

ACCESS PROBLEMS WITH COMPUTER-BASED SERVICES

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## ABSTRACT

This paper examines a specific computer-based service which is in the process of being installed at the University of Wisconsin-Madison. It is an automated library card catalog which students interrogate through the use of computer video terminals. Access problems which may be encountered by individuals with various physical impairments are described. Ways in which access problems could be reduced or avoided are discussed. Particular attention is focused on possible uses of data routing modules and keyboard emulators.

The general access problem is then examined, and industry trends and their possible impact are investigated. The report concludes that the trend towards using multi-purpose personal computers (as exemplified by the IBM PC) in place of the more traditional work stations or word processors may result in reducing access problems.

## Introduction

Computer technology promises to open up both career opportunities previously denied to handicapped people, as well as entirely new kinds of careers. As computer technology begins to permeate our society, steps must be taken to prevent the introduction of computer-based services from bringing with it new access barriers.

A well-designed computer-based service will have taken into account the special needs of people with disabilities. Few services do. Disregarding this fact, even well-designed service delivery systems can be rendered inaccessible or unduly difficult to use due to circumstances beyond the system-designer's control. The system purchaser who is responsible for installing and managing the system plays a critical role in service accessibility.

In this report, we hope to illustrate and clarify the relationship between a system's design, installation, and use to its accessibility. It will help to examine a specific case before we tackle the general problem.

## The New Library System

The New Library System, most often referred to as the NLS project, is a joint undertaking between the University of Chicago, IBM, and the UW-Madison. The UW-Madison Administrative Data Processing (ADP) Center has designated an NLS team to work on this project. The purpose of NLS is to use computers to improve direct services to library patrons. To a large extent, previous library uses of computers have centered on internal administrative procedures, such as purchasing, personnel management and so forth. NLS will provide services that will be much more visible to the library user.

The first of several major applications to be implemented by NLS is an on-line catalog. An on-line catalog is intended to be the computerized equivalent of the traditional library card catalog which is organized by subject, author, title, and so forth. It goes beyond the traditional card catalog in that it can also indicate whether any given book is currently on the shelf or out on loan.

The NLS field-test site for the on-line catalog is the UW-Madison's College Library occupying three floors of the H. C. White Building. It is one of dozens of libraries at the UW-Madison. It is the only one of these libraries specifically designated as the undergraduate library. Note that at the UW-Madison, of a 1983 student population of 42,630 approximately two-thirds were undergraduates.

The library has some 40,000 holdings, all of which are described in the card catalog. The on-line catalog covers all of these holdings.

The intent of the on-line catalog, from a user's point of view, is to provide for much more rapid searching than is possible with a card catalog. Users are also much less likely to miss relevant entries. Since the search findings which appear on the terminal screens can be automatically printed, preparation of correct reference lists, bibliographies and the like will be facilitated. The on-line catalog also easily provides a possibility which is totally precluded in the case of a card catalog. It is economically not feasible to have more than one card catalog for a library of this size. In the case of an on-line catalog, it can, in principle, be used by any patron from any site, even from the patron's home, if support of dial-up patron terminals is provided (such support is planned). The implications for people with disabilities are very significant.

The library administration is very excited about the potential of the on-line catalog and other NLS services. This administration has another good reason for embracing NLS. The costs of maintaining the traditional card catalog are becoming prohibitive. It is a very labor intensive task. The costs of maintaining an on-line catalog are significantly lower. This task can be, and, to a large extent already has been automated. Thus the eventual demise of the traditional card catalog appear to be a foregone conclusion. It will not be thrown out, but it will only apply to the older holdings and those associated with far-eastern languages. It will be necessary to turn to the on-line catalog to search for most acquisitions beyond a particular cut-off date.

It is expected that on-line catalog will, by the coming spring, include 400,000 titles of the 4.5 million holdings associates with the Memorial Library the largest of the UW-Madison libraries. This accounts for almost all titles acquired since 1976, when the library began to record new acquisitions for eventual computer use.

It should in principle be much easier to find ways of making an on-line catalog accessible than was the case for card catalogs. It will soon be the case that it will be essential to find ways of making on-line catalogs accessible to people with disabilities, if they are to be provided opportunities for independent living.

### NLS Specifics

The NLS design is based on a distributed computer architecture. The largest computer involved is an IBM 3083. Connected to it are a number of IBM Series/1 computers. As NLS grows and spreads, it is expected that each of the larger participating campus libraries will house a Series/1 computer. The computer terminals used by patrons to examine the on-line catalog are connected to these Series/1 computers. Whatever may have been the NLS designers' motives for doing so, it is a very fortunate coincidence for us.

The typical larger IBM mainframe computer communicates with user terminals in a synchronous manner. This dictates that such terminals must be, in the vernacular, "IBM compatible." It is estimated that perhaps one-quarter of all computer terminals in use in the U.S. are of this "IBM compatible" type. Such terminals tend to be much more expensive (by a factor of two or three) than the terminals used with smaller computers (e.g., minicomputers). These lower-cost terminals typically use an asynchronous communications technique. The fortunate coincidence alluded to earlier is: the IBM Series/1 computer is categorized as a minicomputer, and its most commonly used communications technique is asynchronous. Thus the NLS on-line catalog terminals are of the lower-cost asynchronous variety. They are IBM 3101 terminals.

The IBM 3101 CRT terminal, was introduced a few years ago (before the advent of the IBM Personal Computer). It was IBM's first and only low-cost terminal, with two significant attributes:

- 1) it uses an asynchronous communication protocol and
- 2) it uses the American Standard Code for Information Interchange (ASCII).

Thus, the IBM 1301 terminal differs in two significant ways from the generic "IBM compatible" terminal. The "IBM compatible" terminals attributes are:

- 1) they use a synchronous communication protocol and
- 2) they do not use ASCII; they use the EBCDIC character code.

It is important to avoid confusing the notion of an "IBM compatible" terminal with that of an "IBM compatible PC," or with "compatible with the IBM PC." The IBM PC (Personal Computer), ironically, is not an IBM compatible terminal! It can be made into one (we will discuss this later) for a not insignificant extra cost.

#### Using the On-Line Catalog

The IBM 3101 terminals are located next to the card catalog, on the second floor of the College Library. As of September of this year, one terminal and one printer was operational, with five other terminals present, but not yet completely installed.

The IBM 3101 terminal has a detachable keyboard. However its cord length precludes having the keyboard much more than 10 inches from the terminal's front. The display unit can be tilted or swiveled. The rather elaborate keyboard, while intimidating, has very few of its special keys used in the normal course of things.

A patron begins a session by typing the word "begin" and

pressing the key marked Send. Except for the commands "begin" and "end," the commands are single letters, such as "f" for find. These can be typed in upper or lower case. The keyboard has a locking shift key. No distinction is made between upper and lower case letters, even in the names of authors or in book titles.

The screen (12" diagonal) may be difficult to read if one has a visual impairment. When a search request is being processed; one has little feedback to indicate anything is happening. The screen seems very cluttered with too much information.

As a patron types, errors can be erased using a backspace key. Old information can be blanked out using the space bar.

Hitting a wrong sequence of keys leads to a prompt to press the Reset key. Printing of search results is accomplished by pressing the key marked Print.

There is no use made of multiple simultaneous keystrokes.

#### NLS Access Problems

Here we can begin distinguishing between the kinds of access problems as they relate to various disabilities, and the causes of access problems.

A person confined to a wheelchair may find that the knee clearance provided by the tables supporting the terminals is insufficient. The floor to table-bottom clearance is 26 inches. It should be greater. Furthermore, the terminals are positioned so that table legs interfere with wheel-chair clearance.

The advantage of having a detachable keyboard, as does the IBM 3101, is that in principle it permits placing the keyboard in a more convenient position (e.g., on the lapboard of a wheelchair). The keyboard cable is too short to permit this. Even if a longer cable were used, the security hardware surrounding the terminal and its keyboard (added by the customer, not by IBM) in effect converts the detachable keyboard into an attached keyboard. Also, the security hardware (intended to discourage theft of equipment) prevents a patron from adjusting the terminal's display, thus defeating its tilt and swivel feature. Means of securing terminals should be found which does not detract from the flexibility intended by the terminals' designers.

It appears that a person only able to type by use of a mouthstick could use the on-line catalog, since no use is made of multiple simultaneous keystrokes.

The relatively small display character size could be



alleviated in a number of ways:

- 1) display most if not all information in upper case,
- 2) use of a hand-held magnifying glass, or
- 3) provide an add-on closed-circuit TV magnifier.

There are no audible cues in use, so hearing impairment does not cause access problems.

#### Use of Special Keyboards

For a person unable to use the IBM 3101 keyboard due to a severe motor impairment, there are two potential solutions:

- 1) use a custom-fit terminal
- 2) use an IBM 3101 keyboard emulator.

If a disabled person has a terminal which has been adapted for their use, the on-line catalog might become accessible in one or two ways:

- i) by providing a dial-up line
- ii) by providing a data-routing module.

In the case of using a dial-up line, the user's custom-fit terminal would have to behave in the same way as the IBM 3101 terminal, as it is used to access the on-line catalog. The minimal prerequisites for this would require that the custom-fit terminal be equipped with a modem (to allow communication over a telephone line) and that:

- a) it use asynchronous communication
- b) it use ASCII codes.

This is more likely than not the kind of capability a custom-fit terminal would have. However, another problem arises; the IBM 3101 can be used in either character mode or in a block mode. The block mode is similar to that found in buffered terminals. That is, the codes corresponding to the user's keystrokes are not transmitted until the Send key is pressed. Many otherwise 3101-compatible terminals are unbuffered. That is, codes are transmitted on a keystroke by keystroke basis. An unbuffered terminal cannot easily simulate a buffered terminal.

Technique (ii), providing a data-routing module, involves the one-time installation of a small box which provides connections which do not interfere with the normal use of the IBM 3101 terminal, but which allow a user's custom-fit terminal to be plugged in so it can operate on the same computer line as the IBM 3101. The data-routing module can only be used satisfactorily if:

- A. the custom-fit terminal can communicate at the same speed (9600 baud) and with the same framing parameters as the IBM 3101,

- B. the custom-fit terminal's user can easily read to IBM 3101 display screen, or,
- C. the custom-fit terminal's display responds to screen positioning codes just as an IBM 3101 would.

The operation of the IBM 3101 in the block mode requires that it have a half-duplex connection to the Series/1 computer. The current implementation of the data-routing module only supports full-duplex communication. It is expected that NLS will soon support the IBM 3101 in a character rather than a block mode. In that case, a full-duplex connection to the Series/1 will be provided.

Providing an IBM 3101 keyboard emulator involves building the electronics or writing special software for a generalized keyboard emulator, which, when used in conjunction with a custom-fit keyboard, can physically be substituted for the IBM 3101 keyboard. In order to use the on-line catalog, the one-time installation of an easily accessible keyboard connector would be required.

Going through the effort of researching, designing and constructing an IBM 3101 keyboard emulator only makes sense if either a great many IBM 3101's are or will be in use, and no better alternative solution is found.

The IBM 3101 has a key labeled PRINT. Pressing this key transfers the text being displayed on the 3101's screen to an attached printer. No signal is sent to the Series/1 computer. Thus the "PRINT" service cannot be activated through a data-routing module. Patrons who need screen printouts must use the few 3101s which have attached printers. It is conceivable that NLS might in the future support a print service which is accessible from any terminal in a given cluster of terminals.

#### Impending Solutions

Since the introduction of the IBM 3101 terminal, IBM has come forth with its IBM Personal Computer. It is rapidly becoming the most widely used and imitated personal computer. It shares with the 3101 the ability to communicate asynchronously, using the ASCII code. Should it be necessary software could be provided to make it completely emulate a 3101. Such software is now available from IBM.

The IBM PC has so many attractive characteristics that the NLS project now plans to support the IBM PC as an alternate user terminal for the on-line catalog.

When the support for the IBM PC is in place, a one-time installation of an easily reachable keyboard port connector could allow the Trace Center's IBM PC keyboard emulator (currently under development) to be used.

Furthermore, when the support for the IBM PC is in place,

use of a data-routing module becomes straightforward if a user's custom-fit terminal is based on (or emulates) an IBM PC. Additionally, use of dial-up lines is greatly simplified if IBM PC support will be provided.

Not all custom-fit terminals will be (or will emulate) IBM PCs. Fortunately, because the NLS project uses IBM Series/1 computers, in effect as front-end computers, and because software known as the Yale package supports the use of a variety of other ASCII, asynchronous terminals, it is anticipated that a wide variety of low-cost terminals will eventually be usable with the on-line catalog, in the dial-up mode.

#### Other Widely Used Services

It has become far more common for students to take advantage of computer-based word processing services to help them prepare assignments, term papers, and so forth. In some settings, students are required to use computers for all of the work associated with a course. This is as you would expect not unusual for a student taking a computer science class. However, it is now spreading to other disciplines. For instance, all student assignments in Freshmen English at UW-Eau Claire are now done at computer terminals. Students do not use paper and pencil or even typewriters!

In looking at computer-based services either currently widely used by students, or expected to be, it is important not to neglect the fact that a student's life may often involve a part-time or summer job. So it is important not to ignore computer-based services that are not usually thought of as being used directly by students.

With this in mind, other services and brands of equipment were examined, to see if any other kinds of special access problems turned up. The factors looked at are discussed next. The findings with regards to specific services or equipment will be detailed in a separate report.

#### Key Factors in Access Limitation/Access Enhancement

Is the keyboard detachable?  
Is the keyboard's cable long enough?  
Is the keyboard's cable easy to disconnect?

Which locking keys are provided:

Shift-lock  
Caps-lock  
Num-lock  
Other

Does normal use of the keyboard require multiple, simultaneous keystrokes?

Control - ?:  
Alt - ?

Does the keyboard have any function keys?  
 How many?  
 What codes do they generate?

Does the keyboard have any programmable (soft) keys?  
 How many?  
 What are their parameters?  
 Can soft-keys be down-loaded?

Is the keyboard encoded?  
 If not, can meanings of keys easily be redefined?

Which special-function keys are provided (e.g. PRINT):

Which code convention do the special-function keys use:

Do keys have auto-repeat?

Is the terminal buffered?

Is the terminal buffered?

Is it an ASCII terminal?

Does it use asynchronous communication?

Does it provide an RS-232C connection?

Does the display respond according to ANSI X3.64 protocols?  
 If not, specify:

Display characteristics:  
 diagonal size:  
 number of lines:                    characters/line:  
 size of char. set:  
 graphical capabilities:  
 color

Broader Considerations: Keyboards Versus Terminals

Access to computer-based services is most frequently provided through the use of a keyboard. Such a keyboard is not necessarily associated with a conventional computer terminal. For instance, automatic teller machines (ATM) used for banking transactions are not classified as "computer terminals." The phrase "computer terminal" tends to be reserved as a descriptor for the so-called "general purpose" computer terminal.

We have to pay attention to the way in which words and phrases are used in the computing industry, because if we do not, we may wind up setting the wrong priorities in reducing access problems.

As a general rule, computer equipment manufacturers do not report how many units of each item of equipment they either

manufactured or sold. One is led to examine surveys and various reports to learn approximately how widely used certain pieces of equipment may be, and what trends are developing.

Thus, to see which general-purpose computer terminals are currently in use in the U.S., one turns to Datapro, a publisher, and finds in the report of April 1983 entitled "All About Alphanumeric Terminals," that 92 vendors were selling 302 models of terminals. Of these, about one quarter were designated as being "IBM compatible" (also referred to as "3270 compatible, the 3270 being a popular IBM mainframe synchronous EBCDIC terminal). IBM itself accounted for sales of about half of all IBM compatible terminals.

The non-IBM compatible terminals are loosely classified by Datapro as ASCII terminals. Four vendors were singled out as leaders (presumably according to their sales). Those were: ADDS, Hazeltine, Lear-Seigler, and Televideo.

Another manufacturer was assigned a special category. Digital Equipment Corporation has established a de-facto standard with its VT-100 terminal. In fact, the manner in which the VT-100 uses code sequences to support more advanced display functions within the confines of the ASCII character set has now been embodied as the ANSI X3.64 standard.

A 46 page report entitled "Alphanumeric Terminal Market Overview" Mini-Micro Systems, Nov. 1982, pgs 350-395 stated that some 3.4 million terminals had already been installed, and estimated that this number would increase by at least one million terminals per year. An examination of this report (it includes detailed information on over 280 terminals, from some one hundred manufacturers) shows that among those terminals claiming compatibility with some other product, there were clearly two leaders:

- 1) IBM 3270 compatible
- 2) DEC VT-100/ANSI X3.64 compatible

Firm conclusions cannot be drawn by looking at the Datapro and Mini-Micro reports. They deal only with general purpose alphanumeric terminals. Such terminals account for only one-quarter or less of the uses to which computer-related keyboards are put.

A report of February 8, 1983, from Electronic News, gives the market share and cumulative share of keyboard uses, as we see in the following table.

<u>Use</u>	<u>Market Share (%)</u>	<u>Cummulative Share</u>
CRT	25	25
Word Processors	16	41
Printers	16	57
POS	11	68
PCs	11	79
Business Computers	7	86
High Reliability	5	91
Other	9	100

#### Keyboard Uses (E.N. Feb 2-83)

Presumably the top entry, for CRT, refers to the general-purpose alphanumeric terminals discussed earlier. The next largest category is that of word processors. Some firms make equipment specifically for word processing (e.g., IBM's Datamaster, CPT, NBI, etc.). In many cases, such equipment can also be used in place of a general-purpose alphanumeric CRT, so this type of use may grow rather than shrink.

The category "printers" presumably includes hard copy terminals (e.g., teletypewriters) as opposed to CRT terminals. This category will probably be shrinking in size. POS (Point of Sale) devices are special purpose terminals such as electronic cash registers which are connected to a computer.

The next category, PCs, for personal computers, seems almost insignificant with its 11% market share. This is very misleading. The E.N. report deals with uses of full travel keyboards (i.e., keyboards with ordinary keys, as opposed to flat-surface membrane keyboards) which are manufactured in the U.S. This does not reflect the actual use of keyboards in the U.S., as many of them are manufactured elsewhere.

If one is to accept the estimate of 3.4 million CRTs found in the Mini-Micro report, and then assume that the market share as a percentage of keyboard sales is proportional to the number of units sold, that leads one to conclude that some 374,000 personal computers were sold in 1982. Even if one excludes the lower cost "home computers" such as the TI-99/4, other sources indicate that personal computer sales in 1982 exceeded one million units.

#### Industry Trends

In terms of setting priorities on where to focus our efforts in reducing access problems, there is mounting evidence that the IBM PC may hold the key to a general solution.

Earlier we indicated that the IBM PC could be made to emulate an IBM 3101. Such a capability is already available as a software option, from IBM. We also alluded to the fact that "IBM compatible" terminals were more expensive than ASCII terminals, and hinted that getting a custom-fit terminal to emulate an IBM

compatible terminal would not be easy.

It is already the case that the extra hardware and software to make an IBM PC emulate an IBM compatible terminal exists. Such an option is available from several vendors, including IBM.

Much of the IBM PC software makes extensive use of simultaneous multiple keystrokes. However, since the IBM PC keyboard is not an encoded keyboard, and by virtue of the manner in which its MS-DOS operating system is structured, it is possible to redefine the keyboard's operation with special software. A software package from Prokey makes it possible to simulate simultaneous keystrokes by pressing the keys sequentially.

When the Trace Center finishes the construction of the IBM PC keyboard emulator, this will provide a path to allow access to services provided by most mainframe computers, and all minicomputers.

#### New Complications and Transparent Keyboards

The attraction of the IBM PC is so great that almost every major computer manufacturer has come forth with an IBM PC "look-alike." A look-alike computer is not necessarily identical to an IBM PC, but it is one in which IBM PC software can fairly easily be adapted for use. The look-alikes either use the same Intel 8088 chip that one finds in the IBM PC, or they use the Intel 8086 which is 100% software-compatible with the 8088 chip.

To date, one can find the following look-alike computers:

<u>Manufacturer</u>	<u>PC Look-Alike</u>
Burroughs	B20
Digital Equipment Corporation	Rainbow
Hewlett-Packard	HP 150
Sperry (UNIVAC)	Sperrylink
Texas Instruments	Professional Computer
Zenith	Z100
Wang	Professional Computer

Major manufactures with IBM PC look-alikes.

We are not here including start-up firms such as Compaq, Corona, Columbia, and so on.

A clear long-range strategy is emerging. PCs are being installed as multi-purpose workstations, and they are beginning to displace the traditional dedicated word processing systems. This is beginning to happen with IBM mainframe systems. It has become the policy at Wang that Wang PCs will be able to take on traditional Wang word processing functions and also double as workstations on Wang VS computer systems.

All of these systems use similar keyboards and they all work through the MS-DOS BIOS software. This should make it straightforward to adapt the Trace IBM PC keyboard emulator and construct emulators for these similar keyboards.

Alternate devices are coming into use, either as keyboard enhancers, or as keyboard substitutes. The devices include:

- 1) touch sensitive screens
- 2) mouse
- 3) graphics tablet
- 4) voice input

These devices need not increase access problems if they are provided as adjuncts to a keyboard. If they are intended to replace keyboards, then we may have some difficult access problems on our hands.

A custom-fit keyboard may be able to simulate input from either a mouse, a graphics tablet or other positional devices (e.g., joysticks).

#### Problems With General-Purpose Versus Special-Purpose Systems

Access to a general-purpose (G-P) computer providing a time-sharing service is less likely to have difficult access problems. By its very nature, a G-P computer will be accommodating to a variety of terminals. Almost any plain ASCII terminal will be usable, so there should be fewer problems in using either a data routing module or a keyboard emulator.

Access problems which arise in the use of special-purpose systems or single-function systems will likely be either much more difficult to cope with or much easier to deal with. We seem to have a paradox here.

The designer of a general-purpose system (e.g., a DEC VAX-11/780 running the VMS operating system) provides a resource which users will program as they see fit. A priori the designer has no inclination to restrict the kind of terminal to be used. So in general many kinds of terminals will be supported.

The designer of a special-purpose system has a specific application in mind. Anything which enhances the successful realization of this application will be considered. In particular, if a one-of-a-kind terminal which has special features which lend themselves to better supporting the application can be found, it will probably be adopted as the exclusive terminal for this application. Some special-purpose systems go as far as commissioning the design and fabrication of custom-made terminals. Such is the case with automated bank teller machines (ATM).

In a special-purpose system, we see that to the extent that only one kind of terminal tends to be used, resolving access



problems reduces to dealing with just one set of access parameters. That is a plus.

To the extent that the terminal type used by a special-purpose system deviates in many ways from a typical ASCII terminal, access problems are increased.

One encouraging trend may be on the increase. The cost of designing and manufacturing special-purpose terminals is high. Unless very special circumstances prevail, it is often cost-effective to use a PC as the basis for a special-purpose terminal. Most PCs can be programmed to behave like almost any imaginable special-purpose terminal.

### Display Features and Security Problems

Some CRTs have special display field attributes to control where and how information is presented on a display. Disabled users with custom-fit terminals may need to have suitable analogs for some of the more significant display attributes if these cannot be fully emulated.

For instance, default choices in menu-driven programs are often indicated by highlighting the default using a reverse-video field. This information should be conveyed somehow to the disabled user's display.

Introduction of a data routing module may be resisted in certain situations. Consider the IBM 3101. One of its field display attributes is "store, but do not display." This makes it possible to respond to queries by having the computer send the same information, but precede the information with field attributes which govern which parts of the screen will or will not be readable. Such control is needed in situations where "need-to-know" hierarchies prevail. For instance, a hospital billing clerk may have access to a person's medical records, but only certain portions of them should be displayed. A hospital physician would be able to examine the pertinent portions of a medical record.

The hospital administrator may be reluctant to grant permission to install a data-routing module because it would be very much like a telephone "wiretap." The administrator would have no assurance that the disabled user's custom-fit terminal would conform to the privacy features of the hospital's standard terminals. Short of having the individual's custom-fit terminal artified "safe" and then sealed, it would be relatively easy for any knowledgeable person to circumvent a hospital's safeguards by exploiting the weak link introduced by the data routing module.

### Display Requirements

Most of the computer-based systems are screen-oriented. The typical screen holds 25 lines of 80 characters each. A full-screen can hold 2,000 characters. Filling up a screen can be a

very lengthy operation (in computing terms) thus computer-to-CRT transmission speeds in use tend to be in the higher ranges, such as 4800 or 9600 baud. At 9600 baud, it takes about 2 seconds to completely fill a screen.

A disabled user's terminal may use a printing device instead of a display screen. Typical printing devices are incompatible with the cursor movements screen-oriented applications rely on. Also, most printing devices are incapable of operating at speeds in the 4800-9600 baud range.

A disabled user's terminal may be using a television set as a display device. A television set is usually not capable of displaying even one quarter of 2,000 characters at a time. As a consequence, application programs which produce easy-to-read output when using standard CRT displays or monitors may be hard to use with television displays. The top-half of a conventional display's text may have been pushed off the top of the television display, and any lines exceeding 32 or 40 characters in width may have been folded.

#### Dial-up Service

Until recently, synchronous terminal dial-up support was almost always provided with 300 baud communications. In the last few years, the cost of 212A modems has been dropping rapidly (it is now below \$400), so it has become much more common to find dial-up services providing 1200 baud communication (a 212A modem provides a choice of 300 or 1200 baud).

The trend to local measured telephone service, and the greater demand for use of dial-up lines will clearly lead to poorer and more expensive service for those whose equipment can only communicate at 300 baud.

In connection with lower-cost 212A modems, it is easy to find 212A modems which support auto-dial. An auto-dial capability, when used in conjunction with a user's intelligent terminal, makes it possible to initiate sessions with dial-up computer services using prerecorded telephone numbers simply by selecting the desired services with the equivalent of a few keystrokes.

## Conclusions

At first glance, the initial implementation of the on-line catalog should be easily accessible to disabled individuals who use custom-fit ASCII terminals, since the on-line catalog system uses IBM 3101 terminals, which are ASCII terminals. A closer look reveals that many problems will be created in attempting to use custom-fit terminals, because of the nature of 3101 terminals. The long-run solution lies in waiting for the development group to support either "plain" ASCII terminals or IBM Personal Computers. Fortunately both measures are planned.

Looking beyond one system, we see that perhaps one-quarter of all computer terminals are of the expensive "IBM 3270" compatible type. Then perhaps as many other devices fall in the category of dedicated word processors. All of these pose access problems. It is clear that as new terminals and word processors are needed, manufacturers are encouraging their customers to acquire personal computers instead. PCs can serve as multi-function workstations. Since the most popular PCs share many characteristics with the IBM PC, it is to be hoped that the Trace Center's IBM PC keyboard emulator may be able to address and resolve many of the access problems associated with computer-based services.

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