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Technological enhancements for personal computers

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THESIS

TECHNOLOGICAL ENHANCEMENTS FOR PERSONAL COMPUTERS

by

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Technological Enhancements
for
Personal Computers

by

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ABSTRACT

This research is concerned with the usability and compatibility of many of the aftermarket enhancements commercially available to agencies using microcomputers in their workplace. These devices include biometric access devices, data input devices, storage devices, and data transfer equipment. A limited number of associated software packages will be evaluated along with the hardware involved.

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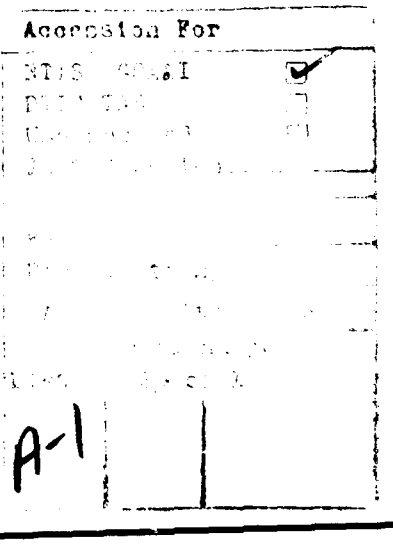
Security considerations for physical area, data access, and transmission media are discussed as this topic should be a vital concern for DOD computer users. The report concludes with a limited number of application scenarios that represent some of what can be accomplished with personal computers.



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I. INTRODUCTION

The availability and capability of Personal Computers (PCs) have progressed exponentially in the last ten years. Evolving from the slow 4.7 MHz 8088 based PCs of the early 1980s to the current 40 MHz 80486 PCs on the market today. Personal computers can be found at all levels of the public education system and today's youth are becoming increasingly computer literate. Availability of inexpensive PCs has created an environment where almost half of the homes in this country now have a computer. Large scale military procurement has evolved since 1983 from the original desktop Zenith Z-100 to the current UNISYS machines.

Many managers are facing the problem of needing computers to automate tasks performed in their offices. With the variety of options available under the current contract and the overwhelming amount of information in the trade magazines, many managers need a consolidated source that is easier to understand and will allow them to get a rapid look at their options in automating. Many officers, senior NCO's, and GS level civilians in our military services today are still very naive with respect to the PC world, yet many of them will be faced with automating their offices and selecting suites of PC's and components with little or no knowledge of how to do it. This thesis

provides a guide for people with little experience, to show them the different "parts" they will have to choose, and what their options are within many of the "parts" categories.

This thesis will explore the options available to military managers in terms of microcomputing power, the contractual history of PCs, the potential advantages in the current Desktop III contract, and some of the many options available to enhance microcomputer use. With the current proliferation of personal computers in the office, schools and home environment this author is presuming the audience has a rudimentary understanding of computers and a thorough understanding of the systems needing automation in their organizations. The purpose of this tnesis is to provide a starting point for potential users to get them thinking about all the possibilities of their purchase, not just the immediate usages. With few exceptions all of the options discussed here are available under the Desktop III contract. The new Desktop IV contract, which is currently under protest, can be evaluated under the same generic guideline presented here.

Using the flow diagrams, questionnaires and the discussions on optional equipment presented in this thesis, the reader will better be able to select a computer system for their office needs.

The first order of business is to decide what can be efficiently automated. What criteria determines whether a task is done better by hand or by machine? With the current state of flux caused by the rapid technological changes more and more tasks can be automated that would not have been possible in the past. Some tasks are almost automatically put on the list. Most accounting functions, simulation modeling, database management, word processing and graphics support are obvious choices. This author uses the following criteria for other types of tasks to decide whether they need automation.

Task Automation Criteria

- Is there a systematic methodology to how the task is done? Is it done consistently and with a well defined set of rules?
- Would automation increase turnaround speed or the accuracy of the output?
- Would creating an automated data base of the organization's information lead to better analysis of facts, thereby increasing mission effectiveness?
- Are the cost savings, or marginal benefits, worth the extra expense of the equipment, software and personnel training?
- Is the physical environment conducive to long term computer life?
- Is the interpersonal environment in the office adaptable to automation?

While this thesis does not directly address the constantly expanding area of workstations, this is an option

the procuring agencies need to consider for some of the more expanded processing requirements. At the other end of the spectrum are the laptop and/or notebook systems. These highly portable systems are a viable option for mobile use and are capable of any application that can be done on a desktop computer.

In view of the broad spectrum of choices available, the military manager faces a confusing array of options when it comes to procuring office automation equipment. Apply the following list of questions to your mission requirements. We will look at them again in Chapter VIII, Determining Needs.

1. What are the possible applications to go on the machine?

   a. Do applications perform heavy number crunching, or contain large spreadsheets?

   b. Graphics, word processing?

2. How large are the software and data files needed to perform these applications?

3. What Input/output devices are needed?

   a. Input - keyboard, pointing device, scanner, speech recognition?
   b. Output - printer, plotter, data plate?
   c. Communications, internal FAX, modem?

4. What security considerations are required by the risk analysis?

   a. Is physical area control required?

b. Do files need to be removed and locked up when unattended?

c. Is positive operator ID needed for any transactions on the machine?

5. Are any office workers handicapped who require special equipment?

6. Will the system need to run more than one program at a time, or break out of a program to get information from a different application?

7. What type and frequency of backups are needed?

8. Is there a need to transfer data between distant machines, or hook up to a mainframe?

9. Is FAX support needed? Integrated or stand alone?

To help managers answer these questions, a brief history of government personal computers is given in Chapter II. Chapter III through VI provide information on what is available on the Desktop III contract and is expected to be in similar future contracts. The reader needs to be aware that this industry is developing at a rapid pace and future technological improvements will make the personal computer even more powerful and user friendly. Chapter VII lists scenarios for using personal computers in the workplace. As Chapter VIII readdresses these questions, the reader is provided with a template to help lay out a system matching their needs. Finally the results of this author's

experiments in making many of the available pieces work together is discussed in Chapter IX.

II. HISTORY & TYPES

A. DESKTOP I CONTRACT.

The original 1983 military contract was for a microprocessor-based system to support general purpose applications, and was originally written for a maximum of 10,000 systems. It was upgraded in 1984 to 17,000 systems. The Zenith Z-100 contract specified two configurations. The first had a pair of 5-1/4 inch floppy disk drives and the second had one floppy and one 10 MB hard disk drive. All of the systems had 192k RAM expandable to 256k.

The systems had both an 8085 8-bit CPU chip using CPM, and an 8088 16-bit CPU chip for MS-DOS. They had three vacant expansion slots. The July 1984 price for the hard-disk version was $2,250.00. Many users found them to be slow and unwieldy and consequentially they did not get the expected usage nor did they provide the advantages we find in more modern computers.

B. TEMPEST I CONTRACT.

In Oct 1984 Zenith Data Services was awarded a second contract for 10,550 microcomputers. Mandatory for the Air Force and Navy this acquisition contract was for stand-alone TEMPEST microcomputer systems. An 8088 based computer, it came with 320k RAM, two 320k floppy disk drives and a choice

of monochrome or color monitor. This contract also had a hard disk version, calling for a removable 10 MB cartridge. The basic system price, without monitor, of $2,699.00 jumped to $4,070.00 on the hard disk system. The Z-150s had the same speed limitations of the Z-100s until contract modification P00022 in July 1987 authorized the substitution of a series of Advanced TEMPEST Microcomputers (ATM). The ATM's enhancements included an 80286, 8 MHZ CPU with 512K RAM and MS-DOS 3.2. (AFCAC,1984)

C. DESKTOP II CONTRACT.

The emergence of the Z-248, an 80286 based microprocessor, in the Desktop II contract signalled a sharp upturn in the availability and useability of micro-computers within DOD. Zenith sold over 450,000 Z-248s to various government users under this contract. Zenith is now offering an open market (not on Zenith's GSA schedule) 80386 upgrade for the Z-248 with an option for a 150 MB hard drive (Danca, 1991, p. 51). The speed increase offered by the ATM and the Z-248 meant the difference between the user having long waits for the computer to catch up and the computer waiting for the person to enter data and instructions. The optional 40 MB hard disk is adequate for most users with proper disk management and backup.

D. DESKTOP III CONTRACT.

The latest general purpose microcomputer contract, awarded to UNISYS in Nov 1989, is an 80386 based processor, 16 MHz or 20 MHz, with a large list of available options. The base price on the 20 MHz version including an arithmetic coprocessor, 4 Mb RAM, an internal 3-1/2" high density floppy disk drive and a serial mouse is only $993.00. Hard disk drives (up to 340 MB), monitors, printers and the MS-DOS operating system are among the items ordered separately (Standard Systems Center, 1989).

This current contract has experienced many problems with delivery. Inaccurate and/or incomplete orders, at the peak of the problem, were running 80 to 85 percent of all orders submitted (Hamblen, 1991, p. 7). Additionally, orders far outreached UNISYS's expected demand: 100,000 units ordered against a quota of 46,000, as of 28 February 1991. Currently UNISYS is meeting its production requirement of 6,000 systems per month but still has a backlog, for some users, of a year or more (Brewin, 1991, p. 1). UNISYS is also under investigation for substituting processing chips in some of its delivered systems. The substitute chip, a 386SX is faster at 20 MHz than the original 16 MHz chip, but has a slower 16-bit vs 32-bit data path. Initial deliveries have been well received and appear to be a great improvement over earlier systems.

The Air Force, with concurrence and urging of the Navy, approved on 15 November 1991 the follow-on Desktop IV. This contract, with an April 1992 effective date, was awarded jointly to CompuAdd and Sysorex. As of 13 January 1992 the contract is under suspension pending resolution of a contract challenge by IBM and Apple Computers among others with resolution anticipated by August 1992 (Baker, 1992, p. 26). Further DeskTop III buys are on hold pending Air Staff and Congressional release of funds for an extension of their contract past the original November 1991 expiration date.

TABLE I. CONTRACT OPTIONS.

Contract	Processor	Hard Disk	Options
DeskTop I	8085 CPM 8088 MS-DOS	10 MB	Printer
Tempest I	8088 MS-DOS	10 MB Cartridge	Color monitor Printer
ATM	80286 MS-DOS	10 MB Cartridge	Color Monitor Printer
Desktop II	80286 MS-DOS 3.2	40 MB	VGA monitor Printers 20 MB Tape Backup

Desktop III	80386 MS-DOS 4.1 and UNIX	41.9 MB, 84 MB, 168 M. 340 MB 44.4 MB and up Cartridge	Monitors(5) Printers(4) Modems(12) CD-ROM, WORM FAXs(11) Page Scanner Tape Backup(3) LAN Interface High Density Floppy Drives

III. PERIPHERALS

A. INTRODUCTION.

No study of computers is complete without examining how to get data into and out of the machine. Processing power is useless unless it can be controlled and channelled toward the applications of each user.

B. DATA INPUT DEVICES.

1. Keyboards.

Keyboards are common to all PCs. They are available in a small variety of layouts differing usually only in the placement and number of the function keys and the availability of a numeric keypad. Some specialized keyboards have special 'hot' keys to initiate certain transactions. In addition there are keyboards available in many different languages, each with their unique character sets.

2. Pointing Devices.

Pointing devices, the most common of which is the mouse, are very useful additions for cursor and input control. In addition to the familiar mouse design hardware, manufacturers have developed pen shaped pointers, various types of trackballs, and joystick shaped devices. Keyboard attached trackball variations, such as Microsoft's new

'BallPoint', provide mouse like operation for portable computer use where there is no room for the articulation of a mouse. (Miastkowski, 1991, pp. 59-60)

Available in two button or three button variations these devices, along with compatible software, are productivity enhancing tools. Freehand drawing, icon selection and pulldown menus are all speedily accessed with pointing devices. Indispensable for graphics design programs, they are also used with many other software tools as a control device to activate pulldown menus and icons.

Industry is also developing devices to assist the handicapped in using computers. An example is the HeadMaster, produced by PRC, a hands free pointing device. Cursor control is provided by head position while a sip-and-puff air pressure device, or any other type of switch, activates the ENTER key. Special software provides a keyboard layout on the monitor screen to simulate manual typing. In this mode, after a given amount of dwell time pointing to a key, the key is activated for the user.

A special type of pointing device, the digitizer tablet, is used to directly convert designs or schematics into files.

3. Scanners.

Scanners come in two distinct types. The hand scanner is useful for inputting small quantities of data,

for example a signature or graphic. The page scanner takes in a larger quantity of data making it very useful for inputting pages of text for inclusion in other documents or for further editing where the source data is unavailable. Scanning can also be used in conjunction with a FAX board to allow transmission of non-computer generated documents. Scanning produces graphics unless available optical character reader (OCR) software is used to convert scanned characters into text editable files.

4. Speech Recognition Devices.

Speech recognition devices can be used for any application where hands free input is required. These devices are available with recognition vocabularies of up to 5000 words (Gallent, 1989). More recent systems in 1991 can recognize 30,000 words in an isolated word or discrete mode.

Speech recognition devices can be speaker dependent, where each operator has to train the system to recognize his voice, or speaker independent, where the machine can recognize a more limited set of words, but does not need individual operator training. In addition two different methodologies are used. Isolated word recognition depends on a pause between words to allow the machine to identify where each word ends. Continuous word recognition can "understand" sentences and phrases using normal speech patterns.

5. Script Recognizer.

One of the newest input mediums becoming available is the stylus and tablet based handwriting readers. Designed to read handwritten inputs through their sensitized tablet, they can capture and convert into text, inputs jotted onto an overlay of questions. Earlier versions could capture signatures for receipts but only as graphics files. Already in use commercially by truckers and deliverymen (GridPad), these devices have potential as onscene input devices for crew chiefs as they conduct maintenance debriefs of pilots.

Currently limited by lack of compatible software, they are an innovative newcomer that can replace the traditional keyboard in some applications. Microsoft (PenWindows) and GO Corp. (PenPoint) are developing operating systems to work with this type of device. Grid Computers has hardware under development to use both of these systems. (Malloy, 1991, pp. 27-28)

C. OUTPUT DEVICES.

1. Printers.

Personal computer printers come in three basic types. The first printers were impact printers adapted from typewriters. These printers could produce letter quality output but were limited by their speed of printing. Faster printing could be done on the dot matrix form of printer,

but at the cost of quality of printing. The early 9-pin dot matrix could be used for drafts or documents needing near letter quality. The 24-pin dot matrix printer greatly improved the letter and graphics output quality.

The best quality output is obtained on the newest type of printer, the laser printer. This printer combines the versatility in font styles of the dot-matrix printer with quality of printing that rivals type-setting. Laser printers fuse the ink to the paper at 392°F producing offset quality printing. These printers can accommodate stock paper, preprinted forms, adhesive labels, envelopes, and overhead transparency film. The laser printer has the additional advantages of being free of the electronic emanation problems and high ambient noise levels associated with the older style of printers.

2. Plotters.

Plotters are an extremely useful output device when large graphics are concerned. Electrical schematics, civil engineering blueprints, and communications path profiles are but a few of the applications best done with the aid of a plotter. Software for Computer Aided Design (CAD) and/or Computer Aided Manufacturing (CAM) increases productivity of critical personnel.

3. Screen Displays.

Output screen displays range from monochrome screens to various color graphics monitors to very large screen displays used in command centers. Resolution is dependent on both the quality of the screen and the graphics driver card, quality improving progressively from CGA, to EGA, to VGA, and ending at super VGA. In addition to the standard cathode ray tube, similar to TVs, displays are available for portables in energy efficient, but lower graphics quality, liquid crystal and plasma displays.

4. Data Plate.

Screen graphics can be viewed by large audiences via overhead projectors by use of a data plate. Data plates are attached to the computer via the monitor port and are placed directly on an overhead projector in place of transparency film. They are available in both monochrome and multicolor formats. These devices, along with display graphics software such as Harvard Graphics or DrawPerfect can quickly produce easily managed briefings from existing databases.

IV. COMMUNICATIONS

A. LANS.

Local Area Networks (LANs) are a mechanism to connect related users and central data files. This practice maximizes system time availability while minimizing fraudulent access and the danger of file contamination.

B. MODEMS

Modems are devices that allow users to transfer data over long distances using telephone grade or better lines. The Hayes and Hayes compatible modems are the most common hardware device used in modem communication. Kermit, BITCOM, PROCOMM, and PROCOMM Plus are some of the many software packages available to operate the modem hardware. The software bundled with the modem is not always the best program available. It is important that what you use is compatible in speed of transmission and protocols with the devices at the distant end. The DeskTop III contract has modems listed for ten NATO countries in addition to the U.S.

Modems can be used to access a mainframe, another PC, an electronic mail service, the Defense Data Network (DDN) or a Bulletin Board Service (BBS). Most modem software includes a host mode to allow set up of your own BBS. Caution should be taken any time files or programs are received from

outside as this opens your system to potential viral contamination which can destroy or damage your resident files. A computer virus can attack files or disk control blocks and destroy your data or programs.

C. FACSIMILE (FAX) BOARDS.

FAX boards are available under DeskTop III for the same countries as for the modems. A PC mounted FAX is more flexible and cheaper than having a separate FAX machine. A single user FAX board running between $150 and $700, with FAX gateways to serve LAN's running from $400 to $2800, compared to stand alone FAX machines at $500 to $1500.(Lusty, 1991, pp. 182-189) Operating costs are less for a FAX board than a stand alone FAX. The speed of FAX board to FAX board transmission is higher by storing to disk rather than operating at slower print speeds of the stand alones. Further operating cost reductions are realized on both board FAXs and some of the more expensive stand alones by scheduling FAX transmission during the lower cost night time telephone rate periods. Automatic redial along with the transaction log insures receipt at the distant end even with an unattended system.

Board-based FAX also have a few disadvantages. FAX operation requires the system to be operational. Externally generated documents cannot be sent on the FAX unless you

have a scanner available. The FAXing procedure, depending on the software bundled with the board, can interrupt any other work on the system. (Beechhold, 1991, pp. 64-65)

When the FAX is received it can be stored for later viewing onscreen, stored and printed on the PC's printer, or forwarded to a different location. Viewing incoming FAXs onscreen allows the user to selectively print only those FAXs needing hardcopy. The PC's printer produces a higher quality printout than the external FAX machines. A big advantage of the computer based FAX is its automatic log for all incoming and outgoing transmissions.

D. VOICE MAIL.

Most modern offices have answering machines to take calls after working hours. Having a voice information system (VIS) greatly enhances the versatility of after hours communications. In addition to the answering machine's ability to save incoming messages, a properly identified caller can receive personalized messages, check their electronic mail, or check personal voice mail. The Watson Communication Center, by Natural Microsystems Corporation, combines telephone management with a built in modem for electronic mail or remote file access, a FAX board, and an attached scanner to provide a comprehensive message management package.

E. ELECTRONIC MAIL.

Electronic mail, whether local via a LAN, or DOD wide using the Defense Data Network (DDN), has become an accurate and timely method of information transfer. One of the big advantages to using DDN for electronic mail is your ability to access your electronic mailbox from any modem equipped PC, while still affording system security with password protection. There are many other networks accessible from DDN and each user needs to evaluate their access requirements on a case by case basis.

V. MASS STORAGE DEVICES

A. HARD DISKS.

Fixed hard disk drives are data storage devices with very rapid access time. They run in size from the 10 MB drives of the Z-100 to the optional 340 MB available on the DT III contract. Cartridge hard disk drives, which can be removed for secure storage of the data cartridge, run from 10 MB on the Z-150 to over 44.5 MB on the DT III. Caution must be taken to use correct file management on hard disk drives. MS-DOS has a limit of 512 files or directories in each hard disk root directory. Disk management programs are available and highly recommended for all hard disk users. Toft's article on hard drive management is recommended reading for all users. (Toft, 1991, p. 33)

B. FLOPPY DISKS.

Floppy disks are small removable disk which is used for storage or to physically transfer files to another system. Available in three physical sizes; 8 in., 5-1/4 in., and 3-1/2 in.; only the two smaller sizes are commonly used on microcomputers. The 5-1/4 in. disks can store either 320 KB or in the high density version 1.2 MB of data. The 3-1/2 in. floppies can store 720 KB, 1.44 MB in high density, or

4 MB in the new extra high density. Floppies have the disadvantage of slower access time to balance their portability advantage.

C. TAPE BACKUP UNITS.

Tape backup units use a magnetic tape cartridge as their media. They are a better device to use for periodic backup of hard disk drives than floppy disks. The DT II had a 20 MB tape backup unit while the DT III contract has both a 40 MB and a large capacity 320 MB unit. A system of regular backup of files prevents catastrophic loss of data should a disk drive crash or become infected with a virus.

D. OPTICAL STORAGE.

1. Compact Disk/Read Only Memory (CD-ROM).

CD-ROMs are a relatively inexpensive method for distributing large quantities of stable data that has a long shelf life. Available with a variety of built-in access programs the CD can search up to 650 MB of data quickly and download the portion needed for further processing to an interactive drive. Drives are available singularly or in a stack of up to six disks. The CD-ROM appears to the operating system as a write protected disk drive.

Publishers are expanding the list of available material constantly. Many governmental regulations are already available by subscription on CD-ROM (Mercier, 1991,

p. 14). These include the Federal Acquisition Regulations (FARs), Defense FARs, The Congressional Record, the daily Federal Register, and various GAO publications. CD-ROM subscriptions are available from both the Government Printing Office and private publishing companies. A recent commercial mail order advertisement listed "Reference Library" from Software ToolWorks, "TypeGallery LJ" from NEC with scalable HP LaserJet typeface's, "Image Gallery", "Grolier's Encyclopedia", World Atlas & U.S. Atlas and a multimedia CD "Mammals" from National Geographic. There are legal libraries, publication summaries, professional desk references, and Biblical references available. The CD-ROM is applicable to any large volume relatively stable database.

2. Write Once, Read Many (CD-WORM).

New on the scene is the CD-WORM drive. With the ability to originally write to a CD and then become a write protected disk in the CD-ROM drive gives the user greater flexibility in selecting applications.

The applications of this technology are limited only by the imagination of the user. With the small size and large data storage capabilities of CDs much larger data bases can be forward deployed. Up to date intelligence and/or targeting data files would need only the changes transmitted, greatly reducing data transmission time.

3. Erasable.

The third type of optical storage media, still under development, is the reusable magneto-optical device. This media shows great potential and is expected to overcome its technological limitations of media durability in the next five years. (Harvey, 1990, pp. 121-130)

VI. SECURITY

A. INTRODUCTION.

Traditional security methods, such as locks, codes, identification badges and guard stations, do not provide the high level of security many installations currently require. Positive identification can be assured using an emerging technology called biometrics. Biometric identification devices measure a physical feature or repeatable action of an individual. Enrollment produces a reference sample that is compared to the submitted biometric each time the individual attempts verification.

Most biometric verification devices work in one of two modes; verify, where the device compares a set of stored samples of the individual identified by a Personal Identification Number (PIN), and recognize, where the device scans the database for the best biometric match. Extensive testing has been done on biometric devices by Sandia National Laboratories and at this school with documented success (Sandia,1990).

A variety of commercially proven biometric devices are already available. The measurements, along with a representative device, include: Finger print scanning by Identix's TouchLock which optically scans the contour of the

ridges of the thumb or finger tip; signature dynamics by AutoSig Systems gages the speed dynamics of the individual signature; three-dimensional hand geometry by Recognition Systems measures finger length, finger thickness, and widths of the hand and fingers at several points; BioAccess, by International BioMetric Systems, measures the keystroke pressure and speed pattern as an individual types their identification code and password into the keyboard of a PC; retinal scan devices, such as those manufactured by EyeDentify Inc., map the unique pattern of each individuals retinal blood vessels as they reflect infrared light on a circular scan of the retina.

B. PHYSICAL AREA SECURITY.

The traditional physical security measures of key cards, cipher locks, etc., can now be supplemented or replaced by biometric access devices. These devices use a physical characteristic to uniquely identify each user. A complete record of each access attempt can be maintained on a central PC attached to the devices. The EyeDentify machine used to gain access to two secure vaults at the Naval Postgraduate School is an example of a biometric device in use. User acceptance of the device is high. Of the few that have difficulty, the common error is taking the eye away from the scanner before it has finished the scan. There are many different reliable biometric entry devices including voice

verification, hand geometry and signature recognition in addition to the eye scanner. Physical area security is just one step in preventing unwanted access to data.

C. DATA ACCESS SECURITY.

Data security can take many forms. The most common method used to protect classified data is on removable media stored in a secured container. Data can also be protected by a file password to control access. A third method to restrict access to the data in a machine is via a keyboard access control system. Some systems use a key lock, which has the disadvantage of anyone having the key being able to access the data. System sign-on password control has a similar handicap. The biometric methods are a good solution to this problem. Currently available devices that attach to PCs include a fingerprint scanner, a hand geometry tester and a biopassword device. The Identix Touchlock, a fingerprint scanner, was recently tested and scored a 99.8% correct acceptance with no false acceptances (Tirado, 1991). The version of BioAccess, the biopassword access control device, had a limitation of six users, with an improved version due out with increased capacity and better biometric control. The limited testing showed no false acceptances with limited problems in correctly accepting enrolled users. Further testing is recommended after the newer version is available.

D. LINE SECURITY.

In situations requiring transmission of classified material cryptographic devices need to be used. Several different cryptographic devices have been tested with microcomputers and with the proper level key provide the required encryption security. Further protection is provided by software encoding the data within the confines of the PC. This method is used on several important U.S. to foreign government communications circuits. When in doubt about the security requirements of your system call your local security manager to perform a risk analysis before attaching your computer to any transmission media.

E. SECURITY CONCLUSION.

Any security device or practice is only as good as the people who use it. Security devices are not foolproof if the users are not in a security mind set. Biometric devices reduce the possibility of invalid access via lost or stolen keys and passwords.

VII. APPLICATIONS

A. INTRODUCTION.

The versatility of each individual personal computer is dependent on the imagination, skill and attitude of the user and any support help readily available. The following sample applications are based on this writer's experience and many discussions with various faculty, staff and students with a high variety of operational experiences. This list is by no means exclusive or intended to restrict the thoughts of a potential user, but is intended to stimulate creative thought on the potential present in these computers.

B. ADMINISTRATIVE OFFICES.

Administrative offices have long used the personal computer for word processing applications. The advent of laser printers and the newer, more user friendly software packages, such as WordPerfect 5.1 and its companion graphics program DrawPerfect 1.1, has greatly improved both the quality and quantity of output produced on these machines. Personnel offices and any section that processes fitness reports and/or disciplinary records should use an access restricting device to protect sensitive records. The

biometric security devices discussed earlier provide the needed access control with minimal interference for authorized users.

Voice and/or electronic mail capability will facilitate both routine daily traffic and after hours contact. Facsimile cards replace the stand alone machines and provide a better log of all transactions.

C. SUPPLY OFFICES.

Supply offices can benefit by using CD-ROM storage and data access methods to replace the current micro-fiche data storage. A periodic master file on CD-ROM, with updates on floppy disks, together with one of the many query packages available has many potential savings. Currently supply personnel, along with the many users of the supply system, spend many hours looking through the microfiche on searches. With the built-in query systems, an inquiry can be quickly processed despite the large size of the databases. One CD-ROM can replace the multitude of microfiche saving storage space for the fiche and the associated bulky readers and printers. The addition of a modem allows online access to central supply computers for up-to-date stock availability status and quicker order processing, shortening the time required to obtain critical spare parts.

Customer service and spare parts tracking are facilitated by having voice and/or electronic mail capability for after hours call transfer, message taking, message retrieving, and remote file access. Facsimile cards speed up order processing and filing. Bar code readers speed inventory control processing.

D. DEPLOYMENT PLANNING.

Many units with high mobility commitments have a dedicated deployment planning workcenter. Responsible for maintaining complete databases on equipment and personnel status, they need large capacity disk drives and rapid file processing times. Fax and modem support allows direct reporting by deployed detachments. Computer assisted aircraft and ship load planning increases deployment flexibility while minimizing manhours needed to process the deploying facilities.

E. COMMAND POST.

Command Centers, and their related briefing rooms are a prime example of areas that benefit from the technological improvements of modern computer hardware and software.

1. Room Access.

Reliable and secure biometric room access devices, such as EyeDentify, hooked to a central control personal computer for automatic logging of traffic can be used as a

central database of the security status of a room. The central security computer can be used to identify the lowest level of clearance of personnel present and can list those personnel needing to depart to clear the room for higher classification briefings.

2. Voice/Electronic Mail.

Command centers can use voice and/or electronic mail capabilities to keep track of deployed personnel and equipment, readiness status of all facilities and location of key personnel for crisis response. Voice mail systems are capable of initiating a recall roster with logging of contacts and automatic redialing of busy numbers, freeing the command center personnel to handle incoming calls and monitoring of responses.

3. FAX Boards.

Hardcopy reporting from subordinate commands and to higher headquarters can be expedited by using PC based fax systems. The automatic logging of all transactions provides an accurate historical record.

4. Presentation Graphics Support.

Graphics software programs, such as DrawPerfect and Harvard Graphics, can rapidly produce briefing slides and create electronic slide shows for presentation on large screen displays or overhead projectors via data plates.

5. Speech Recognition Equipment.

Speech recognition devices can be used to run briefings, remotely controlling computer slide shows, room lights, projection equipment, and electronic status boards.

VIII. DETERMINING NEEDS

This thesis has explored many of the elements that make up a personal computer system. Once potential users decide they need to automate their office, they need to decide what tasks can be automated, and next calculate exactly what type of computer and accessories to order.

The biggest limitation on this process is budget. One method to resolve such limitations is a decision analysis approach. Each situation has different priorities, with corresponding weight factors. The following chart, developed from the author's consulting experience contains those items that, while essential for operation, are the most discretionary for balancing budget against hardware needs.

Decision Analysis Options

Category	Option	Variable Factor
Disk Storage	Fixed Hard	Size
	Removable Hard	Size
	Floppy	Type, Size
Printer	Laser	
	Dot Matrix	Carriage Size
		Color or B/W print
Monitor	Monochrome	
	Color	Screen Resolution

Other options can be included on a yes/no basis in the decision analysis process. The potential benefits of an option can then be weighed against the cost to derive the best system for the given budget. Use these priorities to weigh the options and keep the best that fits the given budget.

Now is the time to again look at the questions from Chapter I. These questions, with notes, and the decision table in this chapter are intended as a guide for managers to determine the options to consider when building their systems. While these tools are based on the author's experiences as a small computer consultant, they are by no means exclusive. Unique needs and new technological innovations need to be considered at the time you evaluate your system. These questions need to be answered and applied to the configuration template in order to construct a system configuration and to establish the foundation for ordering a system.

The potential user needs these answers to properly size their system. The questions are relevant to the managers consideration of the possible uses of this productivity tool. It is easier to add software and applications to a system after installation when consideration has been taken at the time of ordering than if a system is purchased for a limited amount of applications. Every system this author has been involved with, usually after the initial purchase,

has undergone extensive expansion of applications as the benefits of automation have been proven.

Most new systems are procured with the thought of saving manpower. This hypothesis has been proven wrong many times over in the history of automation. Well managed systems have provided greater control of limited resources and increased productivity from the personnel on hand. The questions asked in the configuration table are designed to lead the manager into considering the maximum use of their system.

Configuration Table

1. What are the possible applications to go on the machine?

- List them, leaving space to add notes later.

a. Do applications perform heavy number crunching, or contain large spreadsheets?

- Consider a math co-processor to speed up mathematical calculations.

b. Graphics, word processing?

- You need a larger disk, VGA monitor, and graphics quality printer.

2. Size the software and data files to determine disk and memory sizes. Then add additional space for system control programs and room for further applications and expansion of existing work.

- Example : WordPerfect 5.1 takes 5 MB for the programs alone, data files are additional; ProComm needs 1 MB.

- For any graphics add at least 40 MB to disk requirements for figure libraries and completed files.

- Consider leaving room for additional font libraries that would enhance your printer, the smallest found in this research was 32 kB and the largest 600kB. Font sizes depend on numbers of different fonts included and how many sizes are available in the package. Space can be saved by using printer cartridges or additional printer memory for storing fonts.

3. What Input/output devices are needed?

a. Input - keyboard, pointing device, scanner, speech recognition?

- Speech recognition devices allow hands free input.

- Pointing devices allow use of pull down menus.

b. Output - printer, plotter, data plate?

c. Communications devices - internal FAX, modem, LAN?

4. What security considerations are required by the risk analysis?

a. Is physical area control required? What are the environmental conditions?

- Consider all types of entry control devices; keys, pass cards, biometric devices.

b. Do the files need to be removed and locked up when unattended?

- Cartridge hard disk drives are a must.

c. Is positive operator ID needed for any transactions on the machine?

- Keyboard locks or biometric access devices.

5. Are any office workers handicapped who require special equipment?

- If yes see article by Vanderheiden (1988) or contact the Industry/Government Computer Accessibility Task Force at the University of Wisconsin - Madison, S-151 Waisman Center, 1500 Highland Avenue, Madison, WI 53705.

6. Will you need to run more than one program at a time or break out of a program to get information from a different application?

- Consider multi-tasking control programs such as Windows or MS-DOS 5.0.

7. What type and frequency of backups are needed?

- Tape backup units can hold more data than floppies. A cartridge hard drive can also be used for backup. Consider a software file management program such as Norton Utilities.

8. Do you need to transfer data between distant machines, or hook up to a mainframe?

- Consider a modem or LAN.

9. Is FAX support needed? Can it be integrated into a PC or does it need to be a stand alone machine?

Next use Table II to expand your answers to the questions. To use this table find your need in the left hand column, then use the center and right hand columns for suggested answers. For example, if you need briefing support consider getting presentation graphics software, VGA, and a Data Plate.

TABLE II. Configuration Template.

Basic Need	Software Consideration	Hardware Consideration
Report generation	Word processor Graphics	VGA Monitor Laser Printer Minimum 40 MB HD space
Physical area security		Keys or key cards Biometric devices EyeDentify Voice verifiers Hand geometry Fingerprint
Data access security		Keyboard lock BioPassword Typing Identix Fingerprinting Cartridge HD
Transmission line security	Encryption programs and codes	cryptographic devices
FAX		Page Scanner Laser printer
Two or more applications at once	Windows Multi-tasking	80386 processor or better
Mainframe hookup Electronic data transfer	E-mail	Modem DDN hookup

Briefing support	Presentation graphics	Data Plate VGA Laser printer Speech recognition Remote electronic room control
Reporting to or from other command levels	Word processor E-Mail	FAX Modem DDN hookup
Large, stable reference files		CD-ROM, WORM
Electrical schematics Blueprints	CAD/CAM	Digitizing tablet Plotter VGA Very large HD Math co-processor
Backup	File manager	High density floppy disk Tape Removable cartridge HD
Shared resources Files, printers, etc	Control program	LAN Device sharing switch controls
Dispersed personnel and equipment tracking	V-mail E-mail	FAX Modem Telephone interface
Graphics	Figure library Graphics program	Large HD Pointing device VGA
Number crunching Large spreadsheets		Math co-processor

Once you have the answers to these questions, you need to read the current small computer contract to find out what is available. The Desktop III Configuration Table, on the following page, is based on the current contract and should be used as a basis for formulating your order. Put a check mark beside each item needed then refer to the contract to get the contract line number (CLIN). For each CLIN there are associated items, such as cables necessary for operation. Check the software section of the contract for additional support programs.

Desktop III Configuration Chart

1. Personal Computer
   - __ Basic (16 MHz, 2 MB RAM)
   - __ Advanced (20 MHz, 4 MB RAM)

2. Math co-processor __ Yes __ No

3. Monitor and video board
   __ Mono __ Color __ High resolution color

4. Floppy drives __ 5 1/4 (1.2 MB) __ 3 1/2 (1.44 MB)
   __ CD-ROM

5. Hard disk __ 41.9 MB __ 84 MB __ 168 MB __ 340 MB

6. Cartridge disk drive __ Yes __ No

7. Input devices
   Scanner __ Page __ Hand
   Graphics input device (digitizer) __ Yes __ No

8. Output devices
   Printer __ Laser
   __ Dot matrix (wide)
   __ Dot matrix (narrow)
   Plotter __ Yes __ No

9. Communication devices __ FAX
   __ 2400 baud modem
   __ 9600 baud modem

10. Data backup unit __40 MB tape __ 320 MB tape

11. External expansion slot adapter __ Yes __ No

12. Security devices - Physical area
    - __ Key cards
    - __ Cipher locks
    - __ EyeDentify (controlled lighting conditions)
    - __ Hand geometry (requires bare hand)
    - __ Voice recognition (requires low ambient noise)

13. Security devices - Data access
    - __ Removable media
    - __ Biopassword
    - __ Fingerprint

14. Security devices - Transmission line
    __ Yes __ No

Security devices are not included in the contract and are considered in this thesis as a reminder for users to obtain any required security devices.

Another way of using this information is to use the decision tree flow diagram in Figures 1,2 and 3.

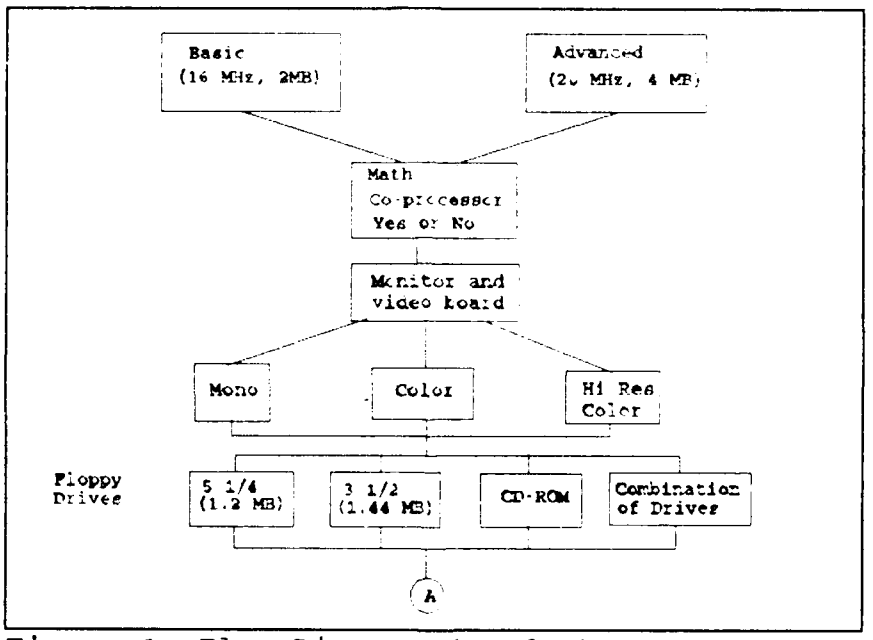

Figure 1 Flow Diagram (1 of 3)

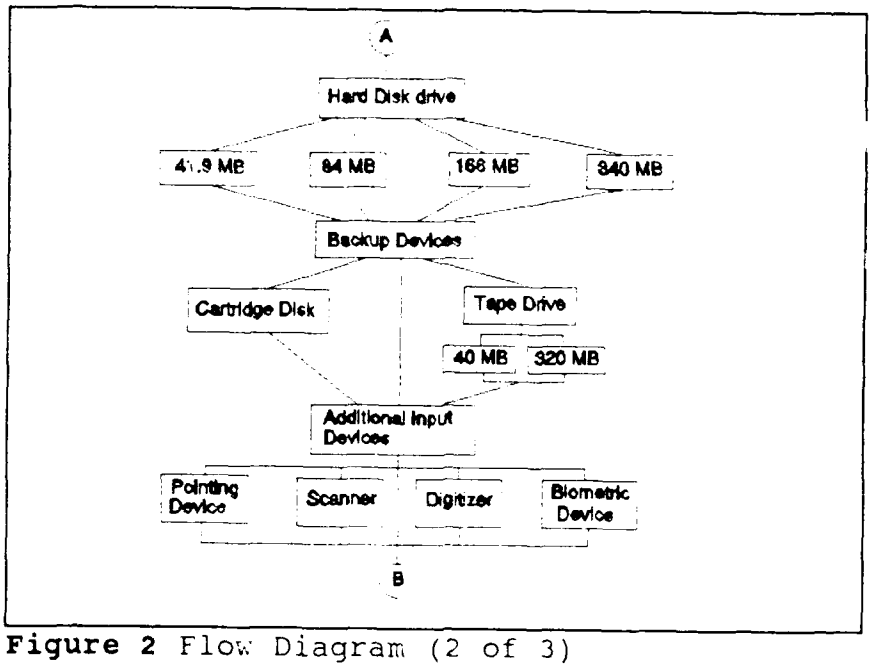

Figure 2 Flow Diagram (2 of 3)

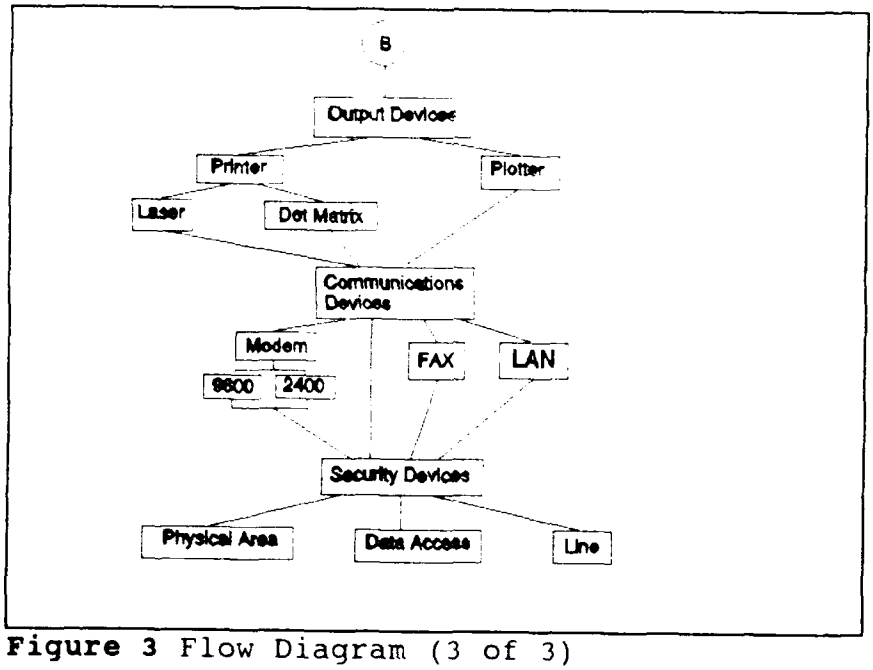

Figure 3 Flow Diagram (3 of 3)

IX. GUIDELINES AND TIPS FOR SETTING UP YOUR NEW SYSTEM

An important part of computer system acquisition is installing the basic machine and all add on accessories. As part of the research for this thesis, the author tested the compatibility of different hardware within the context of an office setting. Very few systems maintain the exact same configuration throughout their lifecycle. Adding new devices need not be a traumatic experience. This chapter deals with the lessons learned from this experiment and contains suggestions to help others progressively expand the system's versatility while keeping their system segments from interfering with each other.

The system used for testing was a Packard Bell PB800-16, an 80286 based computer with a 40 MB hard disk and two high density floppy disk drives, one of each size. The first additional accessory tested was a Mouse Systems Corporation two button OmniMouse II. The OmniMouse is a serial version which hooks into the machine's integral serial port as opposed to a bus version which requires a separate bus card. Operationally there is no difference in these two methods. In view of this you may want to use the serial mouse if you are short on board expansion slots and the bus version if you have other needs for serial ports. The next step was to add mouse control software to the system. The 'INSTALL'

program automatically creates the needed directory, copies the programs from the floppy and modifies your AUTOEXEC.BAT file to start the program at each system start. Rebooting the system then activates the mouse. It is important to remember the mouse uses one of your communication ports, COM1 or COM2 to send signals to the PC.

The next step was to add external communication capabilities to the PC. A 2400 baud internal modem was added to the system. The first problem to overcome was the conflict between the mouse and the modem for the communication port. This modem card has small switches to set the communication port. The importance of reading the instructions first before trying to install anything cannot be stressed enough. Install the software control program and test for proper operation. Try out all previously installed items of equipment as you test each new piece to insure the new one does not interfere with the old.

The next piece added was the FAX board and its hand scanner. Potential problems cropped up immediately with both of these needing COM ports but both ports already in use by the mouse and modem. The thing to remember here is that you will not be using the modem and the FAX at the same time, they can share the same COM port. The same thing applies for the scanner and the mouse. Install software and test. Again, try out all previously installed hardware and application programs for compatibility. Add new

capabilities to the old programs, for example WordPerfect has provisions for FAX output as a printer option. Install the printer driver, then test.

A Hewlett Packard LaserJet IIP was added to replace the original dot matrix printer. Watch out when installing new printers that you go back to all programs that use the printer and install the needed drivers or control settings. Again test each application that uses the new device.

Complete voice mail control was added with installation of the Watson Communications Center. This system has a built in modem on its control board which meant removing the previously installed modem. De-conflicting COM ports was easy on this installation, using the port previously used by the modem. Installation of the this software takes longer because of the need to set up outgoing messages for the user. Testing included incoming messages, automatic calling of a series of individuals with a broadcast message, modem operation and integration of the FAX.

The last item added to the system was a Hitachi CD-ROM device. As an externally mounted device, it had its own control card and also needed installation of a software control driver. The software automatically modified AUTOEXEC.BAT to allow starting of the control program upon system boot and CONFIG.SYS to reset system control parameters.

The most important lessons learned from this process include the importance of reading the instructions, as they usually warn you of pitfalls. Following each and every step is a precaution that cannot be overlooked. This will save you the time of having to go back and find missing parts. You should check switch settings, COM ports, and any system addressing schemes each new device uses to ensure de-confliction with previously installed devices. Finally keep an accurate record of what is installed on each machine, including COM ports, optional board settings, software installation settings and anything that is unique in the setup of that device. This documentation will save you valuable time later as you add new devices and you need to remember what settings you used weeks or months earlier.

X. CONCLUSION

Personal Computers are versatile and productive machines that have almost unlimited application in today's military. Because of their overwhelming potential and myriad of possible functions it is important for users to evaluate their goals for each PC they plan to acquire and order those accessories within their budget constraints. A complete risk assessment is needed before the computer system is designed to include physical security, TEMPEST, and the classification level to be processed.

The list of possible uses of microcomputers continues to increase as microprocessor speed and capability increase. The power of PCs today rivals the mainframes of just 20 years ago. Good software is available for graphics, data manipulation, message handling, word processing, and many types of simulations. A multitude of programming languages and aids are available to produce almost any application a user can conceive from administrative to targeting.

In view of the complicated nature of today's computer environment, potential computer users must be willing to ask for help designing new systems. If required expertise is not available within individual units, many bases have a central Small Computer Support Center, for example Naval Regional Data Automation Centers (NARDAC). The NARDAC at

Norfolk, Va. publishes *CHIPS*, a quarterly magazine dedicated to sharing information on small computers. NARDAC's many branches offer a central cache of experts to assist users at any level. For members of the other services, there are similar agencies dedicated to supporting the microcomputer users.

Although the world of microcomputer system design is confusing, the most important action that a military manager can take is to carefully examine the needs of his unit to determine exactly his microcomputer requirements. By using the questions and analysis presented in this thesis, the manager will be better able to order the computer system which will fulfill the automation needs of his organization.

LIST OF REFERENCES

Air Force Communications Command/SIMT,*Defense Data Networks Operations Concept (Draft)*, 10 April 1985.

Air Force Computer Acquisition Center (AFCAC), Award Contract F19630-84-D-0009, 2 October 1984.

Baker, Caleb, "Computer Buy Protest Slows Fast Acquisition", *Defense News*, vol.7 no.2, 13 January 1992.

Bolt, Beranek and Newman (BBN), *Systems Operational Concepts For the Defense Data Network*, by William Dlugos, July 1984.

Beechhold, Henry F.,"Put a FAX in Your Computer", *Home Office Computing*, vol.9 no.4, April 1991.

Brewin, Bob, "Air Force Charges UNISYS Switched Desktop III Parts", *Federal Computer Week*, v. 5, 11 March 1991.

Brewin, Bob, "AF Ponders Unisys Chip Switchout", *Federal Computer Week*, vol.5 no.12, 6 May 1991.

Danca, Richard A., "Zenith Unwraps Z-248 Upgrades", *FEDERAL COMPUTER WEEK*, vol.5, 11 March 1991.

Gallent, John A., "Speech-recognition Products", *EDN Magazine*, vol.34 no.2, 19 January 1989.

Geophysics Laboratory, GL-TR-89-0174, *The Zenith Z-248 as a Scientific Workstation*, by R.R. Babcock and others, 1 September 1989.

Hamblen, Diane, "Air Force * UNISYS * *Chips* Discuss DT III", *Chips*, v. XI, January 1991.

Harvey, David A., "Optical Storage Primer", *Byte Magazine*, Fall 1990.

Lusty, Susan, "FAX Boards and FAX Gateways", *PC World*, vol.9 no.3, March 1991.

Mercier, Ann M., "Fed Regs Abound on CD-ROM", *Federal Computer Week*, vol.5, no.12, 6 May 1991.

Malloy, Rich, "Grid Will Work with PenPoint and PenWindows", *Byte Magazine*, March 1991.

Miastowski, Stan and Linderholm, Owen, "Pointing to a Portable Future", *Byte Magazine*, April 1991.

Naval Postgraduate School Report NPSOR-91-01, *Voice Verification for Access Control*, by Gary K. Poock, October 1990.

Naval Postgraduate School Report NPSOR-91-12, *Finger Print Verification for Access Control*, by Gary K. Poock, April 1991.

Sandia National Laboratories, *A Performance Evaluation of Biometric Identification Devices*, by James P. Holmes, Russell L. Maxwell and Larry J. Wright, July 1990.

Standard Support Center (AFCC), Award Contract F01620-90-D-0001, 17 November 1989.

Tirado, L., *Evaluation of Fingerprint Biometric Equipment*, Masters Thesis,Naval Postgraduate School, Monterey, California, March 1991.

Toft, George, "Don't Treat Your Hard Drive Like A Giant Floppy", *CHIPS* , v. XI, January 1991.

Vanderheiden, Gregg, *Consideration in the Design of Computers to Increase Their Accessibility by Persons with Disabilities*, Trace R&D Center, University of Wisconsin - Madison, May 1988.

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