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ABSTRACT

The evolution of computer hardware for college computing has mirrored the industry's growth. When computers were introduced into the educational environment, they had limited capacity and served one user at a time. Then came large mainframes with many terminals sharing the resource. Next, the use of computers in office automation emerged. As college computing grew, it took several mainframes to handle the workload, especially at large institutions. Microcomputers then came on the scene, but they had evolved back to the initial limited capacity, one machine-one user concept. They first served as personal computers, then evolved as enhanced terminals. Now, microcomputers are becoming part of networked systems, allowing more users to become part of the overall institutional system, while reducing the dependence on large mainframe systems. The next generation of college computing will allow maximum use of microcomputer networks. Networks allow common use of data and programs and provide a communications link not previously available to microcomputer users. The most immediate applications for these networks are office automation, faculty needs, and staff requirements. Colleges and universities must lead the way in innovation, especially in the area of networked microcomputers. (Author/SW)

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NETWORKED MICROCOMPUTERS -- THE NEXT GENERATION IN COLLEGE COMPUTING

by

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The evolution of computer hardware for college computing has mirrored the industry's growth. When computers were introduced into the educational environment, they had limited capacity and served one user at a time. Then came large mainframes with many terminals sharing the resource. The use of computers in office automation began to emerge. As college computing grew, it took several mainframes to handle the workload, especially at the larger institutions. Microcomputers then came on the scene, but they had evolved back to the initial limited capacity, one machine-one user concept. They first served as personal computers, then evolved as enhanced terminals. Now, microcomputers are joining the educational ranks in networked systems, allowing more users to become part of the overall 'Institutional System,' while reducing the dependence on large mainframe systems.

Networked microcomputers are the next generation of college computing. We are on the verge of technological breakthroughs to allow maximum use of microcomputer networks. Networks allow common use of data and programs and provide a communications link heretofore not available to microcomputer users. The most immediate applications for these networks are office automation, faculty needs, and staff requirements. Colleges and universities must lead the way in innovation, especially in the area of networked microcomputers.

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NETWORKED MICROCOMPUTERS -- THE NEXT GENERATION IN COLLEGE COMPUTING

The influx of microcomputers into the college and university environment is beginning to accelerate. Several schools have taken an evolutionary approach to the opportunity afforded by these microcomputers. I am not talking about just microcomputers for students, but rather as a tool for the entire institution, especially faculty and staff. The demand and reliance on computer resources at every college and university is at its all time high -- and increasing! Most students expect computer training as part of their education process. It has not stopped at students either. To keep pace with the students, most members of the faculty are requiring access and training in computer usage. To keep up with the faculty, the staff are demanding access to the latest in technology. As the snowball rolls, it grows in size.

How are most colleges and universities keeping up with the challange? Most institutions are or will eventially look into the concept of computer networks. With the growth of microcomputers, networks will be the tool to maximize the capabilities of these machines. Networked microcomputers will soon become the next generation in college computing.

Evolution of Microcomputer Usage and Data Access

Initially, microcomputers (personal computers) were used by faculty and staff at many institutions solely as stand alone devices. Microcomputers used in this way provide flexibility and portability of computing power to the individual users. In terms of overall institutional usefullness, this approach has several shortcomings. Many of the functions performed on the microcomputers are duplicated. Different programs may provide slightly different output (in form if not in substance). College data may be duplicated. Data are not transferrable or readily accessable. A stand alone microcomputer within a college or university is truly a waste of resources.

Terminal emulation hardware and software was one of the first attempts to link microcomputers to the existing data processing environment. They are available for a number of different mainframe and microcomputer combinations and they are widely used. In effect, under emulation, the microcomputer becomes little more than a terminal. Even with terminal emulation, there is still a need to transcribe and key data. In other words, emulation was a step in the right direction, but not the cure-all.

Terminal emulation's shortcomings lead to the next level, file transfer. With this capability, users can transfer the data needed from their microcomputer applications directly to and from the mainframe over the same communications link used for terminal emulation. Data can be moved from the mainframe to the microcomputer, 'downloaded,' or moved from the microcomputer to the mainframe, 'uploaded.' The ability to transfer information between the microcomputer and the mainframe increased the potential for the full utilization of the microcomputer resource, but did not maximize it. There still were problems with this approach. Large amounts of data posed a problem for the microcomputer's storage capabilities. Data transfer was often slow. Another problem arose when data was to be transfered among microcomputers; the process was slow and cumbersome. Finally, data security was a concern. If a file could be downloaded, altered, and uploaded from a number of microcomputers, how could the integrity and reliability of the data be maintained? File transfer techniques opened the door to a better approach, but had some problems and failed to employ the full capabilities and features users really wanted and needed.

Although not fully developed yet, total file interface should eleminate the problems associated with the file transfer method of data access. Total file interface will mean microcomputer users can access system files without any data transfer. Specific information needed can be accessed and processed. Users will be able to change data, access data, or add data as their security access allows. The actual programs to access and process the data will reside in the microcomputer and the microcomputer will be doing the actual data processing. Total file interface will revolutionize the use of microcomputers in networked environments.

Defining Microcomputer Networks

Microcomputer networks are being created to meet the needs of users with a large number of microcomputers and the communications needs of that environment. Cur-

rently, there are two methods being used and developed to network microcomputers. Neither method is fully developed at this time to enable microcomputer users maximum utilization of their resource. The methods are:

1. Pure microcomputer networks, and
2. Mainframe-based networks.

Pure microcomputer networks are communications links that connect a large number of microcomputers and other peripheral equipment and storage devices. They usually include:

* Communications cards, containing communications software used to control the entire network
* Storage devices, including winchester disk, cartridge tape, and floppy disks
* Printers, plotters, and other hard copy media.

When part of microcomputer networks, individual microcomputers do not have to have a floppy or hard disk capability. Program and data libraries are maintained on the systems disk storage. Peripheral and storage devices can either be dedicated to one user or can be system resources. Total file interface is available in some pure microcomputer networks.

Currently, these types of networks are being used by several colleges for instructional use. Some schools are also using this concept for administrative data processing. The system requires a communications network, such as Ethernet or Arcnet. These networks support both hard-wired and dial-up capabilities.

The advantages of the pure microcomputer network include:

* Low initial cost. From the user's side, only a microcomputer, keyboard and monitor are required to fully use the system. The communications network, storage devices, and hard copy media are system requirements that are relatively inexpensive and readily available. Several firms package the systems or they can be built using off the shelf components. Compilers, data base management systems, word processing software, application systems, and all other software is available to all users. This 'shared' concept can save money in software purchase and training and can increase compatibility.

* Centralized data storage. Storage devices are usually system resources, thereby providing central data storage. This includes program libraries and data files. Users use the same programs and may (with proper security codes) access central data.

* Unlimited expansion. Some networks have a theoritical limit of 32,768 devices (although I am sure the practical limit is somewhat less).

The disadvantages of this approach include:

* Limited disk capacity. Winchester disks have limited capacities, although they are increasing. Currently, the largest single winchester disk is in the 300 MB range. If there is a need for data bases larger than this, different file handling methods are required.

* Limited vendor support. There are few vendors that produce and support this approach, although the number is increasing.

The mainframe-based networks rely heavily on the central computing capability or on another central processor. Here, the mainframe acts as the system controller and data manager. Microcomputer programs access the data, stored on the mainframe's disk, as if the data were on the microcomputer's own disk. One way to do this is by creating 'virtual diskettes' on the mainframe's disk. The user creates the 'virtual diskettes,' formats them, and reads and writes on them. Files created on the 'virtual diskettes' are marked to allow or disallow shared access. The disadvantage of the 'virtual diskettes' is that it is difficult to access the data from the mainframe or from microcomputers that require differently formated diskettes.

The ultimate capability is for the microcomputer to be able to access data using the total file interface access method as stored on the mainframe's disk and use its microcomputer capabilities to execute the programs and minipulate the data. In this manner, the host mainframe and media-incompatible microcomputers can access the data, given the proper security, as if it were a standard mainframe file. Unfortunately, no mainframe has this total file interface capability yet.

The advantages of this concept are:

* Centralized storage and control. Since the mainframe acts as data manager and system controller, all data is centralized. Strict security measures are maintained for access and alter capability.

* Data compatibility and accessibility. Data are compatible among the microcomputers and the mainframe and accessible by all authorized users.

The disadvantages of the mainframe-based network approach are:

* Cost. Relatively speaking, mainframe computers and associated peripheral and storage equipment are expensive. Software to support a large network can also be expensive.

* Different mainframe manufacturers maintain different communications standards. There are numerous communication protocalls for the various mainframes. This is compounded by the number of microcomputers on the market. If the microcomputers and mainframe are from the same manufacturer, this problem disappears, but individual users are locked out of other microcomputer alternatives.

* No system incorporates the total file interface design yet. Vendors are getting close, especially third party communication and data base vendors. As standards are developed for communication protocalls or third party software vendors overcome the incompatibility and total file interface problems, the concept will become reality.

Several colleges and universities are approaching the solution from a mainframe-based network. These schools are generally setting the standards or dictating the microcomputer that will be used to reduce communication protocall and data storage incompatibilities. Usually, the standard revolves around the mainframe manufacturer's network software packages and capabilities.

Building a Successful Network

College Information Resource planners must comprehend and examine a number of separate issues when planning for and building a microcomputer network. The most important of these include:

* Standardization of the microcomputers
* Data security and integrity
* User interfaces and training
* Communications type and environment.

The first key consideration in building a successful microcomputer network is to ensure the microcomputers used are not so diverse as to make interconnection imposible. If the devices on the network are too diverse, numerous problems will emerge. Most colleges and universities that are working toward this concept have designated the brand selection that will be the standard. Many times the microcomputer operating system will be designated and all microcomputers on the network will be required to run that operating system while on the network. Even with so called "all connective" networks, problems will occur. These problems will mainly involve less popular equipment, which the manufacturer or third party's network interface was not designed to handle. The institution must take the initiative and set the standards for use on the network.

Data security and integrity is the largest organizational problem for a college or university in the use of microcomputer networks. Obsolete data, theft of data, and unauthorized access are some of the problems. Each concern is magnified as the number of users with access to the network increase.

Many college and universities with dynamic data bases are concerned that decisions will be made on data that has changed in some proportion since it was downloaded from the mainframe computer. Users should be aware that data is being constantly updated and may be subject to fluctuations. While microcomputer networks allow the users to have access to the latest data, they must be aware of the problems and responsibilities of this access. Total file interface will solve this problem.

Theft of data has always been a problem for colleges and universities. In the past, worries were isolated to the data center itself and to those who could see and/or print information. With microcomputer access, and the ability to store and manipulate data on the microcomputer, a greater potential for theft exists. Now, theives can steal data, manipulate it, and produce results not previously available. The remote and unsupervised operation of microcomputers on the networks add to the data security problem.

The one area that is improving with the development of networks is that of unauthorized access to data. It is unlikely that a data base that was previously secure against intrusion will have a problem solely because of the presence of microcomputers on the network. Most networks and data base software maintain a good password access capability.

Most of today's microcomputer user's applications are stand-alone. Networked microcomputer systems will not change this. The microcomputer user needs the network to access data, communicate with other users, and access other files (e.g. program libraries, etc.). The network becomes the interface among many users. The problems of designing the interfaces and training the users in the use of communications will be a major hurdle in the effective use of the hardware/software systems being built. With few exceptions, colleges and universities will purchase the network software that will be used. Included in that software will be the user interfaces. Care must be taken when evaluating and selecting the network software and in training the users. Microcomputer networks should not be 'user friendly,' they should be user transparent!

The communications type and environment that will be used will depend on the institutions needs and requirements. Most institutions do not have the talent in sufficient numbers or time to develop their own communications environment, they will probably purchase a third party's package or use the package available on the mainframe they are using. As microcomputers proliferate, microcomputer networks will be developed and appear on the market. To ensure that the network communications scheme is well received and put to use, applications with broad appeal to the user community must be implemented. The Information Resource planner must appreciate the needs of the faculty and staff in specifying the requirements of the network communications software.

Focusing on Needs

Applications with broad appeal to the user community must be the first implemented. This means applications should be oriented first toward:

* Office automation
* Faculty needs
* Staff requirements.

Office automation is usually the first application that is implemented on a network basis. Office automation includes access to information, communications, document generation, personal computing, and personal management. Office automation functions are usually justified through an increase in productivity.

Access to accurate and timely information is one of the primary advantages of the microcomputer network concept. By creating networks, individual microcomputer users will have access to the needed information in an understandable format. It was previously noted that the total file interface concept will be the next data access method for microcomputer networks, but it is still under development.

Communications include person-to-person, person-to-group, group-to-group, person-to-computer and computer-to-computer. Progress has been made in the person-to-person and person-to-group areas with electronic mail. Computer-to-computer and person-to-computer communications has been possible, with some constraints, for some time now. Group-to-group is still an emerging area, although teleconferencing is beginning to fulfill its potential.

Document generation includes word or text processing, but will go far beyond the simple clerical tasks most people think of today. Professional faculty and staff will find it easier to input text, especially internal documents, than to hand write them. Now graphics allows a new dimension in portraying data. Image processing (photos, drawings, and signatures for example) is emerging. Voice recognition is being used by some companies and will be available in the not too distant future. The creation of integrated documents will require extensive data access capabilities and compatible communications networks. Microcomputer networks can combine all areas of document generation into a single useable system.

Personal computing, the fourth area of office automation, will be used by clerical personnel as well as professionals. It will allow users to run or access a wide range of programs at their desk, with access to the data needed. Programs currently associated with microcomputers (e.g. spreadsheets, etc.) will continue to be used, but technical programs and mainframe programs will also be available.

Personal management will be the final area included in office automation. This capability includes calenders, schedulers, and electronic notebooks. Users who find these techniques of value will adopt them quickly, while others will take longer to recognize their advantages. Again, the use of microcomputer networks will speed all the office automation functions along.

One last comment on office automation. Applications should be available for all users, but all users will not necessarily use them. Applications should be used by individuals according to three criteria:

* They should be used at least once daily
* They should be an automated replacement for a manual task
* They should be understandable and users must receive the appropriate training.

Faculty needs are the second set of applications that should be a part of the network. Faculty applications include the availablility of office automation tools, support for research, and tools for increasing teacher productivity. Not much more can be said for office automation. Faculty will use many of the applications available in this area.

Support for research will include the technical, data gathering, and data storage and handling needs to support the research efforts of faculty members. Statistical packages must be a part of the network. Microcomputers will be a big aid in supporting the data handling and minipulation needs of research.

Finally, tools for increasing teacher productivity will be part of the college or university microcomputer network. Examples of faculty tool are computer-aided-instruction and computer-managed-instruction. With the abundance of widely used microcomputer applications, teaching programming will become secondary to teaching application usage to most students. Tools must be available to assist individual faculty members to create automated teaching aids, assist in grade retention, filing and computation, and in record keeping and reporting. Use of the network will mean all faculty members access and use the same data bases and programs to increase consistancy among faculty members in record keeping tasks.

The final focus will be on staff requirements. Areas such as institution research, decision support, alumni and development, and job placement are just a few examples. Many of these applications are computerized now, but their inclusion in the microcomputer network will enhance their usefullness. As with the other applications, access to college or university data will expand the ability to perform these tasks. Use of the microcomputers will maxamize the ability to locally manipulate the data and provide meaningfull output in forms most useful to the ultimate user.

Summary

The use of microcomputers in colleges and universities has come a long way since the days of stand alone processing and there are more improvements to come. Because of their potential in everyday life, microcomputers are here to stay. It is inherent for colleges and universities to take the lead in the use of microcomputers. To that end, networked microcomputers will be the next generation in college computing.

All the tools, however, are not available now. We are on the verge of technological breakthroughs to allow maximum use of microcomputers in the networked environment. Common data and programs and the communication link between microcomputers and possibly one or more mainframes, provide the real advantages of microcomputer networks. Yes, there will be problems, but those problems will lead to opportunities and those opportunities to innovation. Colleges and universities must keep pace with industry to better prepare students. Industry is marching toward communications networks that will link managers' and professionals' microcomputers to each other and to the corporate data bases. What better way to incorporate the innovations of the future than to advance toward networked microcomputers as the next generation in college computing.