PERSONAL COMPUTING

After the telephone, the personal computer (PC) is one of the greatest invention in human history. Computers are a big part of our lives at home, at work, at leisure, and in many other day-to-day activities. In fact, computers are revolutionizing the human life cycle from birth to death in an unprecedented way. Current advances in information technology are creating an exciting computing environment for users. Computers are becoming a combination of telephone, fax, VCR, CD player, and television. Time and distance are becoming meaningless. We are using computers to communicate, to search, to compute, to buy, and to talk. One of the most common usages of computers is in personal computing. *Personal computing* is defined as people manipulating data on computers to enhance their productivity.

Manipulation involves retrieving, filtering, summarizing, calculating, and/or tabulating data. Computing itself can be home- and/or work-related. There are many different types of computers involved in personal computing, from desktop to hand-held computers. Productivity includes both efficiency and effectiveness. Efficiency is defined in terms of faster speed, better data access, and complex analytical and heuristic number crunching. Effectiveness is defined in terms of more alternatives, better communication, and better decision-making.

Since personal computing concerns individuals, it is usually defined by their environment, mainly home and work. Personal computing is indeed categorized as home-related and work-related, commonly known as end-user computing. A user has control over home-related computing but an employer has control over work-related computing. Work-related computing is also commonly known as end-user computing. Though the purposes of home- and work-related computing may be different they both have similar requirements in

terms of hardware and software. The following sections discuss hardware and software environments for personal computing.

HARDWARE

Hardware is defined as the physical components of a computer system. To some extent, hardware defines processing speed and efficiency. It consists of a (multiple for parallel processing) microprocessor including: different memory types such as random access memory (RAM), read only memory (ROM), cache and registers, and arithmetic and logical units (ALU) and a control unit; input/output devices like scanners, mouse, touch screen, keyboard, voice recognition, readers, and printers; storage devices such as CD-ROM, disks, and tapes; display units such as monitors; and communication devices like modems. All the components are assembled together in a computer system, which is usually connected to other systems through a network.

Computers are typically differentiated by their capabilities, functionalities, usage, and speed, which in turn depends on the hardware components of the computer system. Since there are many different possible configurations (permutations) of computer components, there are many different types of computer systems. Following is a description of the various types of personal computer systems.

Desktop Computers

Desktop computers, also known as personal computers, are the largest, fastest, and bulkiest of all PCs. Their introduction has changed computing, especially personal computing, forever. It is estimated that more than 33% of all U.S. households have computers, and this number reaches 60% among the richer quartile (1). Desktop computers are usually standalone systems and most suitable for personal computing. Since they are bulky, they are not portable. In a work environment, a desktop system is networked with other computers to allow exchange of information with peers, clients, friends, and family. It is always possible to communicate with other systems using a modem and telephone lines even if the system is not networked. It should be noted that competition is intense; as a result, computers are constantly improving in terms of speed, storage, and processing capabilities. As the new models arrive, old models become obsolete. Most computers, however, are designed to accommodate some updates.

A desktop computer consists of a microprocessor, disk drives, memory devices, and outlets for printer, monitor, input, and other devices. In addition, many systems have faxing and telephone answering capabilities. Many newer units resemble TV/VCR and have functions (or buttons) for playing CDs, playing a radio, listening to messages, using sleep timers, using a telephone, and using a fax. In addition, some models have remote controls. Two things that make a computer powerful are processor speed and memory. Currently, a typical desktop configuration will have a pentium or a pentium II (Intel trademark) or a PowerPC (Motorola trademark) series microprocessor with 166–333 MHz processing speed, 32–384 MB of RAM, 2–8.4 GB of disk drive, and 256–512 KB of cache. Desktop computers for multimedia applications have additional components like sound cards, graphic accelerators, or video card with 2–8 MB memory. As technology improves, so will the specifications and newer and faster versions will enter the market. Most of the current desktop systems are configured to be "user ready"—that is, they allow users to "plug" the system and the system is ready for work. This tends to hide technical details from users and makes the system more user-friendly.

Laptops and Notebooks

Laptop and notebook systems are also called "mobile" computers since they allow any-time, any-place computing. These are general-purpose systems which can run most application software packages. Laptop and notebook systems are small, are lightweight, and run on batteries. They can be used while traveling on an airplane, riding in a car or a train, at customer sites, at home, at work, or at any other remote location. Since these systems are portable, they can also be used at any time of the day. With the help of a docking station, a device that allows laptops and notebooks to work at office and road, these systems can be used as desktops.

Except for the printer, laptops and notebooks combine all components of a desktop in a subcompact unit. The basic differences between desktops, laptops, and notebooks are in terms of the size of the memory, type of microprocessors, and monitors. Both laptops and notebooks are smaller than the desktop in size and weight and can be used on a person's lap. Notebooks can even fit in a briefcase. Since these systems run on batteries, they are more reliable than desktops during a power failure. Typical laptop and notebook users are salespeople on the road, students learning from remote locations, and executives working from home or other out-of-office locations. There is a wide configuration of laptops and notebooks available to satisfy different user needs.

Though similar to desktops, laptops and notebooks are not as powerful. Compressing units and functions into a compact unit requires advanced techniques. In laptops, notebooks, and desktops, the tradeoff is between weight and size and between capabilities and convenience. Though both laptops and notebooks have adequate processing power, graphics capabilities, and readable screens, they are always a step behind the desktop computers in terms of speed, memory, and processing capabilities.

Portability, however, does enhance computing convenience. It is easier for users on the road to access customer, product, and other information and use it for decision making. Laptops and notebooks maintain and provide access to current information, allowing quality decision making. Space economy is another benefit of these computers, since they take very little room and can be moved from office to office without much problem. They are similar to carrying a briefcase. New laptops are beginning to imitate home accessories, with buttons and other features as user-friendly and familiar as a VCR or a TV.

The major problems with laptop and notebook systems are monitor size, pointing devices, heat generation, and upgradability. These systems have small screens (10 to 12.5 in.), making reading difficult if not impossible. The main screen technology uses passive matrix display causing eye strain. Newer versions, however, are moving toward active matrix technology providing brighter and better colors. Pointing devices include a built-in mouse (or mice). In many cases it is hard to maneuver the mice because of its small size. Newer versions

have touch screens and pen-based input capabilities overcoming point and click drawbacks. As systems are getting smaller and processing is getting faster, heat is becoming a problem. This is because of limited air circulation. Newer versions are using heat pipes instead of fans to overcome heat problems. A major disadvantage with laptops and notebooks is that they are usually not upgradable.

Hand-Held and Palm-Size Computers

These computers are small, weigh about 1 to 2 pounds, and fit in a person's palm. Their functions are limited and are not suited for general-purpose computing. They are primarily used for capturing data at the site of origin. These systems are used to enter data, edit text, and/or take notes. Electronic organizers are one example of a hand-held computer. They store personal information such as telephone numbers and appointments and in some cases can be linked to other computers.

Table 1 provides an alphabetized list of major desktop, laptop, notebook, and hand-held computer manufacturers. The list includes names and manufacturers' internet addresses. Since many vendors provide all four types of computer systems, the list is not categorized by computer types.

SOFTWARE

There are two types of software: system and application. System software are programs written to manage computer resources and facilitate user processing (2,3). Application software assists users in enhancing personal productivity. System software is usually built into a computer, whereas application software is sold separately. Application software can be purchased through a variety of outlets and vendors.

System Software

System software consists of a set of programs that manage computer resources and operations. They are usually written in machine language, C or C++. The complexities of the language and operations of software are generally hidden from the user. They facilitate personal computing but rarely directly assist in computing. The operating system is a system software which facilitates computer management and user computing. System software is hardware dependent and not portable. One of its jobs is to run application software for the user.

Table 1. Companies That Provide Desktop/Laptop/Notebook/Hand-held Computers

Name	Internet Address
Acer Computers	www.acer.com
Apple Computer Inc.	www.apple.com
Compaq Computer Corp.	www.compaq.com
Dell Computers	www.dell.com
Gateway 2000 Inc.	www.gw2k.com
Hewlett Packard Corp.	www.hp.com
IBM Corp.	www.ibm.com
Micron Electronics	www.micron.com
NCR Corp.	www.ncr.com
Packard Bell Corp.	www.packardbell.com
Samsung Electronics America Inc.	www.sosimple.com
Silicon Graphics Inc.	www.sgi.com
Texas Instrument Corp.	www.ti.com
Toshiba Corp.	www.toshiba.com
Sharp Electronics	www.sharp-usa.com
Micro Electronic, Inc.	www.winbook.com

Application Software

Application software, also called productivity software, assists users in performing many different tasks such as querying data, budgeting, forecasting, preparing taxes, accounting, auditing, inventory control, and making routine as well as complex decisions. Application software is hardware-independent and can run on any system with little modifications.

Application software either is general-purpose, provides general computing capabilities, or is specific, providing specific computing capabilities. General-purpose software provides capabilities such as spreadsheet, databases, modeling, graphics, report generation, accounting, and word processing. Specific software is dedicated software and provides support for processes such as invoicing, inventory control, payroll, and order/purchase. General capabilities, such as the spreadsheet, allow financial planning; databases allow monitoring and provide statistical and optimization capabilities that allow trend analysis, scheduling, and allocation of resources. Though software provides either general or specific capabilities, it is still the user's responsibility to develop applications suitable for their personal needs.

Some examples of general-purpose software capabilities are:

Spreadsheet
Database
Desktop publishing
Accounting
Graphics
Report generation
Word processing
Statistical/optimizers
Expert systems
Imaging
Group conferencing

Some examples of specific capabilities are:

Personal taxes
Inventory management
Payroll
Auditing
Learning
Money management

Many software providers are packaging general capabilities in a "suite." A suite provides multiple capabilities, and the data are easily transportable across capabilities. This should be appealing to both home and business users. These suites include word processing, spreadsheet, graphics, database, and

Table 2. Companies That Provide Personal Productivity Software

Name	Internet Address (URL)
Office/Home "suites"	
Claris	www.claris.com
Corel	www.corel.com
Lotus	www.lotus.com
Microsoft	www.microsoft.com
Other Software	
Borland	www.borland.com
Computer Associates	www.cai.com
Comshare	www.comshare.com
IBM	www.ibm.com
Intuit	www.intuit.com
Informix	www.informix.com
Lindo Systems	www.lindo.com
Lotus	www.lotus.com
Microsoft	www.microsoft.com
Oracle	www.oracle.com
Pilot	www.pilot.com
Powersoft	www.powersoft.com
SAS	www.sas.com

in some cases internet links. Table 2 provides a list of major software providers for suites and other software.

Competition in information technology is intense, and many vendors will drop out as many others will join the list. There is a need to constantly update this list. We suggest readers look at the suggested readings.

The following discusses home- and work-related computing.

HOME-RELATED COMPUTING

Home-related computing involves computer usage for personal and home-oriented tasks. Home computing is probably the fastest-growing activity among computer users. Home computers are no longer considered to be an extension of the work computer (4). There is a definite technology diffusion in the home environment. Many vendors are moving away from bland computer models to attractive colors with buttons (functions), similar to a TV, to appeal to the home market. The current emphasis is on making the computer as much an integral part of a home as a TV or a VCR. Advances in technology, especially communication and software, are making this feasible. It is possible to connect a computer from a home to the outside world. Just like TV, it is possible to receive text, graphics, images, data, animation, video, and voice from the outside world. Unlike TV, where communication is one-way, computers allow for two-way communication. Computers not only can receive data, they also can send it. For home users, this provides a means of two-way communication with friends and families and buyers/sellers from one place to another throughout the world.

In addition, computers can be used for personal and family tasks such as money management, taxes, scheduling appointments, writing letters, notes and invitations, long-term financial planning, home banking, home shopping, student and adult learning, social interaction, school homework, and time management. These tasks can be easily accomplished on a desktop computer with or without multimedia capabilities. Since home users have complete control over information and telecommunications technology, they can pick and choose capabilities as needed for their specific computing.

Typical home computing needs can be organized as follows:

- Financial planning (budgeting)
  - Daily
  - Weekly
  - Monthly
  - Long-term
- Personal planning
  - Taxes
  - Health
  - Food/shelter
  - Billing/banking
- Scheduling
  - Appointments
  - Gatherings
  - Meetings
- Learning
  - Educational
- Communication
  - Letters
  - Notices
  - Telephones
- Leisure
  - Games
  - TV/CD/radio
  - Travel
- Others
  - Reminders
  - Emergencies
  - Special/one-time events

Activities described above are not mutually exclusive. In fact, one activity may include many other activities. Almost all activities can be supported by either general or specific software. Table 3 relates home computing activities to general- and specific-purpose software and hardware.

WORK-RELATED COMPUTING

Work-related computing (also known as end-user computing) involves using computers to enhance work productivity. It includes job-related tasks done at home, office, or other location. Since organizations were early adopters of computers, work-related computing has been here since the early 1980s. What is different is the extent to which computers are being applied to solve a variety of problems. Advances in technology are allowing many more tasks to be automated. The emphasis is on any-time, any-place computing as well as on efficiency and effectiveness of decision making.

Typical work-related activities from the user's perspective can be grouped as follows:

- Data analysis
  - Specific data
  - Reports
  - ad hoc queries
- Systems development
  - Analyze
  - Design
  - Implement
  - Train
- Financial planning
  - Short-term
  - Medium-term
  - Long-term
- Model/statistical analysis
  - Develop models
  - Perform statistical analysis
  - Interpretation
- Communication
  - Letters
  - Co-workers
  - Libraries
  - Other services
- Presentation
  - Graphics
  - Multimedia
- Scheduling
  - Travel
  - Meetings
  - Conferences
- Monitor and Management
  - Employees
  - Inventory
  - Evaluations and awards
- Archives
  - Personal
  - Organizational
  - Group
- Cooperative work
  - Teams
  - Partners
- Others
  - Emergencies
  - One-time events

Almost all activities can be supported by general and/or specific software. Table 4 relates work-related activities to personal productivity software and hardware. In both Tables 3 and 4, information technologies are matched to home- and work-related tasks. This match is based on minimum software and hardware requirement. This does not preclude other technologies. For example, financial planning as a minimum requires spreadsheet capabilities. However, a "suite" will be equally desirable and even preferable in some circumstances.

It should also be noted that information technology is a moving target. Both home and end-user computing are related to moving targets in Tables 3 and 4, respectively. As the target changes, so will the tables. It is necessary to keep these tables updated (see the reading list).

The preceding discussion has focused on work-related computing from the user's perspective. However, there is another side, namely, the organization. The next section discusses end-user computing from the organization's perspective, which must manage, train, and implement end-use computing.

END-USER COMPUTING

The biggest challenge from an organization's perspective comes not only from technology, but from its workers as well. End-user computing (EUC) is the development, maintenance, and use of work-related computer applications by an organization's employees in functional areas such as manufacturing/production, marketing, accounting, finance, and human resources, with little or no direct assistance from information systems (IS) specialists. The primary beneficiaries of EUC are the end users themselves, because it enables them to address their own information needs. EUC also gives IS staffs a respite from a horde of small tasks, enabling them to focus on larger, more critical applications with organization-wide im-

Table 3. Typical Home-Related Computing

	Financial Planning	Personal Planning	Scheduling	Learning	Communication	Leisure	Others
Tasks	Daily Weekly Monthly Long-term	Taxes Health Food/shelter Billing/banking	Appointments Gatherings Meetings	Educational	Letters Notices Telephone	Games TV/VCR Radio Travel	Reminders Emergencies Special events One-time event
General software capabilities	Spreadsheet	Database Spreadsheet			Word processor	Database	Suites
Specific software capabilities		Taxes Health PC banking	Organizers	Task-oriented (e.g., math, history)	E-mail	Specific Games	
Hardware	Desktop Laptop Notebook	Desktop Laptop Notebook	Palm-size	Desktop Laptop	Desktop Laptop Notebook	Desktop with multimedia	Desktop with multimedia

Table 4. Typical Work-Related Computing

	Data Analysis	Systems Development	Financial Planning	Model/ Statistical Analysis	Communication	Presentation	Scheduling	Monitor & Management	Archives	Cooperative Work	Others
Tasks	Specific data reports ad-hoc queries	Analyze Design Implement Train	Short-term Medium-term Long-term	Develop models Perform statistical analysis Interpretation	Letters Co-workers Libraries Other services	Graphics Multimedia	Travel Meetings Conferences	Employees Inventory Evaluations & awards	Personal Organizational Group	Teams Partners	Emergencies One-time events
General software capabilities	Database Report generator	Suite Report generator	Spreadsheet Report generator	Statistical Optimizer	Word processor	Graphics	Organizer	Database	Database	Group processing	Suites
Specific software capabilities		Case tools	Forecasting	Model building	E-mail	Presentation		Inventory management Human resource management		Group modeling Writing	
Hardware	Desktop Laptop	Desktop with multimedia	Desktop Laptop Notebook	Desktop	Desktop Laptop Notebook	Desktop with multimedia	Palm-size	Desktop Laptop Notebook	Desktop Laptop Notebook	Desktop with multimedia	Desktop with multimedia

pact. Other important benefits of EUC for IS staffs include higher job satisfaction and improved relationships with end users. When properly managed, EUC is known to significantly increase the overall productivity of the organization.

The computing skills of individual end users vary widely on a spectrum of sophistication. For example, the comfort zone of "novice" users is limited to their ability to run simple applications using a menu-based interface or by following a prespecified set of commands. In the middle of the spectrum, relatively advanced users are able to extract information from databases by constructing simple or moderately complex queries and reports. At the "sophisticated" end of the spectrum, users possess the expertise to rapidly develop applications with the aid of user-friendly development tools such as fourth-generation languages (4GLs). Among these expert users, some are so proficient that their skills are recognized as being comparable to those of IS specialists, and they formally develop and support applications for other end users in their own functional areas (5–7).

Historical Perspective

The rapid growth of EUC has its basis in the mainframe era of the 1960s and 1970s. During that period, end users relied almost entirely on their IS departments (then known as data processing or DP) for their information needs. Users lacked the formal training necessary to design, maintain, and run the mainframe-based systems prevalent at the time. However, users were aware of the potential value of the information output from these systems and increasingly used them in their decision-making processes. User requests for information burgeoned and became more frequent, unplanned, and urgent, causing most IS departments to be caught off-guard and unable to adapt with timely responses. Their unresponsiveness led to enormous backlogs of unfulfilled information requests and generated intense conflicts between users and the IS department. In these conflicts, users perceived IS specialists as inflexible and unresponsive "techies" who had no appreciation of business issues and did not understand the need for quick information. In turn, IS viewed end users as nuisances who could not plan for their information needs in advance and had no appreciation for the technical effort involved in responding to ad hoc requests for queries and reports.

Initially, IS departments often had the upper hand in these conflicts because users had no alternative sources for the information they needed. However, the balance of power shifted dramatically in the early 1980s with the evolution of powerful PCs, user-friendly software packages for word processing, spreadsheets, databases, presentation graphics, and 4GLs. A large number of end users, frustrated with their dependence on unresponsive IS departments, began acquiring and using these inexpensive and readily available tools to address their basic information needs. In less than five years, personal computing had become widespread, and users had successfully wrested some control from IS departments for the first time.

In the years that followed, EUC became firmly entrenched in most organizations. The proliferation of computer networks allowed end users to share applications and easily exchange information. In addition, powerful yet user-friendly software packages such as IBM's Lotus 1-2-3 and LOTUS notes, Borland's Paradox, Microsoft's Visual Basic, Access, and Office 97, and Powersoft's PowerBuilder gave end users the ability to rapidly build complex decision-oriented applications. These technological advances increased end users' confidence in their own capabilities and enabled them to become largely self-reliant for their information needs.

A survey conducted by Nolan, Norton & Co. in 1992 found that 55% of all employees used a PC or workstation (8). This large proportion reflected the pervasiveness of EUC and is even larger today. A national survey (9) of public sector managers in federal, state, and county agencies in 1991 ranked the management of EUC as one of the five most important IS issues. The importance of this issue has declined somewhat since then because organizations have been on a learning curve for several years, have learned valuable les-

sons, and are now managing EUC with finely tuned strategies in place.

Information Centers

The concept of the information center (IC), founded by IBM Canada in 1974 as a solution to a huge software maintenance workload, constituted a large chunk of their total systems development effort. The IC was designed to alleviate the burden of the IS development staff by offering assistance and support to end users in addressing their simple information needs for decision making. This assistance consisted mostly of database access and the creation of simple programs. After IBM presented this concept to its customers in 1979, several organizations established ICs of their own.

By the late 1980s, ICs were flourishing in thousands of organizations. They were known by various other names such as computer resource centers, end-user computing centers, information resource management centers, and user support services. They usually took the form of separate units operating under the aegis of the IS department. Most ICs offered their users at least a helpdesk or hotline for troubleshooting and basic consultation on the use of packaged software. In addition, some offered education, advanced training, and access to corporate databases. Some ICs were even empowered to set standards and guidelines for users and to enforce them.

Managing EUC

The management of EUC consists of two complementary facets: (1) end-user support and (2) controls. End-user support involves encouraging and facilitating EUC, whereas controls establish the rules for end-users and enforce limits on their computing activities. Support activities are designed to satisfy end users, while controls enable IS departments to minimize the undesirable consequences of EUC. A high degree of support without accompanying control mechanisms usually generates a tremendous amount of end-user enthusiasm. However, it also results in an indiscriminate waste of organizational resources over the long run as end users get carried away with their unplanned and uncoordinated computing activities. On the other hand, stringent controls accompanied by little or no support of user creativity, cost the organization indirectly through missed opportunities, and heavy workloads for the IS department. Excessive controls may also result in user discontent and defiance of all rules and restrictions. An ideal scenario for EUC management balances aspects from both support and control.

End-User Support

All end users need support for their computing activities. However, the exact nature of support needed varies depending on the computing sophistication of the user. In general, novice users need a great deal of hand-holding for even the simplest of tasks. On the other hand, sophisticated users are considerably more self-reliant but require different kinds of support for their advanced computing activities. Thus, ICs should design their support services to address the different needs of their various end users. In order to do so, IC staff members need to make an effort to understand the business functions of the endusers. This will enable the IC staff to better grasp end-user needs. In an organization where the IC staff does not possess the requisite skills to assist highly advanced users, they should facilitate the formation of user groups so that users with similar support needs can assist each other.

For novice users, basic support should consist of troubleshooting assistance through a hotline or helpdesk, consultation on the selection of appropriate packages, tools to solve specific problems, and help with hardware installation and maintenance. In addition, training should be provided on the uses and capabilities of popular end-user packages, maintaining system security, and creating backups. For more advanced users, access to corporate data becomes important. Hence a listing of such data resources and facilities for data extraction/access, together with training on data integrity and validation issues, is appropriate. For highly sophisticated users, support should focus on issues related to applications development. Appropriate training topics include problem-solving, cost–benefits analysis and project justification, development methodologies, the use of specific development tools, application documentation, testing and debugging, and maintenance (10,11). Support services from ICs might also include coordinating applications development across end-user departments, maintaining libraries of user-developed applications to facilitate application sharing, publishing periodic newsletters with technology updates and responses to user concerns, and establishing user groups and electronic bulletin boards.

Controls

Although EUC generates user satisfaction and increases corporate productivity, it also has the potential to cause a great deal of harm to the organization. Possible dysfunctional consequences of EUC range from inefficiency of operations and a waste of resources, to shoddy decision-making and loss of business. Controls are designed to avoid or minimize such negative outcomes.

The most common undersirable outcome of EUC is the proliferation of incompatible end-user tools. This occurs because individual end users tend to make decisions regarding software and hardware acquisition independently of each other. Over the long run, in the absence of any standards or guidelines, a variety of hardware and software tools separately acquired end up comprising the de facto organizational computing architecture. These mutually incompatible tools make it difficult for data and applications to be shared by end users across the organization, fostering general operational inefficiency. Moreover, unrelated acquisitions from different vendors undermine the organization's negotiating power and also restrict its ability to ensure the quality of acquired tools. Some controls that could be used to prevent these undesirable outcomes include: (1) creating corporate hardware and software standards, (2) restricting sources of acquisitions to a list of approved vendors, and (3) specifying procedures to be followed before making any acquisitions. Enforcement of these controls could be ensured by making end-user support contingent on documented user compliance.

Operational inefficiencies are also created when poorly trained users spend too much time assessing their own information needs, searching for the right computing tools, or learning how to use the tools. This takes valuable time away from their real work. In addition, users who expend significant amounts of organizational resources developing their

own applications almost never justify their efforts through formal cost–benefit analyses. In many instances the costs of user development far outweigh the potential benefits of these applications. User–developers also tend not to formally document their applications. This may present problems if the developer ultimately leaves the organization and no one else other than this person understands all the intricacies of the application's usage. All the above problems reduce the efficiency and productivity of the organization and may be avoided by employing various controls. They include: (1) generating guidelines characterizing applications appropriate and inappropriate for end-user development, (2) including end-user development plans in periodic organizational IS planning processes, (3) charging some or all costs of user development and related support back to user departments, and (4) creating documentation standards. Points (1) and (4) may be enforced by linking user support to compliance with the respective guidelines and standards.

The most undesirable consequences of EUC arise when users develop applications which they believe to be fully functional and error-free when in fact they are often riddled with bugs, use outdated, incomplete, or totally inaccurate data, and incorporate analyses based on erroneous models. When the information outputs of such seriously flawed applications are used in corporate decision-making, faulty decisions inevitably result, leading to severe consequences. The problem essentially lies in the users' lack of training in systems design, testing, validation, and quality assurance mechanisms. One obvious solution is to provide such training to the users so that many of these problems are prevented. The other solution entails utilizing more controls to detect and correct such problems. Essentially, this requires using IS personnel to conduct independent audits/reviews of user developed applications at various stages of the development process—for example, requirements analysis, tool selection, model design, coding, testing, and maintenance.

FUTURE

The internet, a network of networks, is changing both home- and work-related computing. Organizations are putting more and more software and data over the intranet, a private internet. This is changing end-user computing and putting new demands on software and hardware. Visual software and applets will become the norm. Visual software allows a user to build applications by using programming objects and to "visualize" the outcome of their computing in real time. Applets, a new development in software, allows a user to purchase or lease a part of the software when needed. Applets may be for one time specific usage or multiple time generic usage. Computer systems will become like a TV, where any home and office computing can be done by pressing certain buttons. These buttons may take data from many different sources like the internet, corporate intranet, government published reports, private data sources, and personal data resources and extract desired applets from internet and provide computing capabilities never experienced before. Data transmission will be faster, and users will have access to much faster ISDN lines instead of telephone lines. Computers themselves will have tremendous processing power and speed with multimedia capabilities.

In addition, many businesses will become virtual in that all business activities will be done on the internet. This will change how end-user computing is managed. With no physical office, telecommuting will become a norm and end-user output will be measured by the result and not by the time spent on the job.

Home computing is also going through tremendous changes. Office automation was the key in 1980s but home automation will be the key to the next century. Imagine a scenario where a computer wakes you up and provides up-to-the-minute news, events and activities, a daily schedule, and suggestions on fulfilling obligations or confirms appointments, sends orders, faxes or e-mails messages, provides reminders, programs your favorite TV shows, plays your favorite music, displays your current financial position, and so on. All this may be possible by just the push of a button. This technology diffusion will make home computing almost trivial, whereas a TV will come with a cablebox with multiple channels and users can pay and activate functions (channels) as needed. Once selected, a channel may either automate computing or provide resources for computing.

As technology is changing rapidly, so is personal computing. It is necessary to constantly update and seek other sources of information. We suggest readers to browse through the reading list. We do not claim that this a complete or exhaustive list, but it is one that we find very useful.

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11. J. E. Moore, The application of job rotation in end user computing: Towards a model for research and practice, *J. End User Comput.,* **9** (1): 4–13, 1997.

Reading List

Special reading

The next 50 years, our hope, our vision, our plan, *Commun. ACM,* **40** (2), February 1997.

Research-related issues (in order of coverage)

Journal of End User Computing, a quarterly publication of Information Resources Management Association (IRMA) (URL: http://www.hsg.psu.edu/faculty/mlk/jeuc2.html)

Communications of the ACM, a monthly publication of the Association of Computing Machinery (ACM) (URL: http://www.acm.org)

Various publications of *IEEE Computer Society* (URL: http://www.computer.org)

Information and Management, a monthly publication of Elsevier group (URL: http://www.elsevier.nl:80/inca/publication/store/5/0/5/5/5/3)

MIS Quarterly, a quarterly publication of AIS. MISRC. SIM (URL: http://www.cba. uga.edu/misq/articles.html)

Information Systems Research, A quarterly publication of INFORM group (URL: http://www.isr.uci.edu)

General interest and new products information

ComputerWorld, a weekly publication of computerworld (URL: http://www.computerworld.com)

Business Week, a weekly publication of McGraw-Hill (URL: http://www.businessweek.com)

Inter@active, a weekly publication of Inter@ctive Enterprise (URL: http://www.interactive-week.com)

PC Week, a weekly publication of Ziff Davis Publication Co. (URL: http://www.pcweek.com)

Datamation, a monthly publication of Datamation(URL: http://www.datamation.com)

A. K. AGGARWAL
R. MIRANI
University of Baltimore

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See FINGERPRINT IDENTIFICATION.