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(e.g., the very young/old, non English-speaking visitors). Of course, there are places in which defaults do not make any sense (e.g., an order screen in a POS system or the field to be searched in an online catalog).

Provide Redundant Response Options

One of the difficulties in designing things for people is that all have different preferences. The way to handle this variability with respect to user input is to provide multiple ways of responding. For every major input, there should be two ways of specifying the same response. For example, when a person wants to see the next screen, they can touch the "Next" button on the screen or press any key on the keyboard/keypad. To quit a program, the person selects the "Quit" option on the screen or they press the Q key.

Providing redundant response options allows one to accommodate both novice and experienced users of a system. For example, most novice users prefer to select options from a menu or press buttons. However, experienced users may prefer to make a series of key presses without ever seeing the list of choices.[5] Redundant response options also provide a backup capability in case one of the input mechanisms fail. For example, a program that is designed to be used with touch input or keypad responses could still be used if either the touch screen or keypad failed. Considering the harsh environments that public access systems are often operated in, having response redundancy would seem like a good idea.

[5]*One response mode may work for both provided that the experienced user can select the options quickly without waiting for screens to change.*

Redundant response options are also important for meeting the needs of handicapped users (see Appendix).

Allow People to Change or Confirm Their Responses

One thing to keep in mind when designing response processing sequences is that people frequently make mistakes or change their mind about responses they have made. For this reason, users should be able to change or confirm their responses before they are processed. This is especially important when the response involves an action which has important consequences such as placing an order or canceling a reservation.

There are two levels to this guideline: single options and a set of options. Responses should always require a separate keypress to confirm or cancel a choice. Input fields that involve typing should allow the user to erase and correct something before the response is processed. Alternatively, after a sequence of responses is made (e.g., entering an address or order), the user should be asked if all the information is correct. Input that is processed as soon as the user types it or makes a choice does not provide an opportunity for the user to change his or her mind.

Provide Helpful Feedback

In general, the most appropriate kind of feedback in a public access system is the presentation of the next choice or information desired. However, if the user makes an error, or the system fails, the feedback provided to the user should be helpful and not obscure. For example, if the user selects an inappropriate response or types something incorrect, the system should explain the problem and how to correct it (e.g., "Your response cannot be processed; please try again") rather than deliver an error message (e.g., IE0095 - Out of Range error). Ideally, response processing is designed so that input errors cannot be made, because inappropriate options are deactivated or screened out. On the other hand, people will always come up with ways to respond that were totally unexpected. A well-designed system will catch these unanticipated responses and recover gracefully. Even in the worst circumstances, the system should be able to reset itself and ask the user to start over.

Provide a Help Option

If the preceding design guidelines are followed, a system should be easy to use. A small measure of insurance against usability problems can be achieved by providing a help option. When users select this option, a brief explanation of the current options or screen is given (see Figure 3-4). In many cases, the help is used to remind users of the overall options available. Helps are usually presented in pop-up windows that overlay the current screen and disappear as soon as the person makes a response (e.g., touches the screen or presses a key). Above all, help information must be easy to access, always available, and not confusing.

Help functions can be multileveled and sophisticated (see Kearsley, 1988, for a survey). However, in the case of most public access systems, elaborate helps seem inappropriate, because transactions should not be so complex that they require explanations. As a rule of thumb, any sequence that requires a lot of help information should be redesigned so that it does not. The primary role of help functions in a public access system should be to remind people about things that have already been explained and provide additional information about options or system features.[6]

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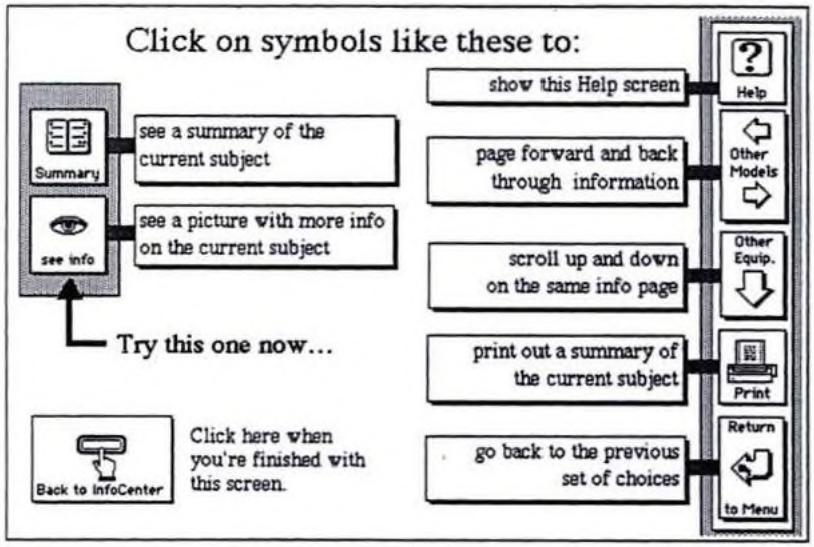


Figure 3–4. A help screen (developed by North Communications for Yamaha USA).

AESTHETICS

While user interface design usually concerns only issues having to do with the usability of a computer system, in the domain of public access systems it also needs to include aesthetics, because the attractiveness and appearance of a system is likely to determine whether it is used or not. Some of the principles already discussed have aesthetic impact, such as consistency, not cluttering the screen, legibility, and the use of color. There are additional factors, however, having to do with screen design and response processing.

Use Borders, Backgrounds, and Shadow Effects

A variety of techniques can be used to make screens more attractive. This includes the use of borders, backgrounds, and shadow effects. Borders give screens a more distinctive appearance and focus the eyes on the contents of the screen. Backgrounds (e.g., colors, textures, patterns) provide contrast and make the text or graphics stand out. Shadow effects produce a three-dimensional look (e.g., beveled buttons), providing more realism and richness to the screen.

The choice of what borders, backgrounds, and shadow effects to use depends on the mood and message that the program is intended to convey. For example, the screens of an ATM or conference message system may need to reflect the image of reliability or efficiency. On the other hand, an information kiosk designed for tourists or a POS kiosk intended for a shopping mall might try to create an atmosphere of excitement or fun.

Producing the desired message using these graphic elements is a subtle art that relies on the skills and experience of a graphics designer. To be effective, these techniques must work in conjunction with all the other elements of the interface and delivery station design. Furthermore, the more adventuresome or audacious the design, the fewer people it is likely to please; however, if it is too modest or mild, it fails to make an impression on anybody. Graphics designers must strike a balance between these two ends of the spectrum. For further discussion of graphics design for computer displays, see Marcus (1991), Vince (1985), or White (1988).

[6]*The kind of information that could be provided by online helps also might be available in printed form on the kiosk.*

Ensure Program Continuity

One of the hardest concepts to describe analytically is program "flow" or "visual momentum" (Woods, 1984). A well-designed program has a sense of continuity from one screen to the next and from one section to another. To a certain extent, this continuity is achieved by consistency of screen design, functions, and content. Hoekema (1991) points out that it is important to have the same depth of content throughout a program so users can properly judge the boundaries of the database. If one part of a program looks or works much differently than other parts, it makes the system seem clunky or disjointed.

Special effects (such as dissolves and wipes) can be used to make transitions from one screen to another smoother or more interesting. In a traditional cut, one screen replaces another all at once and as quickly as possible. In a dissolve, the existing screen appears to fade into the new one. With a wipe, the existing screen moves away in a given direction replaced by the new one. Other possibilities include a checkerboard, vortex, or barn door effect. Like any other attentional technique, special effects must be used sparingly.

SUMMARY

Clearly there are many principles to take into account in the design of a user interface for a public access system. Table 3-1 lists the principles discussed in this chapter.

Some general principles that apply across all aspects of user interface design include: provide a model or metaphor, be consistent, minimize navigation, give users control, and always acknowledge user response. The primary intent of these rules is to make a system easier to understand. If a system tends to confuse or frustrate people, it will not be used.

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Table 3-1
User Interface Design Principles for Public Access Systems

General
Provide a model or metaphor.
Be consistent.
Minimize navigation.
Users should always have control.
User responses should always be acknowledged.
Screen Displays
Don't clutter the screen.
Make sure displays are legible.
Use color and attentional features carefully.
Use headings and numbering.
Response Processing
State instructions clearly.
Provide default options.
Provide redundant response modes.
Allow people to change or confirm their responses.
Provide helpful feedback.
Provide a help option.
Aesthetics
Use borders, backgrounds, and shadow effects.
Ensure program continuity.

Screen displays represent the component of the system that people see and interact with. Principles for screen design include: don't clutter the screen, ensure that screens are legible, use color and attentional features carefully, and use headings and numbering. The way information is presented on the screen determines the overall effectiveness of the system.

Response processing refers to all actions taken by a system in response to user input. Design principles for response processing include: state instructions clearly, provide default options, provide redundant response modes, allow people to change or confirm their responses, provide helpful feedback, and provide help options. The way a system responds to user input also determines its overall effectiveness.

Finally, a system must be aesthetically pleasing to attract users. Aesthetic design principles include: use borders, backgrounds, and special effects; and ensure program continuity. Aesthetics are much more important in the design of public access systems than other types of computer applications because use is discretionary.

Although these principles of user interface design have been discussed separately, there is considerable overlap and interdependence. For example, the rule of consistency affects all levels of design decisions from color choices to the type of help options offered. Every decision about response processing has screen design implications and vice versa. Furthermore, many decisions about user interface design are affected by the nature of the database and delivery station discussed in the next two chapters.

Ironically, the ultimate measure of success for a user interface is that it is not noticed at all by the user. Lazzaro (1991) explains this point well:

> Interfaces are a language and should not be a separate entity, a sheet between the user and the task. Instead, the screen should display an organized, predictable environment with logically shaped and placed controls. In this way the interface is like the handle of a hammer, it disappears when you are intent on the job at hand. In pounding a nail, we aren't conscious that the handle is an interface to the hammer which is in turn pounding the nail. (p. 9)

Trying to achieve such transparency is the overall goal that all user interface designers strive for. It should be the net effect that results if all of the principles discussed in this chapter are taken into consideration.

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4

Database Design

The preceding chapter discussed the design of the user interface, ignoring the structure and organization of the information contained in the system. In this chapter, we examine basic concepts and guidelines of database design as it applies to public access systems.

While the design of databases for some types of public access systems (e.g., ATMs, online library catalogs, message systems) follows traditional data processing lines, many types of systems involve multimedia information.[1] The creation, storage, retrieval and updating of graphics, sound, and video sequences presents new challenges for the field of database design which has historically been concerned with character data. Furthermore, there are new methods of accessing and organizing information such as hypertext/ hypermedia and expert systems that are likely to play a major role in future public access systems.

Although it is not discussed extensively in this chapter, there is a strong connection between database characteristics and certain technologies discussed in Chapter 1 (i.e., storage media, displays). The capacity, speed, and type of data that can be handled all affect the design of the database.

[1]In fact, it is not even clear that the term "database" is appropriate for many types of public access systems- information structures or knowledge bases may be more accurate. However, we stick to the use of "databases" since it is the most common term.

CHARACTER DATA

The storage and retrieval of character data (text, numbers) is the focus of traditional database design (e.g., Date, 1990; Ullman, 1988; Wiederhold, 1983). Data are stored and accessed in "fields" which make up "records." For example, an ATM database consists of customer records; each record would consist of fields containing the customer's name, account number, password, address, phone number, balance, type of account, and so on. Similarly, the database for an online library catalog consists of bibliographic records, with each record having fields for call number, author, title, publisher, publication date, keywords, location, current status, and so on (see Figure 4-1). In the case of ticketing systems, the records consist of flights or trips, and the fields are dates, departure times, destinations, seating categories, prices, and customer names.

In many cases, a database contains multiple types of records that are linked together. For example, in the last example of ticketing systems, there are likely to be separate records for bookings and customers. Customer records would contain details such as address, phone number, frequent flyer-information which does not change across trips. The customer name field in the booking record would simply refer to the customer record thus saving space and eliminating redundancy. When the system involves millions of transactions on a daily basis, minimizing the size of the records is critical in terms of producing fast response times and saving storage space.

Indexing and Compression

Two other factors are important for fast response times and saving space: indexing and compression. Most large-scale databases use some sort of indexing technique that eliminates the need for the system to check every record in sequence. For example, records can be organized into blocks according to numerical or alphabetical order. When a user types in the first digit/letter of their request, the system immediately goes to the data block with the corresponding digit/letter. This same method can be repeated for each successive character allowing very quick access, even when there are millions of records. Compression refers to packing character data more densely by removing blank spaces or using codes for information which is replaced when retrieved.

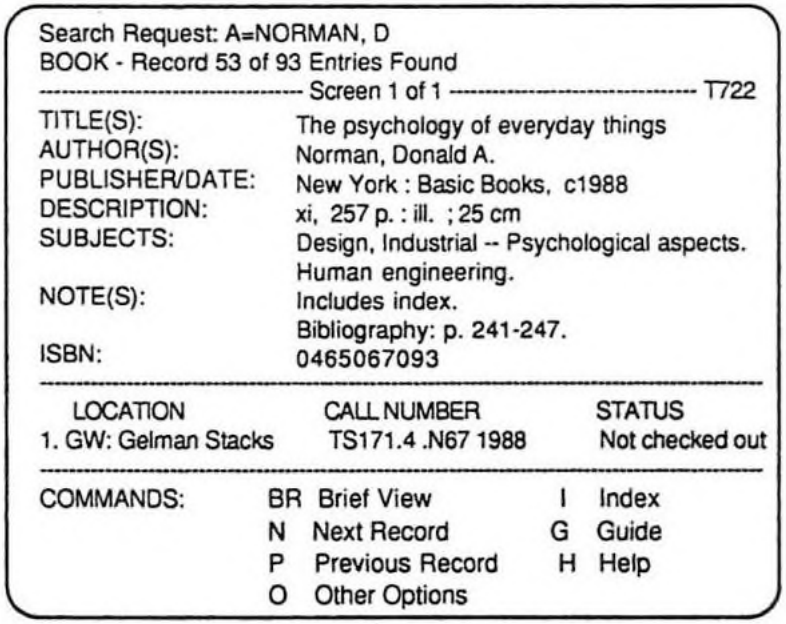


Figure 4-1. Screen from online library catalog illustrating a standard bibliographic record and fields.

GRAPHICS AND IMAGES

The storage and retrieval of graphics and images is critical to many types of public access systems such as information kiosks, POS units, museum exhibits, and entertainment. In fact, in some systems, all screen displays are created and stored as graphics-even those that contain only text information. This is especially true when multiple languages are involved, because the text in many languages is script-like

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(e.g., Kanji, Arabic, Sanskrit) and requires graphic representation.

Graphics and image databases differ in a number of ways from those that store only character data. For one thing, there are many different file formats for graphic and image data that complicate database design. For another, the display of graphics and images is highly dependent on the capabilities of the system-there are many different display standards. For example, on an IBM PC alone, the graphics standard could be CGA, EGA, VGA, or XGA depending on the model. Each standard supports different resolutions and number of colors.[2]

Bit-mapped and Object-oriented Graphics

Most graphics and all images are bit-mapped (i.e., each pixel corresponds to one or more bits) and take a full screen or window. This means that all of the information in the graphic or image is stored and retrieved as a single file. If any changes are made, the entire file must be modified. On the other hand, graphics can also be object oriented which means that they are created and stored as a set of discrete components. This allows individual components to be modified without affecting the rest of the graphic. It also allows different graphic elements to be superimposed which is not possible with bit-mapped graphics. Bit-mapped graphics generally make sense for illustrations and pictures, whereas object-oriented graphics are more suited to drawings, control screens, text, and animation. Bit-mapped graphics are created using "paint" type graphics editors, while object-oriented graphics are created with "draw" type graphics editors or Computer-Aided Design systems (see Figure 4-2). There are also editing programs especially designed for creating three-dimensional graphics.

Formats

Graphic and image file formats are specific to the particular computer system and graphics program used to create and display them. For example, the most common format for graphic files on the Apple Macintosh is PICT or TIFF; on the IBM PC, common formats are PCX, IMG, and TIF. Both of these machines as well a number of others support an object-oriented format called EPS (Encapsulated PostScript) which is actually a typesetting language. Translation programs exist that convert graphics in one file format to another, although the translations are not always trouble-free. See Peddie (1992) for a discussion of the various graphics formats available for personal computers and workstations.

[2] *The current product line, PS/1 and PS/2, all support the VGA standard.*

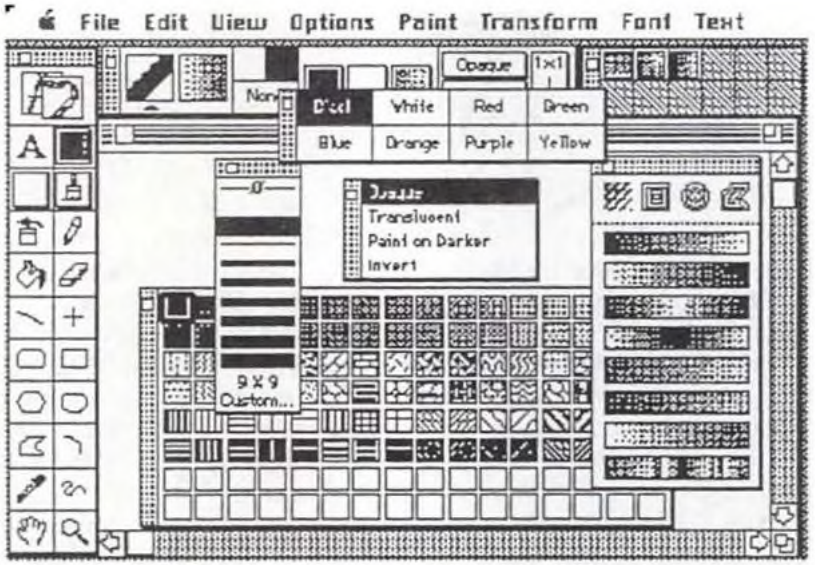


Figure 4-2. An example of a sophisticated graphics editor (Aldus SuperPaint). It offers many options including various drawing tools, line/brush widths, color/pattern/ gradient/texture palettes, and transformation commands.

Compression

As discussed in Chapter 2, compression is a standard aspect of storing and retrieving graphic files because of their large size. Many different algorithms are used for compression-the most widely accepted is the International Standards Organization JPEG (Joint Photographic Experts Group) standard that was principally designed for photographic images. Compression is achieved by averaging the color and intensity of individual pixels or removing data that are redundant or imperceptable to the human eye. Compression ratios range from 5:1 to 100:1 depending on the content and size of the image.

Additional discussion of interactive graphics can be found in Foley et al. (1990), Hill (1990), or Newman and Sproull (1985).

ANIMATION

Animation is produced by displaying a sequence of graphics with short intervals between each display.[3] The differences in successive graphics are perceived as movement. Animation can range from very simple techniques such as two graphics that alternate (e.g. a waving hand) or color changes in the same graphic (e.g., flames) to highly complex techniques that involve three-dimensional modeling or graphic/video overlays. The smoothness of the animation depends on the shortness of the interval-graphics displayed at a rate of 15/second or faster tend to look fluid (full motion video runs at 30 frames/second). The frames used in animation are usually created using a graphics editor and then sequenced using an animation program.

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Uses

Animation is primarily used in public access systems to attract attention. It is common for the initial screen or attract sequence of a program to feature animation in order to capture the interest of a passerby. Animation can also be used to illustrate a dynamic procedure. For example, some ATMs display an animated sequence showing a hand inserting a bank card into the card slot to prompt the customer to perform this action. Animation is used extensively in arcade games and entertainment systems to depict events and characters. Because most people associate animation with cartoons, there is always an issue of realism when it is used in nonentertainment applications.

Requirements

One of the primary issues in the use of animation is the amount of storage capacity and processing power needed. Like video, the storage of many graphics or images for animation sequences quickly fills up disk space. Again, compression of the graphics becomes important. If only the changes between each successive graphic are stored and presented, an animation will take much less storage and computing power. New techniques for motion graphics such the Intel DVI system and the ISO MPEG (Motion Picture Experts Group) standard utilize this concept.

[3]*Animation can also be created by line generation or space-filling according to mathematical specifications, but this is less common in today's systems.*

Animation represents the bridge between still graphics and video. In many instances, it will produce the desired effect without the costs associated with video. Furthermore, animation can be used to represent images that don't exist or would be difficult to film. For example, Figure 4-3 shows a screen from a program that uses an animated "agent" to explain the contents of the current display using synthesized speech. While video could have been used instead of animation and speech synthesis, this approach eliminates the need for video display capability and storage of motion video as well as providing more flexibility in making changes.

For more information about animation, see Lansdown and Earnshaw (1989), Magnenet-Thalman and Thalman (1990), or Weinstock (1986).

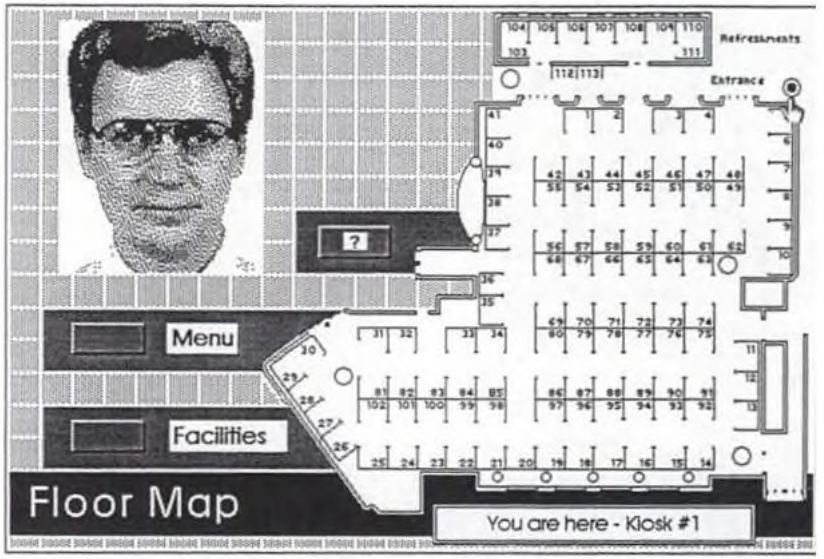


Figure 4-3. Animated "agent" from information kiosk for Washington Computer Faire developed by Bright Star Technology.

VIDEO SEQUENCES

Many public access systems store and display video sequences (or still frames) using videodiscs. Even though videodiscs allow each frame to be addressed individually, the information is still stored and played back in analog (NTSC) format. This means that a television monitor rather than a computer monitor is needed to display the video, unless an adapter is provided that can tranform the analog signals into digital format. With an adapter, the same computer monitor can display digital information (e.g., text, graphics) and analog frames (e.g., images, video) simultaneously.

Newer technologies based on CD-ROM, such as DVI and CD/I, store video sequences in digital format so they can be directly displayed on a computer monitor. However, it is necessary to compress video sequences significantly in order to store more than a few seconds on a CD-ROM disc. For example, at full compression, DVI can store about 2 hours of motion video on a 5-inch CD-ROM disc.

A full-sized 12-inch videodisc can store up to 54,000 frames which is about 30 minutes of motion video. All information to be stored on a videodisc (including stills and audio) is edited onto a single videotape and then sent to a videodisc mastering facility. The order of information on the videodisc matches the order of the orginal tape. However, because each frame has its own number, the information on the videodisc can be accessed in any sequence (or speed) desired. This makes it possible to play very small segments of video sequences or reassemble them into different order.

For more information about the capabilities of different interactive video technologies, see Bunzel and Morris (1992), Lambert and Sallis (1986), Luther (1989), Sherman (1988), or Schwier (1988).

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SOUND

Like video, sound information (music, voice, effects) can be stored in either analog (videodisc) or digital (magnetic disk or CD-ROM) form. In analog format, the sound is stored and played back exactly as recorded. However, digital sound can be sampled during recording so that more or less data are stored per second. The sampling rate (measured in Kilohertz) affects the quality of the sound when played back-the higher the sampling rate, the better the quality. It also affects the amount of space required. For example, digitized sound at a sampling rate of 22 Khz requires about 20K bytes per second. So, a minute of digital audio would need approximately 1.2 megabytes of disk space for this quality of sound.

Sounds sequences stored in an analog form on a videodisc cannot be manipulated except by frame address. However, digital sound can be accessed in a very detailed way. For example, it is possible to work with individual phonemes or musical notes. Figure 4-4 shows a screen from the program Sound Edit for the Macintosh that displays the pattern for a brief voice message ("Please stand by, we are experiencing technical difficulties"). The program allows any part of this sequence to be edited at different levels of detail. A digital sound database can consist of short audio sequences that can be combined and mixed in any fashion desired. *The* capability to store and access sound digitally makes it possible to have "earcons," the audio equivalent of icons (Blattner, Sumikawa, & Buxton, 1989).

SEARCHING, INDEXING, AND BROWSING

There are two standard ways that information can be accessed in a database: searching and indexing. In a search, the user enters a text string and any matches are displayed. For example, in a visitor information system, the user types the word "restaurants" expecting to see all restaurants listed. With indexing, the user selects a portion of the database to be displayed. So, instead of typing the word, the user selects an option labeled "restaurants" and gets the list. In general, searching makes sense when there are too many items in a database to display as options (e.g., all authors in a library catalog) or when the user needs to make selections based on multiple factors (e.g., all flights between two cities that depart in a certain time period, and belong to certain airlines). Note that the two search methods can be combined; consider a system in which the user selects search terms and relationships from lists or options that are displayed.

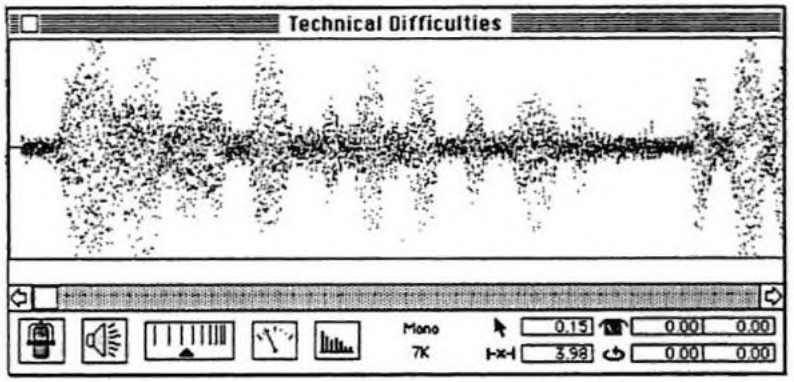


Figure 4–4. Screen from Sound Edit program that allows detailed modification of digital sound sequences

Browsing

A relatively new method of accessing information in a database is browsing. By organizing the database in hypertext or hypermedia form, users can select information in any manner they desire.[4] Each unit of information (i.e., paragraphs, documents, graphics) is considered a node which can be directly linked to any other node. Links are indicated on the screen by highlighted text or graphics. When a link is selected, the connected node is displayed either in a new screen or window (or played if it is an audio link). Figure 4-5 shows a screen with a number of different hypertext links activated as pop-up windows. Each link provides additional explanation for the highlighted term; the windows are closed by clicking on them. In some systems, the pop-up window produced by selecting a link is displayed as long as the mouse button is held down and disappears when it is released.

In graphic displays, hypertext links can produce text windows that describe or explain the selected area or further graphic windows. For example, in maps, equipment schematics, or architectural drawings, selecting a specific component of the drawing results in a more detailed illustration of that component. Figure 4-6 shows the main menu from the "Big Apple" program developed by Applied Imagination. Selecting a particular region of the map produces a "blow up" of that area, and the process can be repeated at the street map level. This capability to "zoom" in and out of a graphical database is one of the unique capabilities that hypertext provides.

[4]*Hypermedia refers to databases that involve multimedia information (graphics, audio, video) rather than just text. For further discussion of hypertext/hypermedia, see Ambron & Hooper (1988), Barrett (1988), Berk & Devlin (1991), Jonassen (1989), Nelson (1981), Nielsen (1990), or Shneiderman & Kearsley (1989).*

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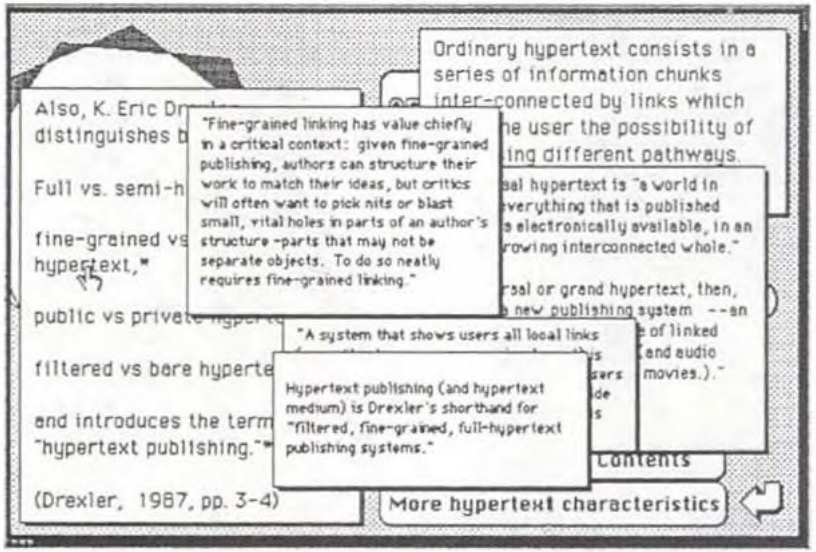


Figure 4-5. Screen showing many hypertext links in the form of pop-up elaboration windows. From *Hypertext for Beginners*, a HyperCard stack by Servando González.

Browsing and hypertext make a database more transparent than traditional access strategies, because the user is able to examine information in much more detail. It also increases the connectedness of information, because many items are linked together. On the other hand, browsing can lead to confusion if the user gets lost in the database or becomes overwhelmed by too much information. Furthermore, browsing is often not a good access strategy if the user is looking for specific information-searching or indexing is likely to be more effective. It is probably a good idea to provide all three access modes in a database to meet the needs of different users.

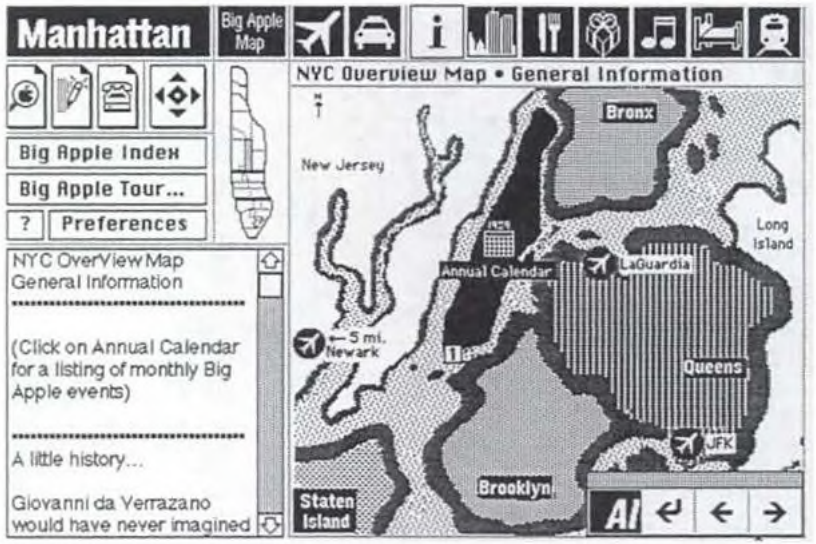


Figure 4-6. Big Apple program allows users to browse through maps of New York city (Applied Imagination).

Hypertext databases that allow browsing strategies are becoming increasingly common in public access systems, especially information kiosks. Evaluation of a hypertext system in a museum application is discussed in Chapter 6.

Information Overload

One of the problems that hypertext/hypermedia databases introduce is the possibility of overwhelming the user with too much information. The enormous capacity of optical storage media coupled with browsing interfaces makes it easy to present very large databases to the user. However, in certain public access settings such as information or exhibit kiosks this may result in information overload. Tillotson (1991) discusses the ramifications of information overload in museum settings where visitors have short attention spans and will only spend a few minutes at each exhibit. She recommends that the major concepts be presented in a very compressed, narrative format with a fast pace. Hands-on activities should not contain a lot of narrative, because the emphasis in such sequences should be on doing, not on reading or listening. Heller and Mckeeby (in press) recommend a "layered" approach to presentation of information in a museum setting: The initial screen should present a summary or overview with successive screens providing more detailed background.[5]

SECURITY AND INTEGRITY

An important issue in database design and implementation is security-restricting access to data to authorized users (e.g., Cooper, 1989; Gasser, 1988; Pfleeger, 1989). In some public access systems, such as ATMs, security is paramount. User identification codes and passwords are used to prevent unauthorized access to the database, and data that are transmitted over a network are usually encrypted.

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However, in most public access systems, access to the database is not restricted in any way, and security is not a primary concern.

Quality Control

Integrity refers to the accuracy or correctness of the data. This is a major concern for all public access databases. If any of the information presented in a public access system is inaccurate, people will stop using it. This means that the contents of the database must be subjected to a great deal of quality control effort. All information must be checked for typographical and grammatical mistakes as well as accuracy by an editor. This is the same process that any writing or video script must go through before being published or broadcast. Software tools such as spelling and grammar checkers can be used to ensure that all text information is examined (in addition to expert human inspection).

Updating

One of the weakest aspects of database integrity is updating. Almost every kind of information changes over time and must be corrected routinely. However, in many systems it is too difficult or expensive to make changes, and the database quickly becomes out of date. In some cases, no responsibility for updating is assigned after the system is fielded. Systems that use optical media (i.e., videodisc or CD-ROM) are especially susceptible to updating problems, because any changes to information stored on the disc involve complete replacement of the disc.[6] On the other hand, in networked systems in which the database resides on a magnetic disk that is shared by all delivery stations, updates are easier to make. Once changes have been made to the master database, they can immediately be uploaded to all workstations. However, it is essential that someone be assigned to make the changes on a regular basis to ensure that updating is done properly.

[5]*There is some irony in this recommendation since this is the standard method of newspaper journalism: summarize the story and then provide additional details. However, the primary rationale for this technique in newspaper writing is to make it easy to cut the story length to fit the amount of space available on a page.*

Viruses

A more recent challenge to database integrity are computer viruses (e.g., Denning, 1990; Hoffman, 1990). A computer virus is a program that copies itself from one magnetic disk to another (either directly from a floppy disk or over a network). The virus can then cause distruptions to the operation of the system or corrupt files. While most viruses to date have been harmless, the potential exists for them to be very destructive. A virus introduced into an unprotected network could quickly damage the system or database and affect all delivery stations. Consequently, almost all current networks (and many personal computers) have some sort of virus protection program that prevents virus infection. Databases that are stored on optical media (i.e., videodiscs, CD-ROM) are safe from viruses, because they are (at present) read-only and cannot be altered.

PRIVACY AND ETHICS

Two other important dimensions of database design and implementation are privacy and ethics. When personal information is stored in or provided to a system (such as is the case in ATMs, POS, and message systems), there are always concerns about who can see this information and how it might be used. While financial records are obviously confidential (and protected by appropriate security mechanisms), what about messages exchanged or logged in a conference mailbox? Does the system manager have the right to analyze such information to determine how people are using the system? Is it ethical to collect data on individual buying habits from a POS system and then use (or sell) this information for follow-up marketing activities?

[6]*One common technique used to overcome this problem is to overwrite information from the optical media with updated information stored on the hard disk or downloaded from a network.*

Data Recording

Any time a person uses a public access system, the complete details of their selections can be recorded and analyzed. Indeed, this is an important selling feature of public access systems to many organizations because it allows them to collect data on user preferences and behavior. It is also an important capability for evaluating the effectiveness of a system (see Chapter 6). Do users of public access systems need to be informed when this is being done? At the present time, there are no laws or codes of ethics that address these questions in the context of public access systems. Each system designer must make their own policies about this issue.

Copyright

Another ethical concern is protection of intellectual property rights (e.g., copyright) with respect to the information presented or the user interface. While the application of copyright laws to electronically stored information is not really any different from other media (i.e., print, film, recordings), it is much easier to modify and distribute material electronically. For example, scanners allow photographic images to be transferred very simply and graphic editors permit cropping, scaling, rotation and transformation of such images with little effort. Similarly, digitizers allow existing video and sound sequences to be easily captured and then edited. Once information is stored in an electronic database, it is relatively easy to copy and distribute (unless it is stored using read-only optical media). So, electronic media dramatically reduce the barriers to deliberate or unintentional violation of copyright.

An even more serious aspect of intellectual property rights in the computer domain is the enforcement of copyrights (and recently, patents) for software interfaces and programs. There have already been a number of famous legal cases in

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the personal computer world over infringement of the "look and feel" of programs (e.g., Lotus Development Corp. versus Paperback Software; Apple Computer versus Microsoft versus Hewlett Packard). It is clear that it is no longer legally safe for a software designer to develop a new program based on the way another one works (or looks), even if their effort is original and represents substantial changes.

Futher discussion of ethical issues in computing can be found in Erdman, Willimas, and Gutierrez (1990), Forester and Morrison (1990), and Johnson (1985).

ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

One way to make computer software easier to use is to make it "smarter." Artificial intelligence is the branch of computer science concerned with the development of programs that can reason and make inferences. Historically, artificial intelligence research has also concerned itself with the design of programs that can understand natural and spoken language, although this area has been deemphasized in recent years. For a discussion of past and present work in Artificial Intelligence, see Barr, Feigenbaum, and Cohen (1981), Shapiro (1987), or Winston (1984).

Expert Systems

One important application of artificial intelligence techniques is expert systems. An expert system involves knowledge about a specific domain and a set of inference rules that can be applied to the knowledge database to produce conclusions or advice. An expert system program typically asks questions and uses the answers to reach conclusions. Expert systems have been developed for many different types of applications ranging from medical diagnosis to completing tax forms (see Harmon & King, 1985; Hayes-Roth, Waterman, & Lenat, 1983).

An interesting example of an expert system in the context of public access systems was developed by Emporium Department stores for a "Holiday Gift Ideas" kiosk in their San Francisco store. The expert system program simulated the interaction between a sales clerk and a customer in determining Christmas gift suggestions. By touching the display screen, shoppers could view up to 134 items based on the hobbies, interests, age, and price range of the people they wanted to buy gifts for. After specifying these particular variables, the program would display photographs and descriptions of the items that matched the specific interests of the shopper. The customer could also request a printout of all items selected along with the department and location in the store. Over a 31-day period of operation, there were more than 3,800 consultations that ended in a printout of gift selections, an average of more than 30 per kiosk per day. The top 20 items selected at the kisoks had a 21% higher selling rate in this store than other locations. Furthermore, the system collected statistical information about the choices made by shoppers that can be used in future merchandise decisions.

Another example of an expert system application in a public access setting is Tulare Touch, an interactive system for welfare assistance (Naman, 1991). The system allows people in Tulare County, California to apply for assistance directly by sitting down at workstation and answering the questions presented. All input is via touchscreen and full-motion sequences of a narrator are used to provide explanations and ask questions. The expert system (which runs on a small mainframe computer networked to the workstations) is used to determine which regulations apply based on the applicants answers. Because there are hundeds of complex rules, the use of an expert system can significantly reduce the likelihood of errors in the completion of an application. In fact, a comparison of 200 applications processed manually versus another 200 completed using Tulare Touch resulted in 38% errors in the manual processing but zero errors with the system. Furthermore, use of the system has reduced the average amount of time required to process an application from 1 1/2 hours to 15 minutes.

Intelligent Agents

While expert systems appear to have the most immediate application of artificial intelligence techniques to public access systems, there are other possibilities. A recent development in artificial intelligence research is the development of so-called Intelligent agents" (Boy, 1991; Sullivan & Tyler, 1991). An intelligent agent is a program that can carry out procedures or requests that are formulated in terms of desired outcome. For example, you might instruct an intelligent agent to search through a product database and find all items that meet certain criteria. Alternatively, you might ask the agent to send a data file to someone else's computer. The intelligent agent takes care of all necessary computer operations in order to achieve the goal specified (including any commonsense reasoning or inferences that are needed to understand and execute the action).

Agents can also serve as guides that take users on a tour of a database from a specific point of view (e.g., Oren, Salomon, Kreit man, & Don, 1991). For example, based on the characteristics of a particular customer (e.g., age, sex, cultural background, socioeconomic status), an appropriate "sales agent" could be selected to make the video presentations in a POS kiosk. Alternatively, a player at a video game could select the characteristics desired in their electronic opponent or partner. Some public access systems already feature animated or video guides; it would not be a big step to create various *persona* linked to important user variables.

SUMMARY

This chapter has briefly discussed some of the database considerations of public access systems including the nature of the information stored (text, graphics/images, animation, video and sound), access methods (searching, indexing, and browsing), security and integrity, privacy and ethics, and intelligent/expert interfaces. Each of these considerations will be more or less important in the design of a particular public access system, although all systems will need to address the structure and organization of the information they present.

5

KIOSK DESIGN

While the design of the user interface and the database structure are probably the most critical aspects of a public access system, the physical characteristics of kiosks can also be very important. For certain applications (e.g., POS, exhibits), the attractiveness of the kiosk may determine whether the system is used or not. The design of the kiosk also affects its reliability /maintainability, who can use it, and where it will be located.

Much of the background knowledge and guidelines for kiosk design comes from the field of exhibit design (e.g., Klein, 1988; Konikow, 1984; Miles & Alt, 1988). Indeed, a major principle of exhibit design is to create displays that attract attention and invite participation. However, the many technology components and the nature of the interaction possible with interactive systems poses many new challenges even for experienced exhibit designers.

One of the critical steps in kiosk design is to examine the specific setting and environment that the public access system will be implemented. Many of the factors discussed in this chapter depend on such information for good decisions to be made. In some cases, it will necessary to field test a prototype (see Chapter 7) in order to get the data needed. Once the design decisions have been made, a set of specifications (including scaled drawings) for the kiosk can be produced.

KIOSK STRUCTURES

Public access systems come in many different forms, but there are three primary structures: free-standing kiosks, sit-down enclosures, and wall units. Some kiosks have "minimal" design and consist only of standard monitors with touch screens that are mounted on pedestals; others involve elaborate enclosures and special input and display units.

Free Standing

Free-standing kiosks are the most common structure for POS, information, entertainment, and exhibit units. A typical freestanding kiosk is rectangular in shape with a height of 2-3 meters (see Figure 5-1). The most important feature of any kiosk is the location of the display screen. It needs to be positioned so that it is at eye level for the intended user of the kiosk. This can present a problem when the users include small children as well as adults, because a screen located low enough to be seen (and touched) easily by children may be too low for many adults. This potential problem is largely avoided when the display is located on the top of the kiosk and angled toward the user (Figure 5-2). Users can adjust their viewing angle by moving closer or further away from the kiosk. It's also possible to place the display in a moveable bevel that allows users to adjust the screen to a satisfactory viewing angle. Another possibility is to have more multiple monitors at different heights to accommodate children and adults (Figure 5-3).

Many free-standing kiosks, particularly those in exhibit and information settings, feature a second display screen on the top or side of the kiosk that allows other people to watch what the current user is doing. The rationale for the additional display(s) is to allow the kiosk to still attract people, even though it is in use (and the main screen is blocked). It also allows people to watch someone else use the system and learn how it works. Some designers feel that this orientation is important to reluctant users who are not comfortable trying a system they do not know how to use. The supplemental displays can also show video overviews rather than what the current user is doing.

Display screens can be flush with the exterior panel or recessed in an alcove. Recessing the screen minimizes glare from room lights or the sun and provides surfaces to locate keypads, card readers, and audio speakers. Putting speakers inside an alcove may improve the intelligibility of an audio message and allow lower volume. Data on the ambient light and noise levels in the planned kiosk location(s) will be useful in determining how much illumination and sound amplification will be needed.



Figure 5-1. Full height kiosk enclosure (Courtesy, Insightguide).

Sit-down Enclosures

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Sit-down enclosures tend to be used for catalog, message, and exhibits in which the transaction is longer, requires privacy, or involves ancillary activity (e.g., reading/writing). A typical enclosure has work surfaces in front of and at the sides of the display screen and partitions separating it from other units. In the simplest case, sit-down enclosures are standard desk units containing terminals or personal computers; at the other extreme they can be custom-designed units that are part of large exhibit structures (see Figures 5-4 and 5-5). Figure 5-6 shows a kiosk designed for personal health evaluations that has a cuff which automatically opens and closes on the user's arm to measure blood pressure. Seats of any kind tend to be discouraged for most information or POS applications, because it encourages the user to spend too much time at the kiosk and reduces availability to others.



Figure 5-2. Waist-level kiosk enclosure (Courtesy, Siemens Nixdorf Information Systems).

Wall Units

Wall units are used primarily for bank ATMs and museum exhibits, and occasionally for POS units and information kiosks. Bank ATMs usually have recessed alcoves to provide privacy to the customer. There may be a retractable shield that covers the alcove when not in use. An enclosed camera may be mounted at the top or side of the ATM to videotape transactions. If the ATM is located on an outside wall, it is often enclosed by a plastic "shell" to protect the customer and ATM from weather (Figure 5-7).



Figure 5-3. Custom-developed wood kiosk with multiple monitors.

Wall units that comprise museum exhibits tend to feature large information panels and may include a number of displays or lighted signs. Selecting options from a keypad or the screen causes certain aspects of the wall panels to activate. Wall units for POS and information kiosks may feature large display units designed to catch the attention of passersby.

LOCATION

To a large extent, the design of a kiosk depends on where it will be located. While every location presents some unique considerations, three fundamental types of locations can be identified: outside/ unrestricted, inside/unrestricted, and inside/restricted. These different categories of locations affect the amount of design effort (and expense) involved in kiosk design. They will also influence the materials selected (discussed in the next section).



Figure 5–4. Sit-down enclosures at EPCOT energy awareness exhibit.

Outside

Kiosks located outside such as ATMs and visitor information units must be designed to withstand the effects of climate, traffic noise, variations in lighting, and vandalism. Such kiosks must be sheltered from the elements, well sealed, self-illuminated, and very rugged. If the climate can be extremely cold or hot, a cooling or heating unit may be needed in the kiosk. It is highly desirable to have isolated kiosks connected to a network so that their operating status can be remotely monitored.

Inside

Kiosks that are located in shopping malls, lobbies, hallways, exhibit areas, arcades, or airports do not require the same degree of ruggedness as outside kiosks, but they still may be subject to some of the same concerns (e.g., high ambient noise, vandalism). Attracting the attention of passersby is typically a major design consideration in these locations; hence, dramatic visual and sound effects are likely. Ensuring that the kiosk has no sharp or protruding edges and appropriate padding may be an important safety element in a crowded environment. The size of the kiosk could also be a critical dimension in such settings, because floorspace may be at a premium.



Figure 5–5. Fitness exhibit at EPCOT with reclining seat.

Kiosks located inside stores, waiting rooms, libraries, or offices require the least "bullet-proofing" and often consist of unenclosed terminals or personal computer units. Such a setting is usually well supervised, and hence the likelihood of abuse or vandalism is low. Attracting someone to use the system may not be a concern, because its use may be sought after. Climate, noise, and lighting are controlled. Furthermore, usage is likely to be confined to business hours, and therefore the kiosk will be subjected to less "wear and tear" than one in an unrestricted area.



Figure 5–6. Health evaluation kiosk with blood pressure testing capability.



Figure 5–7. ATM protected by weather enclosure.

MATERIALS

Considerable attention will need to be given to the materials the kiosk is made out of, in terms of function, attractiveness, durability, safety, and costs.

Many of these variables are interdependent, and decisions about materials are usually made as a tradeoff among many factors.

Function

The purpose of the kiosk should be the most important factor that determines the choice of materials. For example, a bank ATM needs to be secure dictating the choice of metal plating for its structure. On the other hand, a museum exhibit could be constructed from plastic, wood, or even papier-mâché, in order to create the desired shape or effect. Many POS and information kiosks consist of heavy plastic or fiberglass panels that are tough but relatively lightweight.

In some cases, the theme of a kiosk will establish constraints on its design. For example, "Take 5" kiosks located in the World of Coca-Cola museum resemble giant Coca-Cola cans (see Figure 5-8). To produce the look of a shiny red Coke can, the outside shell of the kiosk needed to be made out of plastic or metal.

Durability

Different components of a kiosk have different durability requirements. Obviously any part of the kiosk that is regularly touched or grasped will need to be more durable than sides or support structures. Invariably, the input mechanisms (keypads, buttons, touch screen) will wear out first and need regular replacement. Any protruding edges or sides are likely to get banged and bumped frequently (a good argument for avoiding protrubances if possible). Sides that touch the floor may suffer considerable abuse from floor polishing or vacuuming equipment. Mouldings, trim, or protective stripping may be used to minimize the wear and damage along edges and sides that receive a lot of contact.



Figure 5-8. Kiosk at World of Coca-Cola museum.

Appearance

Kiosk materials will be selected for their appearance qualities. Plastics and fiberglass are often used, because they provide good surfaces for artwork. Cloth and fabric give the kiosk a "warm" or "earthy" look; polished metal and glass produces a "hi-tech" or "futuristic" feel. Wood may be used to give the kiosk a prestigious or historic quality (e.g., Figure 5-9). In some cases, it may be desirable to choose materials that allow the the kiosk to blend in with its surroundings; in other cases, the intent may be to make it stand out. Many designers believe that the choice of kiosk materials (and associated artwork) sets the tone for the interaction between the user and system and should therefore be selected on the basis of the image or message they convey.

Safety

Kiosk materials must be selected with safety considerations in mind.[1] They need to be fire resistant and nonflamable. All electrical/ electronic components should have fuses. Wiring needs to properly shielded and grounded. The kiosk must be sturdy and weighted properly so it will not topple or collapse even when subjected to unusual loads (e.g., being sat on or pushed). Glass on displays or panels must be thick enough not to break when hit accidently with umbrellas, cameras, or jewelry. Safety rails or partitions may be used to keep people away from the rear or sides of a kiosk (see Figure 5-10). Subjecting kiosks to "crash tests" with runaway grocery carts, baby strollers, heavy luggage, and 6-year-olds is a good way to discover if they are rugged enough to stand up to daily use in a public setting.

[1] *It is likely that the environment where the kiosk will be located will have its own fire and safety regulations that a kiosk must adhere to. Such regulations might dictate not only materials but also size, power consumption, VDT radiation standards, etc.*

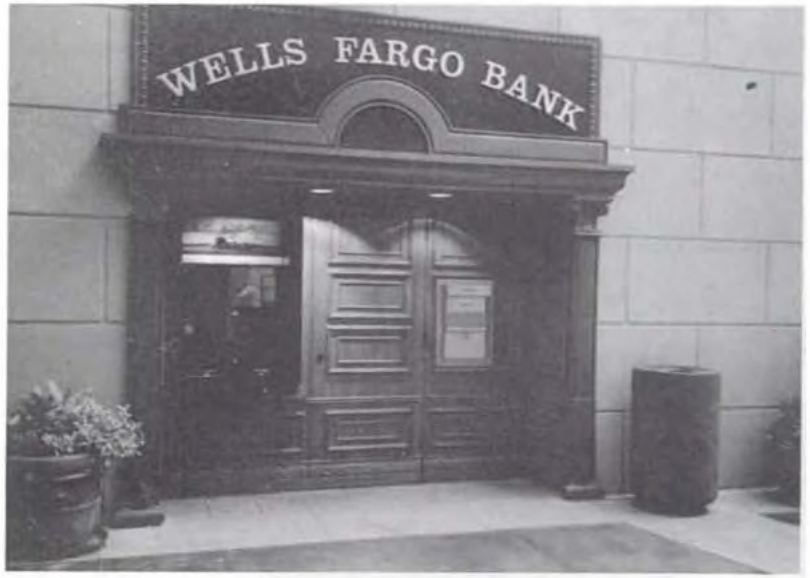


Figure 5-9. Historic look for bank ATM.

Costs

Finally, costs will play a role in the choice of kiosk materials. Kiosks that can be made out of standard-size panels will be much less expensive than those that involve unusual shapes and require special fabrication. One of the critical factors determining cost will be the number of kiosks required. If only one or two units are needed, it is much less expensive to use an off-the-shelf design with common materials. On the other hand, if many kiosks are to be built, the extra costs of custom design and unusual materials can be spread over the total quantity. For single kiosks that have unique designs, wood and fiberglass are probably the least expensive materials to use. On the other hand, given the expense of the technology involved (especially the design and implementation), the cost of the kiosk manufacture is not likely to be a major component.



Figure 5-10. Safety railing limits kiosk access.

OPERATION AND MAINTENANCE

Kiosk design must account for a variety of operating and maintenance factors. Unless these factors are planned for in the design of the kiosk, it may not function effectively, no matter how well the rest of the kiosk is designed. Furthermore, consideration of these factors may change the design of the kiosk from its initial specifications.

Power

Each electronic device in the kiosk (i.e., display, cpu, videodisc/CD-ROM player, printer) as well as support equipment (lights, heaters/ fans, amplified speakers) will need reliable electrical power. Power cords need to be located out of the way so that they can't be accidently (or deliberately) disconnected or damaged. It is also important to ensure that kiosks are on dedicated electrical circuits so that they will not be affected by overloading or outages in adjacent rooms or buildings. Circuit breakers or fuses should be easy to get to (but not so accessible that they are subject to vandalism). If kiosks are to be fielded internationally, attention will need to be paid to the different power standards and plug types used around the world.

Network Connections

Kiosks that are connected to networks will need access to a telephone line or suitable cable. Like power cords, this line/cable needs to be protected from disconnection or damage. If a kiosk is to be located some distance from a wall or building, it may be neccessary to run power or communications lines underground or overhead. Local site personnel need to understand that once a kiosk is "tethered" with communications lines, it usually cannot be moved more than a few feet without

expensive rewiring.

Temperature Control

Maintaining a satisfactory temperature range in a kiosk may require special heating, cooling, or ventilation. Consider an outside ATM intended to operate in a northern location where the winter temperature could be well below freezing. Any moving parts such as buttons on keypads, disk drives, or printers could freeze solid unless kept warm. On the other hand, the electronic components inside a kiosk in a very hot location could burn out due to overheating if not kept cool. Obviously, it makes sense not to locate kiosks outside in areas that experience extreme temperatures, but this may be necessary in some instances. In any case, good ventilation is normally needed for a kiosk in order to dissipate the heat created by the electronic components.

Servicing

Cleaning and servicing of a kiosk requires easy access to all electronic components. Ideally, access involves removal of panels at the rear or side of the unit so that the front of the kiosk does not need to be dismantled or blocked off. Components should slide out so they can be inspected or removed easily. There is a tendency to design kiosks so that they cannot be disassembled easily in order to discourage vandalism or unauthorized opening. However, this causes problems for quick and easy maintenance. Panels or doors with locks or special screws can satisfy both security and maintenance requirements.

Another consideration is a way to indicate that the kiosk is out of service. Many things can go wrong: a disk drive could fail, the network connection could be lost, a key could jam, the touch screen could go out of alignment, the printer could run out of paper, and so on. Ideally, the system software has built-in diagnostics that detect a problem and take the unit out of service, displaying an appropriate message on the screen. For example, some ATMs have a status window that indicates whether the unit is "open" or "closed." When an ATM is out of service, the closed message is shown. Otherwise users may not understand that the system is not working properly and become frustrated or dismiss the system as useless (see Figure 5-11).

Telephones

Some kiosks feature telephones that allow users to call a support center and get assistance using the system or report a problem (see Figure 5-12). Telephones can also be integrated into the function of the kiosk. For example, telephones included in the Shell Canada InfoCentre kiosks can be used to directly contact hotels and restaurants described in the database for reservations and more information. Or, to turn things around, telephones that include video display screens can be used to access online databases, read electronic mail, or present POS information (Figure 5-13).

Transportability

One last operational factor that is especially important for kiosks that are frequently moved to different locations (e.g., as part of a traveling exhibit) is their transportability. The size and shape of the kiosk may make it easy or difficult to ship and set up. For example, the Soil Conservation Theater discussed in the next chapter was designed as a large kiosk to attract attention; however, the size of the kiosk became a problem for shipping the exhibit to new sites. Another aspect of transportability is durability - if the kiosk is to be set up and shipped many times, all of the components (i.e., panels, cables, computer and video hardware) need to be rugged enough to stand up to frequent handling.



Figure 5-11. People need to know when a kiosk is out of service.

INTEGRATION

So far in this chapter we have focused on kiosk design as an independent entity. However, interactive systems must be designed as a component of an overall application that usually involves other aspects. For example, the location and usage of an ATM or POS must be considered in the context of counter staff or merchandise displays. Tillotson (1991) discussed the integration of interactive exhibits in museum settings. She suggests that well-designed kiosks can create conceptual links among

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surrounding displays and provide continuity in a collection or series of exibits. Each interactive kiosk should lead the visitor to other exhibits in the museum. Tillotson also emphasizes the capability of interactive exhibits to complement other exhibits. For example, an interactive kiosk can provide hands-on activities to contrast displays that involve passive viewing. Alternatively, an interactive kiosk could provide a simple viewing experience of photographs or video sequences to support other exhibits that involve high levels of participation. If the surrounding exhibits lack audio, the kiosk could focus on audio; if the setting involves a high level of ambient noise, the kiosk might be completely silent.



Figure 5-12. Telephones are often provided for assistance or problems when using public access systems.

A program designed for an exhibit at the National Museum of American Art (part of the Smithsonian Institution) on abstract art illustrates this point. The program allows visitors to watch interviews with the artists whose works are displayed in the exhibit. In the interviews, the artists discuss their lives and artistic struggles in their actual studio settings while working. The kiosk is located in the gallery where the works are displayed and features a bench that allows people to sit and use the program comfortably. Visitors go back and forth between the program and study of the actual works. The nature of the program and the design of the kiosk make it a trully integral component of the exhibit.



Figure 5-13. AT&T public telephone with display screen.

All of the kiosk design factors discussed in this chapter could play a role in such integration. For example, the Mannington Floors POS kiosk is designed as a wall unit so that carpet samples can surround the display unit and provide immediate connection between what is shown on the screen and the actual product. The Clarion Beauty Computer is located in the middle of racks of the beauty products recommended by the system (see Figure 5-14). Information kiosks in a shopping mall or convention center should be located where people are most likely to need help (e.g., near entry points and rest areas). Choice of kiosk materials will be determined by the overall theme or decor of the entire exhibit or setting.

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Maintenance and servicing considerations will need to take into account the particular characteristics of the location (e.g., climate, access, utilities).



Figure 5-14. The Clarion Beauty Computer is an integral aspect of the product display.

Finally, the kiosk design needs to be integrated with the design decisions made about the other components of the system discussed in previous chapters. The kiosk must properly support all of the technology involved, the characteristics of the user interface, and the nature of the database. For example, the physical structure of the kiosk should not obstruct viewing of the display or access to the input mechanism (i.e., keypad/keyboard, touch screen). If the program makes use of sound output, the kiosk should provide the best acoustics possible (e.g., Lawrence, 1989). Decisions made about appearance should be consistent with the theme or atmosphere created by the interface or database structure.

SUMMARY

While not the most complex aspect of designing a public access system, creating the physical interface for the user involves many considerations. Table 5-1 lists the factors discussed in this chapter in a checklist format. This includes the type of structure (free-standing, sit-down, or wall unit), the location (outside/inside, restricted/ unrestricted), the materials used (function, durability, appearance, safety, costs), and a number of operating and maintenance factors (power, network connections, temperature control, servicing, telephone use, transportability). Furthermore, the kiosk design must be integrated functionally and aesthetically with the setting it is used in and with the other design components discussed in previous chapters (i.e., hardware, user interface, database).

Table 5-1
Kiosk Design Considerations

Structure	Type Free-standing
	Sit-down enclosure
	Wall unit
Location	Outside/Unrestricted access
	Inside/Unrestricted access
	Inside/Restricted access
Materials	Function
	Durability
	Appearance
	Safety
	Costs
Operation/ Maintenance	Power
	Network connections
	Temperature control
	Ease of service
	Telephones
	Transportability
Integration	Surroundings
	Other design components

An additional factor that needs to be taken into account in kiosk design is its suitability for use by handicapped individuals. The Appendix discusses some considerations along these lines.

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6

System Implementation

Preceding chapters discussed design characteristics of the user interface, database, and kiosk that are important for public access systems. This chapter focuses on implementation issues in the context of an overall system and actual applications. The issues include: reliability, coordination, experience, minimizing resources, system constraints, content, inertia, and sponsorship.

RELIABILITY

The large number of ATMs installed and the frequency of their use (over 10 million transactions per day in the U.S.) provides us with an opportunity to examine the kinds of reliability problems that can occur with large-scale implementation of public access systems. To some extent, these problems are unique to the nature of banking transactions and the characteristics of ATM functions; however, many of the issues generalize to all forms of public access systems.

Errors in ATM transactions are relatively common - estimated to be about 1% of all transactions (Luchsinger, 1988). Given the complexity of an ATM system and the number of components in an ATM unit, the high error rate is not too surprising. Problems can be due to the hardware, software, customer, network, or bank personnel. Hardware problems can occur in the card, input device, the cash dispenser, the receipt printer, the keypad, or the display. For example, a wrinkled bill can get caught in the dispensing unit and fail to be delivered to the customer (even though the transaction is complete as far as the system is concerned). The customer's bank card may be damaged or worn and fail to be read properly by the card reader (or worse, may jam the reader).

There may be incompatibilities between the hardware and the system software. This is especially likely when the hardware and software come from different vendors-for example, when a bank merger or acquisition is involved and different systems must be integrated. This problem also occurs when new equipment is purchased which may not work the same way as the equipment it replaces. Banks may join networks and be required to change the way their ATMs operate to conform to the network standards, causing incompatability problems.

Transactions may be interrupted or lost due to network problems (e.g., disruption of a data transmission channel such as fiber-optic cable or satellite link). Similarly, failures in the ATM or mainframe telecommunications hardware could cause errors or delays in transactions. While these kinds of problems are unlikely, due to the redundancy built into network hardware and equipment, they are possible. They are particularly likely during peak loads or when new applications are added to the network.

Customers may fail to understand how to operate an ATM or forget to remove their money, card, or receipt. When making deposits, they may enter the wrong amount, forget to include a deposit slip identifying their account, or fail to include their deposit. Bank personnel may improperly load the ATM (e.g., receipts, money) or fail to do routine servicing (e.g., replacement of printer ribbons, check the reader /printer/keypad). Obviously these kind of problems require well-defined policies and procedures for resolving customer complaints and staff oversights.

To a large extent, many of the problems just mentioned can be eliminated or minimized by designing smarter hardware and software. For example, cash dispensers can be built with reversible belts that can clear a jammed bill. Sensors can be added to all input/output devices that detect whether a card, receipt, or money has been removed at the end of the transaction and generate a warning sound/message if forgotten. In addition, such sensors can provide a more detailed record of a transaction (e.g., money was removed from the dispenser) for diagnosing problems and dealing with complaints. At the network level, all transmissions can require verification by both sending and receiving software (i.e., a message is sent back verifying the details of the transaction just completed and a check is made to ensure that there is no discrepency).

Many potential problems can be prevented simply by good maintenance or service procedures. For example, components that wear out such as printer ribbons, keypads, or card readers can be replaced based on a schedule of average life expectancy (rather than waiting for them to fail). Site coordinators can be required to run a test transaction that checks all ATM components once a day. A "mission control" center can be established that continously monitors the operation of the entire ATM network (using diagnostic software and equipment sensors) and immediately identifies any malfunctioning unit.

Improved reliability, whether it is achieved by smarter components or good maintainence routines, costs money, and someone must pay the price. Typically such additional costs are passed to the consumer in the form of service charges or lower interest rates. Banks may absorb the increased costs as part of their operating expenses (hence, lowering their profitablity) if they believe that it gives their ATM system a competitive advantage or reduces customer service costs. On the other hand, banks may settle for a lower level of reliability in order to keep operating expenses down and tolerate a higher level of frustrated customers. Clearly, this latter strategy is not a good one and could jeapordize a bank's viability.

The widespread placement of ATMs in nonbank locations (e.g., grocery stores, airports, shopping malls) introduces a series of ownership problems. For example, is the site responsible for security and ensuring proper access to the ATM? When people have problems with an ATM, they often expect local personnel to provide assistance or answer questions (including grocery clerks and custodial staff). Even when an ATM is located at a bank branch, the customer may have a problem with a credit card transaction that has nothing to do with that particular bank. Provision of a telephone in the ATM which connects customers to trained service representatives can alleviate some of these problems.

COORDINATION

The development of public access systems typically involves the collaboration and cooperation of many people and organizations. In order for the system to be fielded successfully and according to schedule, considerable coordination is needed, usually

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by a project manager or steering committee. Coordination has to be recognized as a distinct function and activity to be completed, otherwise it tends to get overlooked and neglected.

To illustrate this point, consider the development of the ACCESS system, a public online catalog for the Library of Congress. The system consists of terminals located in the Library of Congress buildings in Washington, DC. The ACCESS terminals use a touch panel as the primary user interface, although they also include a keyboard (see Figure 6-1). The terminals (which are personal computers) are connected to the mainframe computer via a local area network. The bibliographic database used by ACCESS has been in existence for many years, but has only been available to reference librarians. The purpose of the ACCESS system was to make the catalog available to any user of the Library.

Development and implementation of the system involved a number of different groups within the Library of Congress. The project was the responsibility of a system development group. Reference librarians and technical information specialists helped with the design of the user interface and database structure. Other computer groups including production support, systems engineering, quality assurance, and user support were also involved. In addition, a public access group developed an ACCESS workstation for visually handicapped users.



Figure 6-1. ACCESS terminals at Library of Congress.

In order to prototype the system, it was initially implemented in the form of a kiosk in the main lobby of one building; staff were invited to try the system and provide feedback. Over a two-year period, various hardware and software designs were evaluated as the final form of the system evolved. Initial users were observed and interviewed. Outside consultants with expertise in user interface design and public access systems provided design ideas and critiques of prototypes.

Because responsibility for development of the ACCESS system was assigned to a single group, they were able to coordinate the input and activities of the other parties involved. In any large-scale project that has many components, such coordination is essential to success. This is especially true when the project involves a mix of different organizational entities (with differing missions/purposes) and outside contractors.

EXPERIENCE

Another factor that is critical to the success of a public access project is the level of experience of the project team. Because public access systems typically involve the development and integration of a number of different technologies (i.e., hardware, software, video, kiosks, networks), there are many things that can go wrong. A great deal of expertise is needed to put all the pieces together and have the system work well.

Organizations and companies that have developed many public access systems accumulate experience that allows them to create systems that are much more likely to succeed. Lunaria Incorporated, a small company located in Alexandria, VA, is a good example. Lunaria has developed many interactive programs for a wide range of applications and clients. This includes a number of projects for the Smithsonian Institute including kiosks at the Museum of Natural History, American Art, and Information Center (IBM Multimedia Solutions, 1991). A recent project involves the development of five visitor kiosks for the Patuxent Wildlife Research Center in Maryland.

The expertise of the Lunaria team spans all aspects of design and implementation. In terms of design, they have a deep understanding of the kinds of principles and guidelines that were discussed in Chapter 3: the user interface must be very simple, the content must be compelling to make the program worth using, the user must become involved in the program within the first few seconds of use, the program must be visually interesting and attractive, and so on. Indeed, they often reuse the same design elements and techniques in different projects, because they have proven effective. This saves creative time and produces reliable results.

Their expertise also shows up in the development and implementation aspects of a project. They make sure that they understand the potential audience and purpose of the system, either by extensive discussions with the content experts or by sampling the audience themselves. For example, in designing the information kiosk for the Smithsonian Visitor Center, one of the Lunaria designers spent a day working in the Information booth at the Center, learning what kinds of questions people asked. Maintaining good communication with the client as the project progresses is also a critical priority-even though it is likely to mean many meetings and phone conversations. Lunaria staff know that attending to the administrative aspects of a project is every bit as important as the creative components. Indeed, when it comes to keeping within budgets, project management can involve significant creativity.

Lunaria is also careful not to go beyond its own expertise and capabilities. They subcontract much of their graphics, programming, and video production work to

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people who are very good at what they do and have specialized skills required for a particular project. They also place a lot of emphasis on creating a partnership with the client and making use of the client's knowledge of the content, audience, and system setting. Despite their considerable expertise, they recognize that a successful project usually requires the collaboration and energy of many parties.

MINIMIZING RESOURCES

One of the design goals of many public access systems is to minimize the system resources (i.e., hardware, software, network usage) required in the development and final form of the system. In addition to lowering the costs of the user workstation or kiosk, minimizing resources can also reduce the development time.

An interactive theater developed for the National Museum of Health and Medicine (part of the Armed Forces Institute of Pathology) by High Techsplanations of Rockville, MD is an example of minimizing resources. The theater was designed for teaching elementary and high school students about alcohol and drug abuse. It features real-time data acquisition for polling audience response, an interactive videodisc presentation system, and computer controlled exhibits. All three of the subsystems are operated by a single computer (an Apple Macintosh) and share a common software interface based on HyperCard (see Figure 6-2).

The audience response system consists of 36 four-button response units located beside each seat in the theater. When the instructor poses questions to the audience, students can respond by pressing the buttons on their individual response unit. All responses are automatically tabulated and graphed on the main display unit at the front of the theater. This allows the instructor to immediately determine if the material being presented is being understood or discover student interests/experiences. For example, the instructor could ask students about the nature of their drug use and see a plot that reflects the audience experience-while ensuring the privacy of each person in the theater.

The interactive videodisc presentation system allows the instructor to selectively access different videodisc sequences to illustrate a lecture or discussion. The initial use of the system involves a commercially available videodisc on substance abuse created by ABC News Interactive. The primary benefit of interactive videodisc relative to standard videotape is that any sequence on the videodisc can be accessed instantly, allowing it to be used as a multimedia database. Material on the videodisc can easily be selected by the instructor or students based on their interests. In addition, videodiscs have a longer lifetime than videotape, because no physical contact is involved when playing.

The computer-controlled exhibit consists of three large transparent panels that involve photographic images with rear-screen lighting (see Figure 6-3). The panels show human figures, and the lighting reveals different organ systems. The system is used to display the relationship and function of the organs relative to specific health issues (e.g., the relationship of maternal and neonatal circulation). Lighting sequences can be programmed for use in talks or to run automatically as a stand-alone exhibit. Furthermore, the panels could be replaced and the lighting reprogrammed if the content of the exhibit was changed.

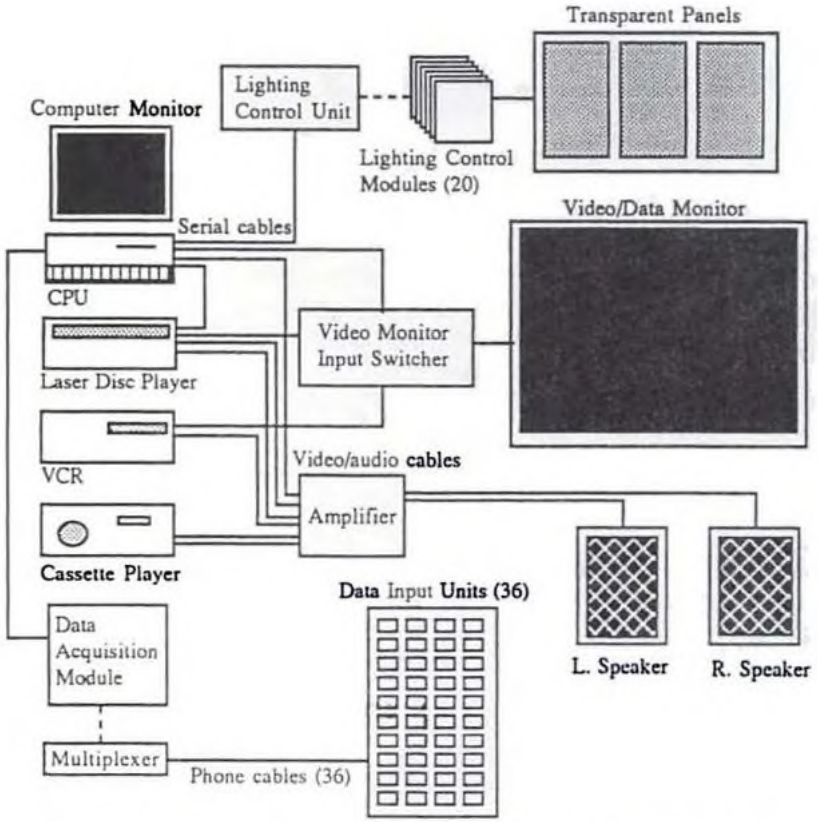


Figure 6-2. System diagram of interactive theater at the National Museum of Health and Medicine (courtesy of High Techsplanations).

By using a single computer to control all three interactive components, the system is highly compact and economical. More importantly, the use of the same software (HyperCard) for all components allowed the development of a common interface that makes the system easy to operate and program. In many public access systems that involve multiple components, different hardware and software are used for each component. This often results in a complex user interface and compatibility problems.



Figure 6-3. Computer-controlled exhibit panel at the National Museum of Health and Medicine (photo courtesy of High Techsplanations).

SYSTEM CONSTRAINTS

Another consideration in the development of a public access system is working with the limitations of the particular hardware/software involved. Once a particular system configuration has been selected, certain capabilities and functions are possible, while others are eliminated. Effectiveness of the system depends on how well these capabilities are exploited.

As an example of this point, consider *Treasures of the Smithsonian,* a CD-I program published by the Philips Interactive Media and the Smithsonian Institution (Hoekema, 1990). The program is an interactive sampler of over 100 million objects found in the 14 museums (and national zoo) that make up the Smithsonian. Like most CD-I programs, *Treasures* is intended for home use and for playback on a standard television set. These two characteristics of CD-I established a number of design and development considerations for the project.

The fact that CD-I programs are created for home use means that they must be very easy and intuitive to use - comparable to any public access application. Furthermore, the users of such programs could range from young children to senior citizens. Because CD-I programs are viewed on relatively low-resolution television monitors, all text and graphics must be large and well defined. In addition, because people are watching something on television, they tend to expect the same level of production quality that they would normally see in commercial television programs.

The initial generation of CD-I systems were not capable of displaying full motion, so the *Treasures* program could only use photographic images and audio. Even though a CD-ROM has a capacity of 650 megabytes, when each photograph requires almost 100K bytes, this allows for a maximum of 6,500 photographs (not allowing for any audio or programming). Each minute of high-quality digital audio requires about 5 megabytes of space, and the *Treasures* program involved almost 2 hours of audio. Thus, even a small number of high-quality images and audio sequences can quickly fill a CD-ROM-determining the scope and depth of the database.

Another important consideration in making the *Treasures* program was ensuring equal treatment of all objects included in the database. Unlike a linear production in which certain segments can be given special attention (e.g., "flashy" opening sequences, dramatic endings), interactive programs can be viewed in any order. The particular segments that a user selects cannot be predicted in advance. For this reason, the quality of an interactive program must be consistent and distributed evenly throughout the program. Any random set of segments selected should be as interesting or informative as any other.

Along these lines, each object included in the program was afforded the best visual images possible, lively narration, and a full soundtrack with music and sound effects. Photographic images were made from 4x5 color transparencies, and sound was captured in analog format, then converted to PCM digital audio. About 25% of the items in the database featured an additional interactive capability that allowed the user to "play" with the object in some way. For example, a work of sculpture might allow you to "walk around" the work by moving a slider bar from left to right. (This was achieved by photographing the object many times at the same eye level but spaced apart by the same angle.) With flat art (e.g., paintings, quilts, wallpaper), the slider lets you zoom in and out on the object. Musical instruments let you hear or create a composition by moving the slider bar. The telegraph key lets you type out Morse code. The capacity of the CD-ROM limited the availability of interactive

features to a portion of the database.

A great deal of production effort was expended on achieving the desired "look and feel" of the program. For example, the main menu of the program uses an architectural metaphor and shows a room containing a tree stump (for choosing dates), a file cabinet (for categories), a bust (for people), a map (for selecting museums), and a poster (for tours). The room has realistic surfaces and lighting with brick walls, marble columns, and a polished floor. The intent is to convey a mood of grandeur and mustiness typically associated with the Smithsonian. The menu was created by making a physical model at a 12:1 scale, lighting it with stage lights, shooting it with 16mm film, and then transferring it to video for CD-I mastering.

Clearly, this sort of production technique makes sense in the context of the intended audience, an entertainment application, and the nature of the CD-I delivery system. It would be less appropriate (and probably a wasted effort) for other types of public access systems such as information kiosks, POS, or ATMs. On the other hand, every type of public access system presents a range of capabilities and features to be taken advantage of in a given application.

CHOOSING CONTENT

In many public access systems, especially information kiosks and exhibits, the amount of information that could be selected for inclusion in the database is enormous. For the system to be successful, the information provided must be selected so that it is interesting and meets the needs of users. The developer must determine what kind of information is best by conducting needs analyses with potential users and consulting subject matter experts.

An interesting example of this aspect of system development is the SCS Conservation Theater developed for the Soil Conservation Service of the U.S. Department of Agriculture by Electronic Learning Facilitators (ELF) Inc., of Bethesda, MD (Blank, 1992). The purpose of the kiosk is to educate the public about conservation and the wise use of soil and water. A primary design challenge was to develop a system that would appeal to a broad cross-section of the public from small children to adults. SCS had a large collection of audiovisual material including public service announcements, training films, and news footage that could be used for the database. In addition, it was felt that some kind of game would be a good strategy to present information in an interesting and enjoyable fashion.

The creative concept for the kiosk took the form of a theater metaphor. The kiosk itself was designed as an art-deco-style ticket booth topped by a marquee. Motive-type posters advertising the "feature films" are displayed on the side of the kiosk. The touchscreen is located where the ticket seller would be located, and there is an upper screen in the center of the marquee for group viewing. An attract sequence shows previews of the theater content until the screen is touched. A ticket seller appears on the screen, welcomes the visitor, and the main menu which looks like a theater lobby is displayed (see Figure 6-4).

The theater provides four activities: short features, cartoons, the interactive newsreel, and the arcade game. In the feature films, visitors can choose different endings. For example, the film *Washout* is a suburban mystery in which the visitor trys to decide how the characters can prevent their backyard from disappearing due to erosion (i.e., by planting grass and trees). The cartoons promote the soil conservation message and are public service announcements originally produced in the late 1970s. Other existing film footage (some from the 1930s) was repurposed for the interactive newsreel activity. Visitors can interrupt the main newsreel at various points to see a mini-newsreel on the topic being discussed. When they select a mini-newsreel, the main story is suspended until the mini-newsreel is over, and then it continues from the interrupted point. In the arcade game, called "Save Our Soil" (S.O.S.), the visitor must move the "Powerful H20" character across a field without eroding the soil; scores in the game depend on the amount of soil conserved.

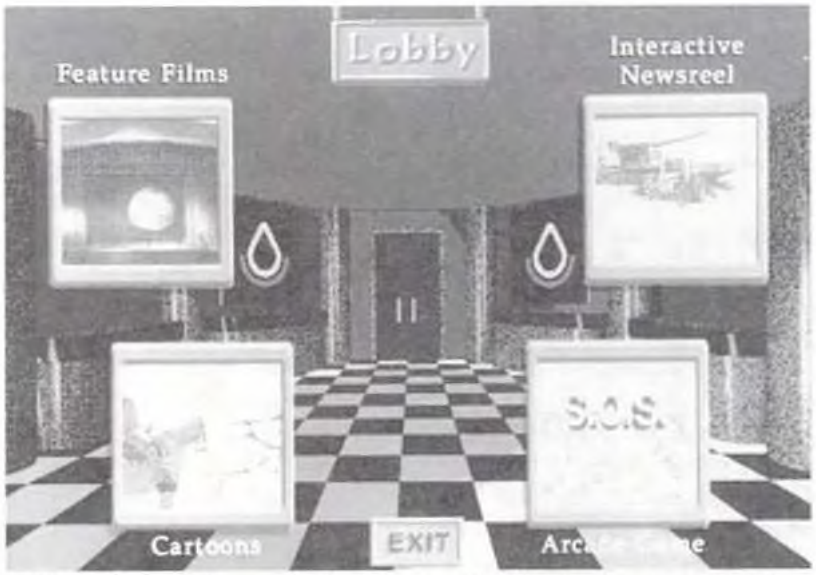


Figure 6-4. Main menu in SCS Conservation Theater (courtesy of ELF, Inc.).

In this project, the task was to select content from the extensive materials available that could be integrated into the theater metaphor. Approxiately 80% of the videodisc was repurposed material. This resulted in considerable savings in initial production costs; however, the substantial editing needed made postproduction lengthy and expensive. Because the materials were provided by the client (i.e., USDA), approvals and copyright clearance were not a problem in this project.

INERTIA

One of the biggest considerations when implementing a new method of providing information or services is overcoming the inertia of existing approaches. Even if the new method has some strong advantages, most people will naturally resist change and prefer the status quo. This includes both end users as well as employees and managers in the organizations developing the systems.

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A good example of this issue are POS kiosks for real estate listings. The idea behind these systems is to make real estate listings available in public access settings (particularly shopping malls) and take advantage of the multimedia capabilities of current technology. In Chapter 1, the HomeVue system that displays color photographs of properties stored on magnetic disk at the kiosk and downloaded from a central database via telecommunications every day was described (Carper, 1989). The system allows real estate agencies to list as many properties as they want, paying a fixed rate for each property listed. The user can print a listing of any properties they are interested in along with the name and phone number of the real estate agent. In addition, the kiosk maintains an activity log of what properties were examined, and this information is uploaded to the master workstation so that daily activity reports can be given to the real estate agencies.

A prototype HomeVue kiosk was installed as a field test in a Springfield, IL shopping mall. The mall management was active in reviewing the architectural drawings for the kiosk and making sure that the design blended in with the decor of the mall. It also assigned the location, originally alongside an escalator in the center hub of the mall, and later relocated it under the escalator to protect it from trash. Five realtors listed properties representing a mix of suburban and inner-city listings. Realtors provided the content and classifications for the listings as well as the photographs to be displayed. The HomeVue staff entered the listings and scanned the photographs into the database at the master workstation which was located at an office in Decatur.

In order to make people aware of the HomeVue kiosk and generate interest in using the system, a media campaign was conducted that included radio and television commericals on local stations as well as print ads in the real estate sections of local newspapers. The commercials and advertising emphasized the convenience of browsing through listings at the shopping mall. During the first month of the prototype period, 14 of the initial 73 listings were sold, and 45 new properties were added. In addition, other realtors, home developers, mortgage lenders, and decorating services indicated an interest in joining the system.

While the field test was considered successful, it highlighted a number of problems. Some realtors saw the HomeVue system as a competitor to the Multiple Listing Service (MLS) that all agencies already use (and pay for). The MLS system is used by agents to check listings, not used directly by customers. Some agents perceived the HomeVue system as redundant with MLS and possibly a threat to their job (rather than a supplemental marketing tool that produced extra sales leads). There was also a problem getting realtors to provide the information for their listings in a timely manner and good quality photographs. It became clear that this function could not be left to the realtors to perform, but needed to be done by HomeVue staff (for an additional fee). Realtors were happy to follow-up on the sales leads generated by the system, but were not capable of creating or maintaining the database.

Thus, a full-scale implementation of the HomeVue system would require significant administrative support for realtors beyond the kiosk itself. A similar result was found with the HomeSight system developed by Coldwell-Banker. The system was successfully tested in shopping malls in Colorado but failed in Florida, because the Florida realtors were not willing to maintain the database. The extra effort required to enter and update listings was not perceived as worthwhile in terms of the extra sales leads produced in the Florida location. Even in cases in which realtors value this type of system, they may not have the necessary staff to administer it properly or be willing to make the procedural changes necessary for an outside entity to do so.

On the other hand, the Home Vision system developed for HOME, a large real estate company in Denmark, seems to be more successful. In this case, the kiosk is located in the companies' offices and is used by realtors to show listings to customers. Furthermore, the listings include exterior and interior photographs, floorplans, and neighborhood maps-much more information than would be found in a traditional listing. The major payoff of the system has been to reduce the number of houses that a customer decides to visit (from an average of 15 to 7), allowing the realtor to close the sale faster and serve more customers. In addition, use of the system has attracted more customers. The number of people visiting HOME offices increased by four times the level before Home Vision was introduced, and the HOME market share increased from 15 to 24%. Use of the system as a sales tool by the realtors in their offices (rather than unattended use in shopping malls) and the more extensive multimedia listings likely account for the success of the Home Vision system compared to the other similar systems.

SPONSORSHIP

A common problem for many public access systems is funding, especially the purchase costs of kiosks. Many locations such as libraries, retail stores, hotels, and shopping malls are willing to provide the space for a kiosk, but cannot afford the price of the equipment and installation (typically between $5,000-$ 10,000 per kiosk). Even when the system provides a useful service to customers or visitors, it is often difficult to convince local sites to pay for it, unless the system directly produces revenue as in the case of POS or game arcades. Raising the money needed for the initial development of a program (which is usually in the $100,000$500,000 range) can also be a significant problem, because it represents a major financial committment.

Overcoming the financial hurdles in a public access project requires strong sponsorship by influential individuals or organizations. The Target Interactive Project (TIP) created by the National Federation of State High School Associations (NFSHSA) illustrates this point. The purpose of the project is to use interactive systems to help teenagers develop coping and refusal skills in the context of alcohol, drugs, and sexual behavior. TIP involves two programs, DART (Drugs and Alcohol Responsibilty for Teens) and AAIDS (An AIDS Interactive Disk for Students), that are installed in over 350 high schools around the United States and Canada. The programs feature a realistic drama that allows students to make choices for the characters as the story unfolds and experience the consequences of their decisions, without getting hurt. TIP kiosks are located in libraries, lounges, and cafeterias as well as classrooms and can be used in informal learning settings by individual

students or small groups with a teacher or counselor (see Figure 6-5).

While NFSHSA funds the development of the TIP programs, the costs of placing the kiosks in schools involves the sponsorship of other organizations. For example, the American Legion has passed a national resolution in support of the project and has helped raise the money needed for TIP systems in a number of states. In Utah, the National Guard has funded the installation of TIP systems in schools. Corporations and local companies have underwritten the costs of TIP in some locations.



Figure 6-5. TARGET kiosk delivers the TIP DART and TIP AAIDS programs.

Another program for teenagers, called "Choices and Decisions," is designed to help young people understand their rights and responsibilities as consumers. The program presents a series of typical consumer-buying situations (e.g., purchasing a new car or taking a vacation) and requires users to make financial decisions in the context of their income and expenses. This program was developed by Visa in conjunction with the National Consumers League and the U.S. Office of Consumer Affairs and is made available free to schools through local banks and financial institutions.

As both of these examples illustrate, development and support by widely recognized organizations is a critical aspect of implementation for many types of public access systems. This kind of sponsorship is important not only for financial reasons but also in terms of convincing others to adopt or try out a system.

SUMMARY

This chapter discussed a number of issues that play a significant role in the successful implementation of a public access system. The reliability of a system is critical to user acceptance; ATMs provide a good example of the variety of problems that can occur in large scale usage. Almost all public access systems involve a team effort and the participation of many different groups inside and outside the sponsoring organization. Coordination of everyone involved is a vital function. Furthermore, development of a public access system requires a broad mix of skills in computers, graphics design, audiovisual production, and project management. Building a team that has the necessary level of expertise in all these areas is a difficult task.

Another important consideration is minimizing the resources (i.e., hardware, software, kiosk materials, database) needed for the system. Extra components increase the cost of the system (for both development and purchase price) as well as increase compatibility and maintenance problems. Once the system components have been identified, the design challenge is to do the best job possible within the limits imposed by the system. These two principles keeping the system lean and exploiting the full capability of the system-seem to characterize the work of the best system developers.

The issue of overcoming the inertia of current practices was discussed in the context of real estate POS systems. The primary problem in this example was maintaining the database (i.e., property listings). Although realtors appreciate the benefits of such systems, they are reluctant to change the way they do things in order to accommodate the needs of the system. Almost all public access systems will require some sort of change in procedures and administration in order to be successful.

Finally, two projects focused on teenagers and "real-life" skills were used to outline the importance of sponsorship. In order to overcome financial obstacles and gain acceptance for a system, support from influential organizations can be critical to success.

Additional factors affecting the success of public access systems are discussed in Chapter 8.

7

EVALUATION

In this chapter we examine methods for the evaluation of public access systems as well as the issue of cost-effectiveness. The two fundamental questions about public access systems are: (a) Do they work (and how well)? and (b) Are they cost-effective? While systems may be initially fielded and used because they are novel or faddish, they will only remain and continue to be used if they satisfy these two criteria. Furthermore, evaluation is a critical aspect of the development process in terms of identifying improvements and changes needed.

ANALYSIS METHODS

There are numerous ways that data on the effectiveness of a system can be collected: online tracking, online comments, observation, protocol analysis, walk throughs, interviews, focus groups, and experiments. Each of these methods yields different kinds of information about how a system is being used and has its respective advantages and disadvantages.

Online Tracking

Online tracking is a unique capability possible with interactive systems and allows very detailed analysis to be made of what the user does. Every screen touch or key press can be recorded along with a time stamp. This allows a summary of what options were selected and an estimate of how long each screen or sequence was viewed. Both of these measures indicate the popularity of a particular feature as well as identify problem spots where people spend too much time making a choice or where they abandon the program. It is also possible to analyze the pattern of responses made by individuals to determine if the database is organized efficiently (e.g., do people move around a lot or stay in the same level?).

Online Comments

Online comments allow users to provide information while they are using the public access system. This could be in the form of a questionnaire in which users are asked specific questions, or it could be completely open-ended in which people type whatever they want. While the former can be done with any kind of input method, the latter requires a keyboard or speech-recording capability. Typical questions that might be asked include:

- demographic characteristics (age group, gender, occupation)
- reason for using the system (just browsing, specific inquiry)
- value of system (useful vs. useless)
- ease of use (easy vs. difficult)
- enjoyability of system (fun vs. boring)
- number of previous times used
- intent to use again
- suitability of location (convenient vs. inconvenient).

People can also be asked to rate the content of the database, i.e., indicate what information they found most worthwhile or what additional information they would like added. The virtue of online comments relative to a questionnaire completed afterwards is that people may remember details while they are using the system that they may forget later. In addition, the system can automatically tabulate results and print reports.

Observation

Observation of system usage can be done live or by videotaping. Live observation allows the observer to interrogate users about their behavior if desired. Use of videotape provides a permanent record that can be analyzed in detail whenever desired. Observation allows information to be collected on:

- how people are attracted to the system
- how long they use the system
- problems with the hardware, kiosk, and possibly user interface
- social behavior while using the system
- demographic characteristics (age group, gender, race).

It should be noted that there are ethical considerations about observing people (even in a public setting). Generally, their consent should be obtained before doing so. This can be obtained by asking permission after they have completed their use of the system and may be combined with an exit interview (see below). Alternatively, a notice can be placed on the kiosk or screen indicating that people may be observed or videotaped while using the system (implied consent).

Protocol Analysis

One of the problems with observation is that it does not reveal what people are thinking or experiencing as they use a system (although inferences can be made about certain states such as confusion, frustration, or elation). A standard method used in psychology research (e.g., Ericsson & Newell, 1984) is to have the individual say out loud what they are thinking as they solve problems or make decisions and record their comments for analysis. In the context of evaluating a computer system, the individual explains what they are seeing and why they make certain responses or selections. Protocol analysis allows system designers to determine how the interface is interpreted by the user and to identify any misunderstandings. Such data would not be revealed by simply watching someone use the system or asking them questions.

Interviews/Questionnaires

Interviews can be conducted in person or over the telephone. In-person interviews are usually done immediately after the person finishes using the system; telephone interviews are typically used to collect follow-up data some period after using the system. Queertionnaires can be handed out immediately after system use or mailed to users for follow-up. The information collected through interviews or questionnaires would be the same as discussed for online comments. Interviews and

questionnaires are easy and inexpensive ways to collect data; a limitation with these methods is that they only measure opinions and not behavior. How the questions are asked signficantly influences the results obtained.

Focus Groups

Focus groups involve a group interview of a small number of actual or potential users (i.e., 10-20 people). This data collection method is very useful for testing ideas before they are implemented. Participants are presented with illustrations or videotaped sequences of alternative designs and then asked for their opinions. The presence of a group allows for discussion among the participants which may result in valuable insights. Focus groups are also a good way to collect data from users that represent a range of demographic variables.

Choice of Methods

Table 7-1 summarizes some of the major advantages and disadvantages of each of the methods just mentioned. Online tracking allows very detailed, quantitative data to be collected automatically and unobtrusively. However, it requires additional software development work and data storage capability in the workstation (or network transmission of data to a central database). Data collected via online tracking often requires considerable interpretation and cross-checking with other types of data in order to understand what users are doing.

Online comments provide immediate (and often candid) reactions from users and like online tracking data are automatically tabulated. It also provides users with a sense of empowerment, because they know they can comment on the system any time they want. The disadvantages of online comments include the disruption of program use, the need for data storage capability, and the requirement for typing input (although this can be done via touch screens).

Observation and protocol analysis methods produce very rich, qualitative data with minimal preparation requirements. Observation is also very flexible, because the observer can follow up on any action. Both methods are very time-consuming (hence, expensive), and the data collected may be difficult to analyze because of its richness. In contrast, questionnaires and surveys are quick and inexpensive to administer. The validity of data collected via questionnaire/survey can be a problem, because users may forget details or distort their answers. Focus groups provide rich qualitative data but involve considerable preparation. One of the strengths of focus groups is that they allow specific user variables to be examined. Like questionnaire/survey data, however, focus group results must be interpreted carefully, because they represent opinions not actual user behaviors.

Table 7-1
Advantages and Disadvantages of Analysis Methods

	Advantages	*Disadvantages*
Online Tracking	- minimal effort - very detailed data - nonintrusive	- additional development - data storage required - interpretation needed
Online Comments	- immediate reactions - automated tabulation - empowers user	- interupts usage - data storage required - typing required
Observation	- flexible data collection - rich (qualitative) data - minimal preparation	- time-consuming - difficult to analyze - obtrusive
Protocol Analysis	- rich (qualitative) data - minimal preparation	- time-consuming - difficult to analyze
Interviews/ Questionnaires	- inexpensive/quick	- validity questionable
Focus Groups	- rich (qualitative) data - allows user sampling	- time-consuming - validity questionable

As this discussion illustrates, the choice of analysis method is determined by the type of data desired, the amount of preparation possible, the time and resources available for data collection, and the degree of user cooperation expected. Because most forms of data collection involve some difficulties in interpretation or validity, it is highly desirable to use multiple methods.

RESEARCH STUDIES

Various kinds of research studies may be conducted, ranging from informal observations made in field settings to formal experiments conducted in laboratories. Such studies may be conducted for the purpose of making design decisions or evaluating the effectiveness of a system in the field. Any of the analysis methods just discussed could be used for data collection and analysis.

Experiments

When a design question needs a concrete answer, it may be desirable to conduct a experiment that isolates a specific variable. The critical characteristic of an experiment is that all factors, except the one(s) of interest, are controlled. For example, Felix, Graf, and Krueger (1991) examined two alternative designs for a user interface in a railway ticketing ATM. One design presented all options on a single screen, while the other presented sequenced options on successive screens. The study was conducted in a German railway station with actual passengers who were buying tickets; the program was alternated for each successive user. The time to complete the transaction as well as errors made was measured. Data were collected by online tracking as well as videotaping. The results indicated that the sequential approach seemed to be best for most people, although there was a difference

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depending on the level of education and computer experience of the user.

Ventura (1991) reports on the comparison of touch versus mouse input in a hypertext program about Finnegans Wake at a James Joyce exhibition in Switzerland. Two identical systems were set up side by side, one with touch input and the other using a mouse. Posters on the wall behind each system explained how to use the mouse or touch panel. The primary method of data collection was online tracking, with all user responses being recorded. The data showed that people using the system with the touch input had slightly shorter sessions and examined less of the program than those using the mouse. In both cases, 50% of all sessions were less than 5 minutes in duration, and 90% were less than 15 minutes. In terms of screens viewed, more that 50% of all users looked at less than 10 screens, and 90% of users quit the program after less than 24 screens. The usage data showed exponential distributions decreasing quickly but with long diminishing tails.

Some experiments are conducted to examine more general design questions the system-specific issues of prototyping studies. For example, Sears, Kochavy, and Shneiderman (1990) were interested in the relative effectiveness of different touchscreen interfaces for searching text databases of different sizes. They compared three interfaces for input: a QWERTY layout, an alphabetic layout, and a Reduced Input Data Entry (RIDE) layout that successively displayed larger prefixes until the full text items are listed (e.g., V, VE, VERN). They calculated the average number of inputs needed to complete a search with a database containing approximately 160, 1,600, and 16,000 names using each of the three interfaces. While the RIDE interface is faster for all three databases, the advantage is greater for smaller databases. The QWERTY and alphabetic layouts result in about the same average number of inputs regardless of the database size. They also discovered that the RIDE interface is dependent on the performance of the system, because slow displays decrease the effectiveness of this interface relative to the other two layouts.

Field Evaluations

Field evaluations are usually concerned with measuring the usage or impact of a system in an actual setting. The data may be used to determine the feasibility of a full-scale implementation or whether to continue with an existing effort.

Shneiderman et al. (1989) discuss the evaluation of a particular hypertext system in three museum installations. In two of the museums, a database describing the work of photographer David Seymour was used. Data were collected by online tracking. These data included the time each user session began, the name of the database article accessed, and the number of seconds spent viewing each article. From these data, the developers were able to determine the most popular articles and access patterns. They were also able to compare the nature of the usage across the two museums. For example, the session length, number of articles, and use of the index differed between the two museums reflecting differences in the interests and backgrounds of the visitors to each museum. In the third museum, a different database on volunteer opportunities in archaeology was involved. In this evaluation, observation and interviews preceded the use of online data collection. Problems with the hardware, the hypertext system, and the organization of the database were quickly identified. After correcting these problems, online tracking was used to study the nature of system usage. These data allowed conclusions about the popularity of different articles and use of the index.

An example of a comprehensive field evaluation is provided by the Virginia Cooperative Extension Service for a public information system installed in public libraries and shopping malls in Virginia (Lambur, Worrell, & Hypes, 1990). The kiosks provide information on topics such as household plants, insect identification, consumer products and law, nutrition, and financial matters (e.g., borrowing money). The evaluation involved a number of different data collection methods including: online tracking, online comments, observation, and interviews (both exit and follow-up). As far as usage is concerned, the data indicated that:

- The systems were used almost continuously during peak times accommodating an average of 19 people per hour.
- The same programs were popular at all locations.
- People were easily attracted to the systems and tended to persist using the system once they started. In some cases, they had to be "bumped" off the system by people wanting to use it.
- The print option was a popular feature with people often making several printouts of fact sheets.
- The most important characteristics of the system according to users was the ability to control all aspects and the entertaining presentation style.

Information about impact was collected via follow-up interviews. More than half of the respondents (36/65) indicated that they had used the information obtained in some way; many were able to provide specific examples of how they used the information. For example, one woman indicated that she used information from the houshold plants program to describe flowers to her customers and to prepare for the FTD test. Some respondents reported a behavior change as a result of using the system. Two people used information from the nutrition program to avoid high-calorie foods. Another used information from the consumer products program to purchase a camera. Others used the insect pests information to get rid of fleas and ticks on their pets. Many people returned to use the system again for new or additional information.

Continous and sustained use of a system indicates that it is meeting a need. However, data from follow-up interviews are necessary in order to determine how well a system is fulfilling its intended purpose. It is possible for many people to try out a system (resulting in high-usage data), but few may find it worthwhile. Thus, field evaluations that only report usage data do not give a complete picture of system effectiveness.

PROTOTYPING

Conducting evaluations while a system is being developed is just as critical as evaluation after the system is fielded. The primary method for doing this is prototyping, i.e., building models of the system and trying them out. Models can take many forms including written descriptions, scale or full-sized physical mock-ups, simulated computer displays, or videotaped scenarios. The primary goal of

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prototyping is to discover any problems with the current design and make improvements.

System Testing

The most common use of prototyping is to test out and refine a system prior to its full-scale implementation. Gould et al. (1987) report a comprehensive prototyping effort in the development of the Olympic Message System (OMS) for the 1984 Olympic games in Los Angeles. The OMS was a multilingual voice message system in the form of 25 kiosks located around the Olympic village, which allowed athletes, officials, friends, and families to keep in touch with each other during the one-month period of the games. Some of the prototyping activities included:

- printed scenarios of people sending and receiving messages used as specifications of how the system would work
- development and tryout of user guides to obtain feedback on system operation prior to development
- simulation of the system on a mainframe computer using terminals to test understanding of the commands
- placement of a full-sized mock-up of the kiosk in the hallway at the IBM Yorktown Research Lab (where the system was developed) and later on a working prototype
- simple contests (with trivial prizes) to encourage individuals at Yorktown to try out specific functions on the prototype
- various "bullet-proofing" exercises in which groups of users (e.g., college students) would try to crash the system
- a field test at pre-Olympic trials with actual athletes and officials as users
- final prototype testing with a large number of users at Yorktown (2,800) and in Los Angeles (1,000).

Every one of these prototyping activities identified potential problems and resulted in improvements to the system. Clearly, the effectiveness and reliability of the fielded system were largely due to the extensive prototyping efforts.

One of the problems with prototyping is that it requires the development of a working system in order to collect data. Lewis et al. (1990) propose a methodology called *cognitive walk-throughs* that allows system developers to investigate potential design features without actually creating a working model. To use this technique, the designer identifies the sequences of actions that a user is expected to perform, using the system for a given task or activity. Evaluators then examine the ease with which a user could carry out these actions for each step of a task/activity. A structured evaluation form which asks questions about the user's behavior and system response is followed during the walk-through. Lewis et al. claim that this methodology can detect almost 50% of the problems that would be found in a full-scale evaluation with an actual system. However, they also state that the walk-through does not eliminate the need for prototypes, but may reduce the extent of testing needed.

Alternative Designs

Another common prototyping application is the comparison of alternative system designs. It is extremely hard to evaluate the design for an interactive system based only on written descriptions and drawings, especially if the design is innovative or unusual. To really assess the design, it is necessary to have a working version. However, this is feasible only if prototypes can be constructed quickly and inexpensively. The multimedia capabilities of current personal computers and the availability of powerful authoring tools make it possible.

Salomon (1990) describes the prototyping and field testing associated with an information kiosk for the 1989 Computer-Human Interaction (CHI) conference. The kiosk provided information about conference presentations, conference attendees, and the host city (Austin, TX). Of particular concern was the screen layout and nature of the control options for the main screens. From initial tryouts they discovered that users could not easily distinguish the differences in functionality, because the major options were similar in appearance. In addition, people did not understand the difference between global and local controls. The design team changed the design of the screens and controls until these problems were resolved. Extensive use of online tracking data was made during the field testing and implementation of this system.

Allen and Sterman (1990) describe their experience prototyping interactive exhibits for an aquarium using HyperCard and graduate students working with a budget of $2,400 (including videodisc mastering). In this case, the prototypes were intended to provide working demonstrations of potential exhibit ideas for museum administrators, sponsors, and visitors. One of the major goals of the project was to show how interactive exhibits might increase the amount of time visitors spend viewing an exhibit (which is usually less than a minute per exhibit). They developed four prototype exhibits, each using one side of a videodisc. One of the prototypes was selected for inclusion in a new museum facility.

QUALITY CONTROL

Another form of evaluation that is critical to the success of a system is quality control (also called quality assurance). Quality control is basically the process of checking that the system works as it is supposed to and is free of any form of errors or problems. A key element of quality control is the development and use of standards or criteria that specify what is to be checked and how it should appear/perform.

Quality control applies to the development of software and optical media for a public access system in various ways. It means careful proofreading of all screens for typographical and grammatical errors, making sure that all screens are legible and all sounds audible, that all options work as intended, and that all input is processed properly. Given that even a simple interactive program can contain hundreds of screens and thousands of branching alternatives, the job of checking each one to be sure there are no problems can be formidable.

One useful tool for quality control of interactive systems is the Questionnaire for User Interaction Satisfaction (QUIS) developed by the Human/Computer Interaction Laboratory at the University of Maryland. Table 7-2 lists the major categories included in the QUIS without the subitems and rating scales. The questionnaire has been validated over a number of different applications and

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systems (e.g., Chin, Diehl, & Norman, 1988) and is therefore valuable for quality control tasks.

Another concern of quality control is to ensure that all aspects of a public access system comply with any industry standards or government regulations. Graphics and video should adhere to common formats for the computer and video devices used, otherwise there may be problems integrating the software and hardware components. All aspects of the hardware and kiosk must meet appropriate safety regulations as well as laws pertaining to handicapped access (see Appendix).

Table 7-2
The Questionnaire for User Interaction Satisfaction (QUIS)

A. SCREEN
1. Characters on the computer screen
2. Highlighting
3. Screen layouts
4. Sequence

B. SYSTEM INFORMATION
5. Terminology
6. Relevance of terms

7. Instructions
8. User messages
9. Feedback about actions
10. Error messages

C. LEARNING
11. Learning to operate system
12. Exploration of features
13. Remembering commands
14. Task completion
15. Help messages
16. Supplemental reference materials

D. SYSTEM CAPABILTIES
17. System speed
18. Reliability
19. Noise levels
20. Correcting mistakes
21. Meets needs of novice and expert users

Quality control procedures must also be developed for assembly, installation, and routine operation of a public access system. Because the production units are likely to be assembled, installed, and operated by personnel other than the initial development team, it is essential that checklists be provided to ensure that all systems are configured and run properly. A site manager or service technician may not be very familiar with how the system is supposed to work and will depend primarily on guidelines supplied by the developers to operate and maintain it. All aspects of the public access system, from database organization and graphics/video formats to hardware components, should be well documented so that the system can be updated easily.

COST-EFFECTIVENESS

So far we have discussed effectiveness only in terms of whether systems achieved their desired goals. However, in the real world of limited resources, the question of effectiveness is usually framed in the context of how much it costs to achieve a certain result. In general, we are interested in getting the best results for the least cost.

Reducing Overhead

There are a number of expected benefits that underlie the use of public access systems. One of the most common is the desire to lower the overhead costs (especially wages) of providing a service or selling a product. An ATM provides basic banking services without the need for a human teller or an expensive building. A POS kiosk can sell merchandise without the need for a sales clerk or inventory. An information kiosk can answer questions or provide explanations without the need for a knowledgable and patient individual behind a desk. Not only does the system alleviate the need for a person and facilities, but it also reduces the need for training programs, employee supervision, and employee benefits.

Of course, public access systems do not eliminate the need for all bank tellers, sales clerks, or information desks. There are always some transactions that are too complex or unique to be performed well by computers. In addition, there are always individuals who do not want to use machines for one reason or another (e.g., technophobia, disabilities, illiteracy). Public access systems allow a smaller staff and facilities to handle a larger customer load, because most people will use the machines.

It also has to be remembered that while the need for direct contact staff may be reduced, people are needed to design, implement, maintain, and manage the public access system. While this may be a relatively small number of employees (or contractors), their salaries are likely to be much higher than the clerks displaced by the system. Furthermore, considerable money must be spent on the development of the materials and the software/hardware involved. Like any technology-based approach, there is a shift in the budget from money spent on operating expenses (i.e., wages and benefits, facilities) to the capital costs of development and equipment (Figure 7-1). The basis for a sound cost-benefits argument is when the extent of system usage over time (or number of people) significantly outweighs the initial start-up costs.

Increased Convenience/Effectiveness

Reducing overhead costs is not the only rationale for public access systems. Some systems are designed to help employees be more effective in their job. For example, a POS system could be intended to be used by sales clerks to increase their sales performance. Another common justification for public access systems is to provide increased convenience to the customer by making services or information more available and accessible. Clearly, ATMs and POS/information kiosks do this by being located in grocery stores or shopping malls and by being open all the time. For the system provider, this translates into additional business that would have been missed

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otherwise. Arcade games are an excellent example of the value of convenience-their location in stores, self-service laundries, restaurants, airports, hotels, or convention centers allows them to generate revenue ubiquously.

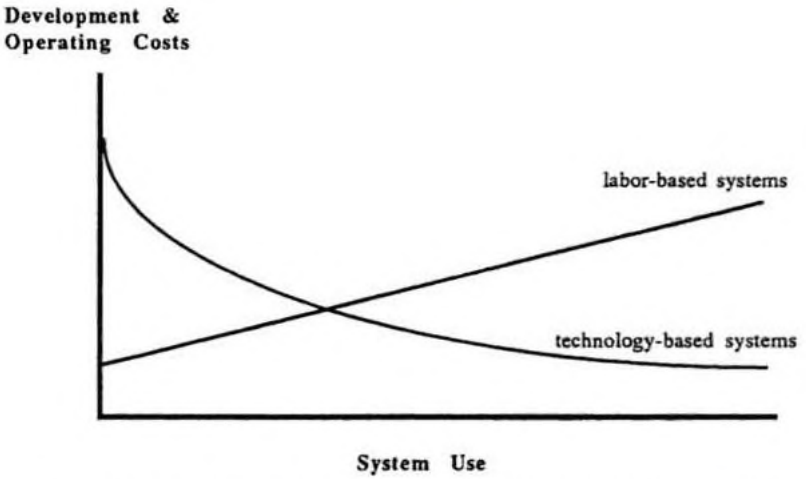


Figure 7-1. Technology-based systems normally involve higher initial development costs but lower operating costs than labor-based systems.

The impact of increased convenience is demonstrated by an evaluation of coupon-dispensing POS kiosks placed in Phar-Mor discount chain stores (Celeste, 1989). During a one-month test period, the average redemption rate for kiosk-generated coupons was 18% compared to *4%* for newspaper inserts and 6.4% for direct mail. Clearly, the presence of the kiosk resulted in a much higher buying pattern for the featured products. Customers using the *VideOcart* system mentioned in Chapter 1 buy more groceries (9-30% depending on the type of customer) and result in an 8-14% increase in sales of featured products. Because most purchase decisions (particularly brand choices) are made while shopping, POS systems can have significant impact on sales. Of course, for these applications to be cost-effective, the increased sales must exceed the costs of developing and implementing the POS systems.

Some public access systems result in better (i.e., faster, more accurate) service. For example, online catalogs allow library patrons to find materials of interest much faster than manual card files. Does this translate into reduced costs or additional revenue for a library? Not really. (Perhaps it lets more people use the catalogs or reduces the number of inquiries that need to be handled by librarians.) Interactive exhibits are not likely to attract more visitors, but they may improve the learning experience or enjoyment of those who do visit. Information kiosks in airports, hotels, or convention centers do not reduce costs or produce revenue, but they may result in more satisfied visitors. Benefits such as these are intangible and difficult to include in cost justifications. They can be measured by questionnaires and surveys that assess user attitudes. By comparing the attitudes from comparable groups who did and did not use the interactive systems, it is possible to identify the effects of using the system on service and satisfaction.

Cost Components

Development costs of the software and optical media (videodiscs, CD-ROM) are usually the single largest cost in a public access system (see Figure 7-2). For example, a single videodisc or CD-ROM that contains hundreds of photographic images, audio sequences, and video footage can cost $75-150,000 to produce. The costs of developing software depend on many factors, including the complexity of the application, the experience of the programming team, the authoring tools used, and the number of different hardware devices involved. While most software must be custom developed, the programs for some public access applications (e.g., online catalogs, ATMs, message systems) can be bought "off the-shelf."

Hardware costs include the computer, display monitor, disc players, card readers, and printers and can range from $1,000 for the minimum configuration used in online catalog systems to $10,000 for a fully outfitted ATM or POS unit. Similarly, the costs of kiosks can range from less than $1,000 for a simple desk enclosure to many thousands for an elaborate custom kiosk or exhibit. The complete cost for a fully functioning kiosk is typically between $5,000-10,000, assuming that "off-the-shelf components are used.

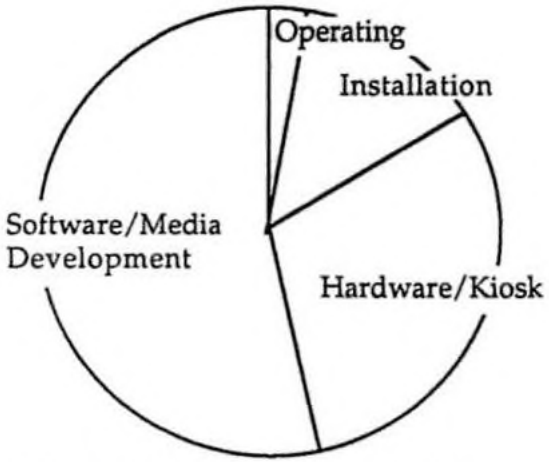


Figure 7-2. Typical distribution of costs in a public access system.

Installing a public access system involves the costs of shipping and setting up the kiosks as well as any power or telecommunications hook-ups required. Once set up, the system will need to be thoroughly tested to ensure that all components have been connected and are functioning properly. If a network is involved, it will take additional time to determine that each unit is uploading/ downloading data correctly. Installation also includes training site personnel how to use or supervise the system. Depending on the nature of the application, this could be a significant activity. For

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example, bank ATMs and online library systems represent major changes to the way those institutions conduct business and hence considerable training would be needed. On the other hand, installing an information kiosk in a shopping mall or airport would only require a brief orientation for a few individuals.

Beyond the initial development, hardware and installation expenses are ongoing operating costs. This would encompass utility bills and any supplies used (e.g., printer paper). There would also be a cost for routine servicing (i. e., cleaning, maintenance, upgrading media/software) and any major repairs needed. In general, operating costs are almost negligible relative to the other cost components discussed.

Cost-Benefit Models

A critical part of the planning for a public access system is the development of a cost-benefit model. Such a model estimates all the cost components involved in the design and implementation of the system as well as the anticipated payoffs in a form that can be measured. The point of the model is to provide a means for decision makers to weigh the costs against the benefits and determine whether to go ahead with the project (or perhaps try to reduce costs).[1]

[1]For general discussions of cost-benefits analysis, see Cascio (1982), Irvin(1978), or Sassone & Schaffer (1978).

A cost-benefit model may be developed while the system is still in the conceptual stage or after a prototype has been fielded. Cost data are usually not too difficult to obtain because existing systems or vendor proposals can be used to make estimates. The major problem in estimating costs is completeness, that is, ensuring that all cost components have been included. Estimating benefits is more challenging because it may be hard to quantify the expected payoffs, especially in terms of financial returns. Table 7-3 lists some of the benefits and effectiveness measures associated with different categories of public access systems. The benefits of ATMs, POS, and games can be directly measured in terms of dollar value.

As discussed earlier, increased convenience to the customer is a common benefit provided by many public access systems. This can be measured in terms of an increased number of customer transactins for a given time period. In the case of ATMs or POS units, increased transactions means additional revenue attributable to the system. On the other hand, in the case of an information kiosk, convenience may translate into increased visitor satisfaction, which cannot be directly translated into financial payoffs (but may result in increased business for the particular area served by the kiosk). Online catalogs may lead to increased circulation in a library which may help justify a larger budget allocation for books or staff.

Calculating benefits in terms of reduced overhead costs is usually easier than trying to estimate the value of increased effectiveness. If an ATM, POS unit, or information kiosk can displace the need for one or more full-time employees and a store front, those wages and building expenses are cost savings that can be attributed to the public access system. Alternatively, the system may allow existing employees and facilities to handle more customers, eliminating the need to acquire additional staff or space (which is a cost saving).[2] For example, consider the Tulare Touch system for processing welfare applications mentioned in Chapter 4. Because applicants complete their own paperwork, a case worker only needs to spend an average of 15 minutes on each application compared to 90 minutes before. This means that each case worker can now handle 5 times the number of applicants, greatly increasing the productivity of the public services in Tulare county. Whereas the system cost $3.2 million to develop, it is projected to save approximately $20 million in its first year of operation due to reduced labor expenses (Naman, 1991).

Table 7-3
Benefits of Public Access Systems

Category	*Major Benefit*	*Effectiveness Measure*
ATMs	• convenience	• increased transactions ($)
POS	• convenience	• increased sales ($)
Information	• availability	• greater satisfaction
Exhibits	• involvement	• longer visit
Catalogs	• accessibility	• increased circulation
Message	• accessibility	• more messages
Games	• participation	• increased use ($)

SUMMARY

There are a number of different aspects to the evaluation of public access systems. The nature of the data collected depends to a large extent on the evaluation methods used: online tracking, online comments, observation, protocol analysis, interviews/questionnaires, and focus groups. It also depends on the purpose of the evaluation. Research studies (i.e., experiments or field evaluations) examine the effects of a specific variable or the overall impact of a system. Prototypes assess the system design or investigate alternative designs. Quality control activities check for inconsistencies or defects in the system. Cost effectiveness studies determine the payoff of a system. Benefits may be measured in terms of reduced overhead expenses, increased convenience, or more transactions.

As the discussion in this chapter illustrated, evaluation activities can be carried on at any time during the development of a public access system. There is a tendency to only think of evaluation in terms of final assessments. But evaluation in the form of research studies, prototyping, quality control, or cost-benefits analysis can (and should) be done in the beginning or middle of a project. As a rule, the more extensive the evaluation activities in a project, the greater its success.

[2] A public access system may also serve new groups of users (e.g., the handicapped, foreign language speakers) who would not otherwise be served.

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8

CONCLUSIONS

This final chapter presents models of the development process and user interaction for public access systems as well as a discussion of the critical issues that underlie the success of such systems. The chapter concludes by summarizing the problems and prospects for public access systems.

DEVELOPMENT PROCESS

Figure 8-1 outlines a model of the development process for public access systems. The model includes five major development phases which are arranged in circular form to suggest that development is a cyclic process which could begin at any phase. The model is idealized in the sense that the phases are represented as distinct, whereas in reality the transition among phases is invisible. Furthermore, certain phases may be more or less important in a particular application or project.

Analysis activities are usually the first phase of a project. This involves asking a series of questions about the public access application:

- What is the purpose or goal of the system?
- Who is the system intended for?
- When and where would the system be used?
- What should the content be?
- How should the system work?

The result of asking these questions should be a set of written specifications for the system that describes the objectives, the anticipated users, the projected usage, the relevant content, and the functional characteristics. This specification process is very important, because it provides the framework and basic assumptions for design of the system and the basis for evaluation of its success. A mistake in the specification, such as incorrect identification of the primary users or where the system will be located, can result in the design of a system that fails to meet its objectives. A poorly done specification, or its complete absence, jeapordizes the success of a system, no matter how good the subsequent design or development efforts.

Specifications also play an important role as a communication vehicle for all parties involved in the development of a system. Typically, there will be a number of different (and conflicting) ideas about the purpose and use of a system; the specification process forces concensus and decisions about alternatives before the design phase starts. The specifications can also be used for preliminary cost-benefits analysis to identify viable design options.

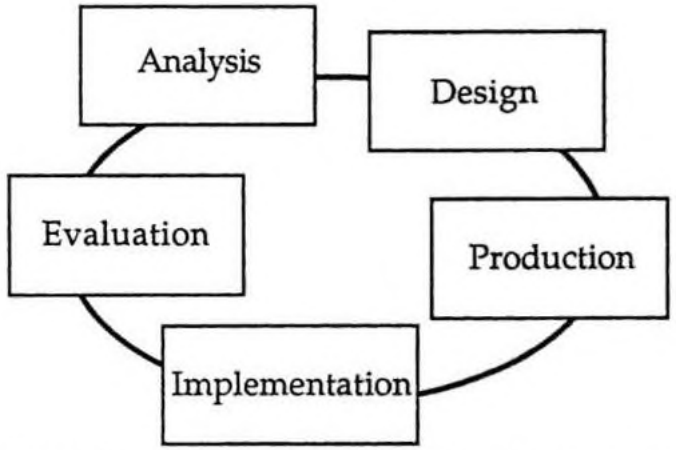


Figure 8-1. Model of the development process for public access systems.

The design phase involves translation of the system specifications into more detailed specifications for the user interface, the database, the hardware, and the kiosk. In most cases, it may be necessary to examine other systems, talk to vendors or consultants, or study the literature. In some instances, research studies may be conducted to investigate critical design questions. Prototypes are likely to be developed in order to try out different design alternatives and test out software/hardware. The design phase must bring together aesthetic and technical dimensions in the specification of screen layouts, program control, and kiosk form. The result of the design phase should be scripts or storyboards for the software and video sequences, schematics for the hardware, and sketches or physical mock-ups of the kiosk.

The production phase involves the completion of all software components (screen displays, branching options, graphics, animation), videotaping and editing, hardware interfaces, and kiosk fabrication. If optical media are involved, the videodiscs or CD-ROMs must be mastered and duplicated. Extensive quality-control activities are required in this phase to ensure that all system components are free of problems and working properly.

Implementation involves shipping and installation of the systems. It requires the development of a support plan that describes any training needed for site personnel and service procedures. In most cases, implementation is scheduled in stages, beginning with pilot testing of a small number of units to identify any unforeseen problems. A great deal of time is typically spent during the initial implementation period making small design changes and improvements to all aspects of the system based on user reactions. One aspect of particular attention is "bullet-proofing" the system to prevent people from "crashing" the hardware or software.

While evaluation has been left as the final phase to be discussed, in fact, much evaluation will have already taken place during the other phases. For example, focus

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groups and interviews/ questionnaires may have been used to answer questions during the analysis phase. Cost-benefits analysis may have been conducted during the analysis phase as well to decide whether to proceed with the application. The possibility of conducting research studies and prototyping during the design phase was mentioned. Quality control is a major part of the production stage. Pilot tests are usually conducted early in the implementation phase to ensure that the systems are functioning as intended. Indeed, the only form of evaluation that would be carried out after the system is fully fielded is effectiveness studies.

In many ways, the development model just discussed is idealized. The flow of activities from one phase to another is continuous, and there is usually no distinct sense of going from one phase to another. Different aspects of a system will vary in their progress; for example, the kiosk might be in the design stage, but the videodisc in production. Problems may require that some or all of a stage be repeated; time pressures may force a stage to be partially or totally skipped. Nonetheless, a well-managed project will run through all the stages discussed from analysis to evaluation.

USER INTERACTION

The essence of any public access system is the way it handles user interaction. The nature and extent of the interaction determines whether a system is successful. All of the ingredients for interaction have been discussed in previous chapters.

Figure 8-2 identifies four major aspects of user interaction for a public access system: attraction, learning, engagement, and disengagement. The first aspect is attracting the attention of the user. The appearance of the kiosk (color, materials, graphics, size) will contribute to this. So will the use of an "attract loop"-screen displays that involve animation or graphics along with sound or music. The use of a proximity sensor to trigger a presentation when someone comes within range of the kiosk is another technique for attracting attention. Mounting additional display screens on the top or sides of the kiosk also attracts attention.

The importance of this first aspect will depend on the type of application involved. For ATMs, online catalog, and message systems, the user will readily use the system once they find it; hence, attactiveness is not a major concern. On the other hand, for POS, information kiosks, exhibits, and games, attracting the user is a primary consideration. People will not use one of these systems unless it captures and holds their attention amid all the distractions of a crowded shopping mall, museum, or game arcade.

Beyond the visual appearance of the kiosk and screen displays, what characteristics capture and keep our attention? Psychological research suggests that novelty, uncertainty, and familiarity all attract attention (Berlyne, 1960; Eysenck, 1982), Any design that is unusual, unpredictable, or presents something we know (e.g., faces, voices, locations) will momentarily gain our interest. However, to maintain attention for more than a few seconds, the source must provide information that is personally relevant or meaningful. Unless there is some minimal level of interest in the subject matter being presented, the initial attraction will be lost.

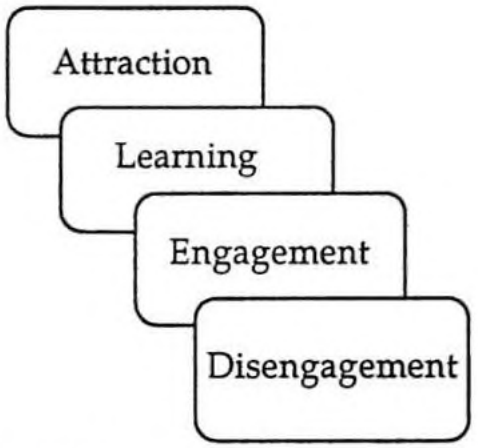


Figure 8-2. Model of user interaction in public access systems.

The second aspect of user interaction is learning to use the system. Once a person is attracted to the kiosk, they will want to do something. Figuring out how to operate the system must be so simple and intuitive that almost anyone can use it immediately. Otherwise, their interest will wane, and they will walk away from the system. All of the design principles discussed in Chapter 3 contribute to this goal. In addition, making it easy to watch someone else use the system, by means of a secondary monitor or open access to a kiosk, provides an opportunity for learning by modeling (e.g., Bandura, 1986).

Once the user has learned how to operate the system, he or she has engaged engaged in the primary task, for example, perform a banking transaction, purchase something, find out something new, learn where something is located, or be entertained. In most public access applications (i.e., ATMs, POS, online catalogs, message systems), the goal is to minimize the time on the system. The major interface design concern is how to make transactions as error-free and fast as possible. Research on human performance (e.g., Card, Moran, & Newell, 1983; Fitts & Posner, 1967; Norman, 1987) is relevant to this concern.

On the other hand, the goal of many exhibit, information, and entertainment systems is to maximize the engagement time (or the number of sessions). The primary design concern is to make the program interesting enough to keep the user participating. Malone (1984) suggests that an effective computer game involves challenge, fantasy, and curiosity. Crawford (1984) argues that sound and graphics should be the primary means for conveying ideas in a game-not text. Laurel (1991) proposes that designers think about the human- computer interface as a theatrical experience. Many designers believe it is critical to make the interaction personally relevant to users through the use of their name, their interests, or other information acquired from input.

Disengagement refers to the process of terminating the session. In the case of transaction-oriented systems such as ATMs, POS, online catalogs, and message

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systems, the successful completion of the task provides the basis for leaving. For information kiosks and exhibits, users generally leave when they lose interest, although some people may stay on the system until they have browsed through all options. Arcade games have a well-defined ending; they are over when the player loses.

The critical design concern at the disengagement stage is to be able to detect when the system has been abandoned so it can be reset. Most systems use a time-out technique-assuming the user has left if there is no input for a specified length of time (e.g., 20-30 seconds). Abandonment can also be detected by motion detectors that sense the user has walked away. To avoid an undesired termination, it is common to present a warning message asking the user to respond before the system is reset. It is also highly desirable to have a restart option so that a new user who takes over from someone else can manually reset the system.

Even though the model of user interaction just discussed is very rudimentary, it illustrates that system design must take into account a large number of psychological factors (e.g., attention, curiosity, memory, perceptual-motor skills). For a public access system to be successful, it must deal adequately with the four basic aspects of user interaction described above.

CRITICAL ISSUES

There are a number of critical issues that underlie the immediate or eventual success of a public access system. They include:

1. Will people use it?
2. Will organizations buy it?
3. What changes will it require/produce?

While these three issues are closely related, it is useful to examine each one individually.

Will People Use It?

Creating a public access system is almost always an exercise in innovation. Consequently, it entails all the risks and unknowns that innovative projects involve. There is no guarantee that people will use the system, even if it is well designed and functions properly. In a well-managed project, the answer to this question will be assessed as early as possible through surveys, focus groups, and prototype tryouts. However, it is often difficult to get a definitive answer about the usage of a system until it has been fielded.

It is certainly possible to identify some conditions that are likely to prevent a system from being used. A successful system must meet real needs. For example, bank ATMs that provide cash during the evenings or weekends provide a service in much demand. On the other hand, an information kiosk in a bank lobby that provides information on types of accounts and financial offerings has much less value-especially if customers can easily get this information from bank staff or brochures located a few feet away. A POS unit that allows the leisurely perusal of products or quick fulfillment of an order may be preferable to a sales clerk who is too aggressive or apathetic. Does an electronic message system work better than posting written notes on a notice board? Perhaps, if the messages are answered faster and reliably. Does an interactive exhibit or game provide more stimulation and enjoyment than some other activity in a museum or shopping center (such as watching other people or reading)?

In short, a public access system is likely to be successful when it provides services, information, or experiences that cannot be obtained just as easily from alternative sources and does not require that people wait or spend time on things they are not interested in. As the last part of this sentence suggests, the system must not only meet a general need, but also the specific needs of a given individual. Because there is tremendous variation in people's needs across age, gender, and socioeconomic categories, this is a very difficult task. That's why a careful analysis of the characteristics of the intended audience for a system is so important. While the system may not be especially effective for a secondary audience, it should work well with all members of the primary user group.

Of course, a system must be highly dependable for people to use it regularly. If the system is sometimes unavailable or broken, people will quickly stop trying to use it. Achieving a reliable system is a function of extensive testing and quality-control efforts, as well as a good servicing plan. If the hardware components fail often or are hard to maintain, reliability is going to be a problem. In Chapter 4, the importance of updating was discussed. If the user perceives the system as providing out-of-date information, he or she will stop using it. Conversely, if the system is always up to date with the latest information, this will serve as a strong incentive to keep using the system.

When first introduced, public access systems tended to be either underused or overused (the former being more common than the latter). Over time the usage may increase or decrease depending on how well the system is designed and promoted. System usage can be increased by providing incentives for its use, changing kiosk locations, improving the attractiveness of the kiosk, and redesigning the interface to make it faster or easier to use or more interesting. System usage can be decreased by limiting session time, improving response time (i.e., using faster hardware/ software), introducing user access codes or cards, adding supplemental monitors, or redesigning the interface to make it easier or faster to use. In either case, the first step is conduct a field evaluation to discover why the system is under- or overused.

Will Organizations Buy It?

Pleasing the end user is one thing; persuading an organization to adopt a public access system is another. Unless the system also meets the needs of the organization, it is not likely to be developed-even if it meets the needs of clients. Unfortunately, the converse is also sometimes true-a system will be adopted because it meets the needs of an organization, although it may not satisfy the customers' needs very well.

Cost benefits tend to be the most important issue with organizations. Top decision makers will pursue a public access system if they feel that it saves the organization money (reduce overhead costs), performs some function more effectively, or generates additional revenue. As discussed in Chapter 6, public access systems can in some instances meet these conditions. Certain applications and benefits are easier to "sell" than others. Any system that reduces overhead costs or generates additional

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revenue (such as an ATM or POS) is going to be relatively straight forward to justify. Systems that have less tangible benefits (e.g., information kiosks, online catalogs, message systems) will be more difficult to make a case for.

Affordability is another important financial aspect of public access systems. Regardless of how desirable (or profitable) a system may appear, does the organization have the money to develop and maintain the system? Even if a system is expected to reduce costs or generate new revenue, the organization must be able to pay the start-up costs including software, hardware, and installation. A question that always needs to be addressed is whether the same results expected with a public access system could be obtained some other way for less money.

Beyond the financial concerns, there is the issue of managerial support for a public access system. To the extent that managers are responsible for setting and enforcing policies that affect the implementation and use of a public access system, their support is crucial to its success. If managers do not feel that the system is important or worthwhile, they will pass this message on to the employees they supervise. Managers may perceive a public access system as usurping their responsibility or control and therefore be antagonistic toward it. In order to enlist the full cooperation of managers, it is neccessary to convince them that the system will make their jobs easier or create new opportunities.

It is very easy for innovations such as public access systems to get caught in the middle of political battles. Executives may push a particular project to gain visibility for themselves within an organization or industry, rather than due to any **intrinsic** merits of the system. A public access system may be used by one group as a vehicle for exerting control over another group by shifting resources (i.e., staff, budgets) or attention to their project. Depending on the success of a system, it may serve as a basis for groups taking credit or assigning blame which can lead to organizational conflicts.

Successful implementation of a public access system requires considerable organizational planning and coordination.[1] The objectives of the system need to be clearly communicated to all employees. Managers need to have a personal stake in its success, otherwise they will not make it a priority. Responsibilities with respect to developing and supporting the system need to identified. Conducting all of the development phases discussed earlier in this chapter will likely mean the involvement and cooperation of many different members of an organization.

What Changes Will It Require or Produce?

Innovations often fail, because developers fail to anticipate the changes that a new technology will involve. While these changes often cannot be foreseen, in many cases they are revealed by initial evaluation results and can therefore be addressed in the full-scale implementation of a system. Of course, if system developers do not conduct evaluation studies of actual usage or ignore the results of such studies, no such changes will be forthcoming.

Successful public access systems are likely to change user habits. Consider, for example, the impact of ATMs on banking behavior. People no longer need to make their schedules fit bank opening hours to obtain cash or make deposits. The availability of ATMs reduces the need to plan banking activities; money can be withdrawn whenever it is needed. This leads to many smaller withdrawals and a higher level of banking transactions. Furthermore, people become highly dependent on ATMs-they count on them working when they want money. They also become used to very quick and efficient transactions; they are likely to find the slow pace of a human teller frustrating by comparison.

Technology often has undesirable side effects. In the case of bank ATMs, there is an increased chance of robbery in their vicinity, because people frequently withdraw money late at night in deserted areas. To thwart this, some banks have put their ATMs in secure enclosures that can only be accessed by use of a valid bank card and are watched by closed-circuit cameras. ATM locations may require improved lighting or increased police patrols. The relationship between ATM implementation and crime is not something most system developers are likely to have taken into account initially (but something that might jeapordize the success of ATMs in certain locations).

[1]For further discussion about the management of technology and innovation, see Archibald (1976), Gee & Tyler (1976), or Twiss (1974).

POS systems could change buying patterns and retail selling methods. Customers can make purchases themselves without the need for a sales clerk or storefront. Customer support by telephone becomes a critical requirement for such systems in order to deal with problems and questions about orders. While fewer sales clerks may be required, they need to be more skilled and knowledgeable, because they will have to deal with the complex transactions that the system can't handle. They also need to understand the POS system well so they can help customers with it and use it as their own sales tool.[2]

Interactive exhibits raise a fundamental issue in the museum world-the significance of showing real artifacts (versus photographic or videotaped representations). Interactive multimedia make it possible to show a tremendous amount of material but all in electronic format. How important is it for someone to see an actual painting instead of a videodisc image of it, or a genuine space capsule rather than video footage of it? Obviously, a museum without any physical objects is a sterile place. On the other hand, interactive exhibits can result in a high level of visitor participation and learning. Given a fixed amount of money and floor space, should the emphasis be placed on showing real objects or interactive exhibits? What would most visitors prefer?

The museum issue raises a more general question for public access systems: Under what circumstances would people prefer to interact with a computer rather than a human being? The question lies at the root of decisions about the development and use of public access systems. Why would anyone want to interact with a machine rather than a person? Here are some possibilities:

[2]Indeed, some organizations assign an employee to stand beside a POS or ATM and encourage customers to use it. No only does this get more people to try the system but it is also likely to increase productivity of that employee.

- The system is more efficient, patient, or friendly
- The system is available when people aren't

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- The system contains much more information than a person would know
- The system is more interesting, fun, or enjoyable
- The system is able to do things humans can't
- The system is more competent, reliable, or intelligent

In circumstances in which some of these possibilities are true, public access systems make sense.

PROBLEMS

Developing and implementing a successful public access system is a difficult undertaking. It must fulfill a genuine need, attract people, be easy to use, and perform flawlessly. It must be sold to the organization in terms of cost benefits and to managers/employees as a workplace enhancement. To do these things, it must designed, installed, evaluated, and maintained properly.

There are many problems that need to be addressed and overcome. For example, hardware and software technology constantly changes, and it is difficult to decide when to adopt something new. New technologies usually provide more capability for less cost, but they may not be reliable and well supported early in the product cycle. Many projects that take a chance on using the latest technology run into problems later when the principal vendor disappears and there is no support or replacement parts available. In general, it pays not to select a new technology before its has gained some degree of industry acceptance (i.e., multiple vendors support it) and there is a reasonable customer base. It is also important not to proceed with a new technology until it has been adequately tested in prototypes and field tryouts to ensure that it is reliable and meets the particular demands of the application.

Another potential problem is user acceptance of a new application. When an application is new, a considerable amount of promotion and orientation is needed. For example, bank ATMs are well understood and accepted by most people; introducing an ATM system is not going to be much of a big deal (except perhaps in areas that have never seen one before). However, a POS kiosk that dispenses lottery tickets may meet with resistance, because people are used to buying their tickets from store clerks. Advertising that shows people using the kiosks (and winning) will lower resistance. Providing a free ticket for every three purchased or some other incentive will also help.

There is also the possibility that particular individuals or population segments will not use a system because of language, cultural, or other factors. For example, as a general rule, senior citizens are not prone to use technology and will avoid public access systems if there is another alternative.[3] If a public access system only offers one language, it is not going to be used by people who are not fluent with that language, or who are illiterate. People raised in a country where technology is highly unreliable are not likely to want to use public access systems. Some people may prefer to interact with human clerks for social reasons, even though they are not very efficient, competent, or dependable.[4]

The cost of developing systems remains the biggest single obstacle to their wider use. While hardware costs continue to come down, the costs of developing software and optical media do not. This part of the process is highly labor-intensive and therefore not likely to become less expensive. However, as more units are fielded and stay in use longer, the price per unit drops and makes them more financially attractive. It also takes time for organizations to become comfortable spending money on capital investments (i.e., technology) instead of operating expenses (i.e., salaries, facilities).

PROSPECTS

For a variety of reasons, the prospects for public access systems are promising. There is more and more acceptance of technology in the general population, especially with the young. People like the convenience and control that public access systems provide. Organizations like the reduced overhead costs or increased revenue that the systems produce. Furthermore, advances in user interface design, databases, and interactive multimedia will make computer systems easier to use, more powerful, and more interesting (e.g., Brand, 1988; Leebaert, 1991).

[3]In contrast to most children and teenagers who like to use technology and find it less intimidating than interacting with adults.

[4]For example, it is easy to imagine young adults not using the ATMs at a bank branch that employs a number of very attractive tellers.

While it is difficult to predict the long-term evolution of computer technology, it seems apparent that there is a definite trend toward the personalization of computing devices. We have seen computers go from huge mainframes to desktop personal computers and recently to notebook size. We have also seen microprocessors become common in everything from watches to microwaves ovens. There can be little doubt that over time, more personal and home appliances will take on the functions now performed by dedicated computing systems. For example, pocket telephones will be able to access almost any database or network via cellular radio links and display data on miniature screens or read it aloud. Intelligent television sets will automatically locate programs people are interested in and assemble them for viewing (along with customized commericals, unfortunately). Cars will feature display screens that allow access to map and travel information databases.

The increasing personalization of computing[1] is likely to reduce the need for public access systems, because information and services can be delivered directly to the individual. For example, ATMs are needed only as long as people continue to use cash-as more and more transactions are done by credit card and electronic funds transfer, their relevance diminishes. POS, information, online catalogs, and message systems become unnecessary if people can access these capabilities directly in their home, car, or pocket telephone. On the other hand, some exhibit and entertainment may persist because they provide experiences that cannot be duplicated on a small scale .

If this prediction is correct, public access systems represent an intermediate step between completely centralized computing and totally decentralized computing. The foundation for many public access systems comes from earlier closed systems. For

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example, ATMs are a descendant of the financial systems used by bank tellers; automated ticketing systems come from the reservation systems used by travel agents; online catalogs derive from the systems originally developed for librarians; and so on. Making these capabilities personally available is one step further down the road. Of course, this step depends on the systems being sufficiently easy to use, robust, and smart.

In the final analysis, public access systems represent an opportunity for people to play a more active and direct role in life, mediated by technology. They can perform banking transactions, buy goods and services, acquire information, exchange messages, or entertain themselves at their own convenience and without the intervention of others. The price paid for this opportunity is considerable structure in how such activities can be conducted. If this structure is at a tolerable level, people will use the system, and it will be successful. The challenge to the system developer is to minimize the structure and maximize the flexibility. With a public access system, people should be able to do what they want, where, when, and how. Public access systems should bring computer power to the people.

SUMMARY

This chapter presented a model for the development of public access systems that consists of five major phases: analysis, design, production, installation, and evaluation. While not all the steps described are critical for all applications, the more steps completed, the more likely the success of the system. Table 8-1 lists some of the most important questions that need to be addressed during development.

A four-stage model of user interaction for public access systems was outlined. The four stages are: attraction, learning, engagement, and disengagement. The model suggests that systems must be designed to accommodate each of these stages in order to be successful.

Table 8–1
Success Factors for Public Access Systems

Does the system meet the needs of the intended users?
Does the system provide a better alternative than existing means?
Does the system allow people to get information or services quickly?
Is the system affordable to develop, run, and maintain?
Is the system easy to learn and use?
Is the system reliable?
Has the system been adequately field tested?
Is the system interesting and fun to use?
Can the system be updated and maintained easily?

Three categories of critical issues were discussed:

1. Will people use it?
2. Will organizations buy it?
3. What changes will it require or produce?

The success of a system depends on addressing these issues in the development and implementation of a system.

Some of the major problems associated with public access systems include: constantly changing technology, user acceptance of new applications, suitability for all individuals, and development costs of software/media.

The prospects for public access systems are very promising. If properly designed and implemented, they provide satisfying experiences for users and increased effectiveness for organizations. Public access systems are likely to provide the foundation for increased personalization of computing in the future.

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APPENDIX: DESIGN FOR THE HANDICAPPED

A great deal of progress has been made in the past few decades with respect to the design of facilities and equipment that accommodates the special needs of the handicapped. To a large extent this progress has resulted from the passage of federal legislation that requires equal access and opportunity for disabled persons (Ladner, 1989). For example, Section 508 of the Rehabilitation Amendment mandates that all electronic equipment purchased through federal procurement be accessible to the handicapped. The Architectural Barriers Act requires equal physical access for the handicapped to and within all federal or public buildings. The Americans with Disabilities Act passed in 1990 extends civil rights protection to people with disabilities. It stipulates that all facilities open to the public (which includes most types of businesses) must be accessible to the handicapped. While none of these regulations apply specifically to public access systems, it seems likely that they fall within the scope of one or more of these laws.

Putting aside the legal and moral justifications, providing equal access to handicapped persons makes good business sense. If a broad definition is used (i.e., including "minor" visual, hearing, or mobility disabilities), the number of handicapped people is quite substantial (about 15% of the U.S. population).[1] Designing a system that excludes handicapped people from using it means that a significant portion of potential users are missed. While it is likely to cost more to design a system for use by a broad range of disabled individuals, the increased size of the potential audience for the system will probably make this expense worthwhile.

[1] *See Elkind (1990) for a detailed discussion of the incidence of disabilities in the U.S.*



Figure A–1. Kiosks need to be designed to allow wheelchair access.

Designing systems that are not usable by the handicapped is rarely a deliberate act; it is normally a matter of being unaware of the limitations imposed on disabled people. This Appendix discusses some of the considerations that should be incorporated into the design of a public access system to accommodate the needs of handicapped individuals.

PHYSICAL ACCESS

The obvious starting point for ensuring equal access is the design of the kiosk. Does the kiosk allow someone in a wheelchair to use it easily? Many kiosks have enclosures or sit on raised platforms that make it very difficult, if not impossible, for a wheelchair to get close enough to use the system. In many kiosks, the screen is mounted too high for a person in a wheelchair to see or reach. If the keypad or controls for a kiosk are recessed, they may also be out of reach for a wheelchair.

Awareness of the kiosk may be a problem for some handicapped individuals. For visually impaired persons, a motion detector that triggers an auditory message (e.g., "Welcome to the _____ system . . . please touch the screen") is highly desirable. An attract loop with sound or music is also valuable in locating the kiosk.

INPUT DEVICES

Visually impaired individuals and those with limited mobility in their arms or hands will have problems locating and using small buttons or screen icons. Some kiosks include an instruction panel and keypad/button labels in braille.

Any form of input that depends on the visual display of options is a problem for blind individuals. In order to overcome this problem, it is necessary to read all screen options aloud, providing time to respond after each one (i.e., sequential presentation). The "one button" interface described in Chapter 3 (which depends on timing of response instead of screen location) in conjunction with an auditory prompt is another possible solution. Voice input is probably the most desirable form of input for the visually impaired and physically handicapped; unfortunately, it is not sufficiently reliable and advanced enough at present to use in most public access systems.

When designing input methods for use by the handicapped, it is especially important to ensure that there are correction and repeat options. While such options are useful to all users, handicapped individuals may have special difficulties responding and need extra tries. Designers should also be careful not to make timeout loops too short for those who need extra time to respond.

OUTPUT

The problems of screen displays for individuals with visual handicaps and the importance of spoken output have already been mentioned above. However, there are a number of accommodations that can be made for people with visual impairments who are not totally blind. The use of large text is one such consideration (see Figure A-2). Not only does this make reading the screen easier, but it also allows the display to be read at a greater distance. The use of redundant cues when color is used is another consideration. For people with color blindness as well as other visual impairments, seeing text or graphics in certain colors is a problem. Outlining, shadowing, or patterning colored items will help.

For hearing impaired individuals, it is important to avoid designing systems that depend on auditory output. Because most public access systems are highly visual, this is not usually a problem. However, a system that relies on an auditory attract loop or voice/sound feedback to responses without accompanying visual display will present problems to a hearing impaired person. If a system uses extensive video segments with narrative, captioning should be considered. In addition, a user should be able to adjust the sound level in a program to meet their hearing needs.

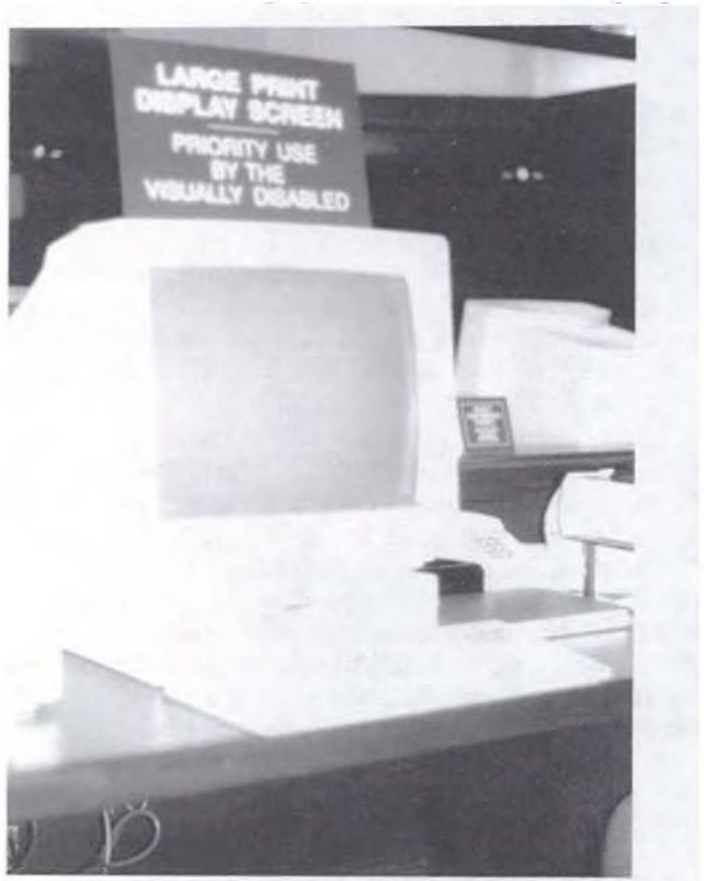


Figure A-2. Large print displays can improve the usability of public access systems for visually impaired individuals.

GENERAL GUIDELINES

A general design guideline for handicapped access is to provide as much redundancy as possible in system operation. Thus, input should be via touch screen, keypad, or buttons. Output and system feedback can be visual and auditory. Icons, keys, or buttons should light up and make a sound when activated. A second guideline is to allow as much user control of the system as possible. Allowing people to adjust sound levels, the angle of the display, the colors used, or the presentation rate are all possibilities. A third guideline is to keep all screen displays and control options very simple, minimizing any potential confusion or complications for translation to other modalities.

The irony of these guidelines is that they not only result in the design of a system that is more usable by the handicapped, but also one that is more usable by all individuals. Indeed, these three guidelines are fundamental to the detailed design principles discussed in Chapter 3.

DESIGN INVOLVEMENT

While the preceding suggestions may provide some helpful ideas, there is no substitute for the active involvement of handicapped individuals and disability experts in the design process. All of the evaluation methods discussed in Chapter 7 can be used to obtain such input. There are a number of organizations that can provide assistance locating appropriate individuals or information including the following:

- Closing the Gap, P.O. Box 68, Henderson, MN 56044, (612) 248-3294.
- Committee on Personal Computers for the Handicapped, 2030 Irving Park Rd., Chicago, IL 60618, (312) 477-1813.
- Computer Center for the Visually Impaired, 17 Lexington Ave., P.O. Box 515, Baruch College, New York, NY 10010, (212) 725-7644.
- National Technology Center, American Foundation for the Blind, 15th West 16th St., New York, NY, (212) 620-2051 .
- IBM National Support Center for Persons with Disabilities, P.O. Box 2150 (WB7F), Atlanta, GA 30055, (404) 988-2733.
- Association for the Advancement of Rehabilitation Technology, 1101 Connecticut Ave. NW, Suite 700, Washington, DC 20036, (202) 587-1199.
- Trace Research Center for Communication, Control, and Computer Access for Handicapped Individuals, S-151 Waisman Center, 1500 Highland Ave., Madison, WI 53705, (608) 262-6966.

In addition, most universities and many government agencies have departments that are responsible for supporting the handicapped and may be useful sources of assistance.

Further discussion of software and hardware design for the handicapped can be found in Brown (1992), Cattoche (1986), Edwards (1989), Mates (1991), McWilliams (1984), and Roth (1992). Casali and Williges (1990) describe major databases of adaptive interfaces for the disabled.

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