DOCUMENT RESUME

ED 294 514 HE 021 563

TITLE	Leveraging Information Technology. Track VII: Outstanding Applications.
INSTITUTION	CAUSE, Boulder, Colo.
PUB DATE	88
NOTE	93p.; In: Leveraging Information Technology. Proceedings of the CAUSE National Conference (Tarpon Springs, FL, December 1-4, 1987); see HE 021 556.
AVAILABLE FROM	CAUSE Exchange Library, 737 Twenty-Ninth Street, Boulder, CO 80303 (Individual papers available for cost of reproduction).
PUB TYPE	Speeches/Conference Papers (150)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	Administrative Policy; Budgeting; *College Administration; Databases; Higher Education; *Information Technology; *Innovation; Local Area Networks; *Management Information Systems; Microcomputers; Online Systems; Private Colleges; Scheduling; School Registration; State Universities; Telephone Communications Systems; Travel; Two Year Colleges
IDENTIFIERS	Baylor University TX; *CAUSE National Conference; Cornell University NY; Distributive Computing; Louisiana State University; School Identification Cards; University of Michigan; Virginia Polytechnic Inst and State Univ; Waubonsee Community College IL; Winthrop College SC

ABSTRACT

Eight papers from the 1987 CAUSE conference's Track VII, Outstanding Applications, are presented. They include: "Image Databases in the University" (Reid Kaplan and Gordon Mathieson); "Using Information Technology for Travel Management at the University of Michigan" (Robert E. Russell and John C. Hufziger); "On-Line Access to University Policies and Procedures: An Award-Winning Administrative Information System" (Bruce B. Harper and Wayland H. Winstead); "Affordable Touch-Tone Phone Student Registration and Self-Registration without Mortgaging Your College" (Paul G. Bosse and Louis A. Herman); "CUDA: An Adventure in Distributed Computing" (Louise Marie Schulden); "The Four-Year ID" (Roth Aymond); "The Development of a Successful Microcomputer Network Operation: Winthrop College's Novell NetWare LANs" (William J. Moressi and C. Brown McFadden); and "Changing Administrative Database Philosophy: Network to Relational" (Becky King). (LB)

ED294514

Leveraging Information Technology

Proceedings of the 1987 CAUSE National Conference

TRACK VII: Outstanding Applications

December 1-4, 1987
Innisbrook Resort
Tarpon Springs, Florida

CAUSE, the Professional Association for Computing and Information Technology in Higher Education, helps colleges and universities strengthen and improve their computing, communications, and information services, both academic and administrative. The association also helps individual members develop as professionals in the field of higher education computing and information technology.

Formerly known as the College and University Systems Exchange, CAUSE was organized as a volunteer association in 1962 and incorporated in 1971 with twenty-five charter member institutions. In the same year the CAUSE National Office opened in Boulder, Colorado, with a professional staff to serve the membership. Today the association serves almost 2,000 individuals from 730 campuses representing nearly 500 colleges and universities, and 31 sustaining member companies.

CAUSE provides member institutions with many services to increase the effectiveness of their computing environments, including: the Administrative Systems Query (ASQ) Service, which provides to members information about typical computing practices among peer institutions from a data base of member institution profiles; the CAUSE Exchange Library, a clearinghouse for documents and systems descriptions made available by members through CAUSE; association publications, including a bi-monthly newsletter, *CAUSE Information*, the professional magazine, *CAUSE/EFFECT*, and monographs and professional papers; workshops and seminars; and the CAUSE National Conference.

We encourage you to use CAUSE to support your own efforts to strengthen your institution's management and educational capabilities through the effective use of computing and information technology.

INTRODUCTION

As professionals in an always-exciting field, we are constantly facing challenges to blend new information technologies into our institutions. It is important for higher education to develop environments that promote the use of information technology for strategic advantages, that allow faculty, staff, and students to benefit from existing technology, and that stimulate the discovery of new opportunities.

The 1987 CAUSE National Conference, with its theme "Leveraging Information Technology," offered the opportunity for us to share, exchange, and learn of new developments in information technology to improve and enhance our environments. The CAUSE87 program was designed to allow the fullest possible discussion of issues related to these new developments. Seven concurrent tracks with 49 selected presentations covered important issues in general areas of policy and planning, management, organization, and support services, as well as in the specialized areas of communications, hardware/software strategies, and outstanding applications.

To expand opportunities for informal interaction, some changes were made in the program schedule. CAUSE Constituent Groups met the day before the conference, as they did in 1986, but were given opportunities to meet again during the conference. Current Issues Sessions were moved to Thursday afternoon to provide some flexibility with time, encourage interactive participation, and extend opportunities to continue discussions with colleagues. Vendor workshops were offered for the first time this year, the day before the conference. The Wednesday afternoon schedule accommodated continued vendor workshops, vendor suite exhibits, and concurrent vendor sessions.

David P. Roselle, President of the University of Kentucky, set the tone for CAUSE87 with a Wednesday morning opening presentation expressing his commitment to the value of information technology in higher education. John G. Kemeny, past president of Dartmouth College and currently Chairman of the Board of True BASIC, Inc., spoke during Thursday's luncheon of new developments in computing for classroom learning. The concluding general session, Friday's Current Issues Forum, offered an exchange of philosophies about making optimal use of technologies on our campuses.

We were extremely fortunate to be at Innisbrook, a resort with outstanding conference facilities and great natural beauty (and weather)—a real distillation of the best of Florida.

Almost 800 people attended CAUSE87. Many of them described the conference, in their evaluation forms, as stimulating, informative, and memorable. We hope this publication of the substance of CAUSE87 will be a continuing resource, both for conference-goers and for those who will be reading about the conference offerings for the first time.

Wayne Donald
CAUSE87 Chair

Leveraging Information Technology

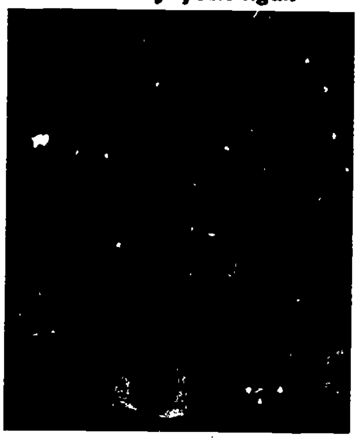
Table of Contents

Track VII
Outstanding Applications

Coordinator:
Cheryl Munn
University of Michigan

Many institutions have developed exciting applications in administrative and academic computing, in personal computing, in integrated and distributed processing, and more. Papers in this track describe such imaginative and effective applications.

John C. Hufziger
University of Michigan



Reid Kaplan
Yale University

Wayland H. Winstead
Virginia Tech

IMAGE DATABASES IN THE UNIVERSITY

by
REID KAPLAN

Presented by
REID KAPLAN and GORDON MATHIESON

Management Information Systems
Yale University

Historically, computer database systems have been used only for applications that had easily codified and key-entered data elements, or a payback great enough to justify complicated encoding and processing. Advances in personal computers now make it possible to include complex objects or documents in databases inexpensively. Instead of relying on descriptors alone to convey information about an object, we can include an actual picture of it in a database. This image can be manipulated, stored, retrieved, and displayed by standard database management systems augmented by a few special purpose modules and assisted by a graphics board. We have found that there are as many administrative applications of image systems as there are academic ones. After discussing image system concepts, we will describe, and demonstrate, prototype systems from each area. The first will be for a Human Resources Department: an image database for tracking applications for employment. This document has much handwritten information that causes key entry to be prohibitively expensive. Also, the paper form itself is hard to find in simply indexed filing cabinets. Conversely, electronic images of the document can be scanned and retrieved quickly and cheaply. The second will be a database of archived color paintings in one of Yale's museums. This allows researchers instant access to paintings for comparative studies, stylistic analyses, and many other scholarly tasks.

I. Introduction.

In the Spring of 1986 it became apparent that essential hardware and software components of image processing and image database management systems had been created for use with personal computers and were inexpensive enough to be cost effective in many applications. Some were commercially available and the release of others was imminent. At the same time, it was also apparent that this facet of the data processing industry had only recently emerged and both the marketplace and the technology were chaotic. In essence, there were a number of different solutions looking for a problem and key elements of a solution to some specific problems did not exist. However, the potential advantages of manipulating and managing pictures in the same ways as traditional data were so obvious that Management Information Services (MIS) initiated an investigation of the technology. The way to do this was to develop prototype image databases with off-the-shelf hardware and software. Actual experimentation would graphically illuminate the issues involved as no amount of speculation or literature searches could.

From the very beginning we had a clear idea of the heart of any microcomputer-based image system, the database management system. It is essential that images be managed in the same way, with the same flexibility and with the same response to unanticipated demands, as Yale's alphanumeric data. It is also essential that image database management systems be compatible with those that manage the university's central data resources.

It was also clear that we had to select objects that were visually demanding as well as informationally complex. A simple task would not tell us much. We were fortunate to find two organizations that had suitable objects, had text databases describing the objects, and had enough interest to cooperate with us: the British Art Center (BAC) and the Department of American Decorative Arts of the Yale University Art Gallery. We created integrated text and and color video image databases of a subset of the paintings in the former and of three dimensional silver artifacts in the latter.

In order to investigate scanner technology and pursue the elusive grail of the paperless office, we coupled together an easy to use PC database management system and an image scanner. The application we chose to develop was for the Human Resources Department: a system for tracking applications for employment.

This report describes, in general terms, what we have learned during the course of creating these prototypes and the current status and potential applications of this technology.

II. 1. The structure and content of digital images.

An image on the monitor screen of a personal computer can be considered to be the analogue of a table: a rectangular array of cells called picture elements, pixels for short. If the notion of an image as a table is extended in one conceptual dimension, the color of each pixel can be integrated into an overall image description. Imagine the bits that encode the color of the image to be orthogonal to the plane of the image, sticking out of it, if you will. We can now talk about "bit planes", layers of bits in a rectangular array. The larger the size of the code representing the color, the greater is the image's fidelity to the original because more discrete colors can be represented. For our purposes, we can consider gray levels of monochrome images to be colors, too.

What is a color that ye may know it? For the purposes of computer displays, a color is a number that differs by a single bit from all other numbers used in an encoding scheme. That single bit will cause a primary color component to be increased or decreased by one quantum or level. In the most commonly used additive color model, red, green, and blue are the primary components that are varied to produce a final color. Contrary to common belief, it is not possible for combinations of three primary colors to match all colors, nor must primary colors be red, green and blue. However, it turns out that these three match the largest numbers of colors and so are most efficient (Sears and Zemansky 1960, 886-888). An example will make clear how colors might be encoded. In the scheme used with AT&T's Truevison Advanced Raster Graphics Adapter (TARGA) 16, red, green, and blue are each represented by a 5 bit number; 00000 00000 00000 is black, and 11111 11111 11111 is white. Pure bright red is 11111 00000 00000; lightest pink is 11111 11110 11110. There are 32 possible levels of each primary color and, therefore 32 cubed or 32k colors total. Grays are indicated by three identical 5 bit groups. Obviously, if only grays were being displayed, the redundancy inherent in this encoding would be grossly wasteful of storage. One would choose, therefore, to employ a single number to indicate each level.

How many colors are enough? It depends on what you are trying to do and it depends on the interaction of the human eye with the display. It has been reported in journals, unfortunately without attribution, that psychovisual studies have shown that a human can distinguish between 16 million different distinct colors but can only identify about 50 different gray levels. Our own studies have shown that the ability to distinguish between two adjacent colors is dependent on which components are changed. It is not only that the eye is most sensitive in the green portion of the spectrum, there is also some sort of weighted averaging going on. If a majority component of a color is changed by one unit, the result is much more apparent than if a low level component is changed. To continue the TARGA 16 scheme with the use of decimal equivalents, suppose that the RGB components of a color are 31 15 15: a tomato red. A change to 31 14 15 is just barely noticeable even though the eye is most sensitive to green. A change to 30 15 15, however, is very noticeable.

In addition to color content of an image, subject matter makes a great difference in perceived image quality. For instance, humans are extraordinarily talented at recognizing human faces. Many fewer colors are required for a picture of a face to be rated highly. Thus, personnel or security applications of image systems can get away with lower performance hardware than more general systems. There are also situations where a large number of colors is not desirable. In an application where the image is schematic and not intended to reflect reality, too many colors can be distracting. Standard presentation graphics, maps, or CAD images use color for information encoding, by and large. In such cases,the image is very confusing if it is shown with more than about 16 colors. However, if the image is of an actual object or scene, or a simulated object is intended to appear real, 32,000 colors might be barely adequate.

The eye's ability to discern color variation is not the only reason for wanting many colors in a natural image. Color resolution can, to a certain extent, create an illusion of high spatial resolution. This is why the woefully inadequate color TV specification in this country has not sparked viewer rebellion. The way this happens is by an effect called antialiasing. We have all seen the stairstep pattern that results at a diagonal border between areas of two different colors. It is sometimes called "jaggies" and it is an artifact of raster scanning on low resolution devices. The technical term for this is aliasing. The appearance of aliasing can be mitigated by inserting pixels of intermediate colors between the adjoining areas, but it requires that many colors be available for smooth transitions to occur. The TARGA boards have clearly demonstrated the value of a large number of colors. They are nominally 512 x 512 pixels; only 482 are visible in the vertical dimension. This is no better than many EGA boards on the market, but, with 32k to 16m colors available, the images they display are vastly superior. Even the new VGA, with 256 colors, displays images that look like crude posters in comparison. Antialiasing can work with gray levels, too. Another AT&T group has developed a system for teleconferencing that uses a scanner capable of detecting 16 gray levels. The scanned image is displayed on standard EGA boards with a resolution equivalent to 80 dots per inch (dpi). This is much below the 300 dpi that has become the desktop publishing minimum standard, but the images are much more realistic and legible when displayed on the monitor screen with anti-aliasing.

II. 2. Scanning and video image capture.

There are, at the moment, two primary ways of getting images from the real world into a computer: scanning them with a charge-coupled device (CCD) array or capturing a frame from a video camera. The electrical signals representing the image are converted to numbers, digitized, by a special processor board in a personal computer.

Scanners are primarily intended for flat objects, but that is a matter of the design of the optical subsystem; at least one device has a depth of field of several inches. Scanners have the virtues that they are inexpensive, optimized for paper handling, and, at the moment, have higher spatial resolution than video cameras. They are comparatively slow however; scanning a full page takes about 14 seconds. Video cameras are more versatile in that they can take pictures of any sort of object or scene and the image can be modified during capture. They have highly developed color reproduction mechanisms and can operate swiftly; an image can be captured in 1/30 of a second. As in photography, lighting and color calibration are of crucial importance.

Image capture is the most expensive and technologically limited step in the process. It is expensive because it is labor intensive and because cameras with capabilities at or in excess of current broadcast standards do not benefit from the economies of scale that consumer electronics like personal computers enjoy. It is technologically limited because there have been few incentives to develop devices with capabilities beyond the current broadcast standards. Nevertheless, it is possible to capture images for about the same cost per image as photography because there are no consumables and the labor costs in either case swamp the capital costs.

II. 3. Image editing and enhancement.

After digitization, the image is invariably manipulated in some way. Even the simplest application will require elimination of distracting backgrounds, centering, sizing, rotating, and the like. More complex applications will demand the sort of processing that, until now, has been used only by television and movie studios. Examples are color alterations and the integration of text and original graphics with the image.

If the central goal of the application is image analysis or enhancement, image manipulation can be extremely involved and the results can border on the miraculous. We have seen most of this technology exercised on the fascinating pictures sent back from space by the Voyager vehicles. It is possible to filter out salt and pepper noise - the equivalent of snow on the home TV screen, restore definition, accentuate features such as edges, expand the dynamic range of the picture, and so forth. Image processing programs that do all these things are routinely available for PC's and cost about as much as 2 to 4 copies of a full function word processor.

II. 4. Image storage and data compression.

Images are file hogs. In the worst case, a full page, 16 gray level image takes around 100k. The smallest half page, 4 level image we have seen is around 23k. Color images take about 490k for an uncompressed, 32k color, 512x512 picture. No single magnetic disk at the DOS limit of 32 mb (320 pages) can hold enough images for a practical database. However, with the steady improvement of magnetic disks, the emergence of new storage devices, and the judicious use of compression techniques, practical, useful systems can result.

At the moment, we are using standard magnetic disks for storage. An IBM PC-AT with a 20 mb hard disk and an external cartridge disk drive with 40 mb immediately accessible, can store about 240 full screen color or 1200 black and white pictures. As the cartridges are removable, the total potential size of any database is infinite. Currently, there are commonly available personal computers with 100 to 130 megabyte disks. If history is any guide, the capacity of magnetic disks attached to PC's will quadruple in capacity and halve in cost per byte in the next three years. This means that image databases of 1000 immediately accessible color or 5000 black and white pictures stored on magnetic disks will be commonly affordable. In that same time, a new technology should mature. This is fortunate as many applications will require larger storage than magnetic media can provide.

Optical disks, capable of storing between 200 mb and 1000 mb on a single disk are available now, and will be routinely supported by PC system software. They have one important technical limitation; the data can only be written once. Thus, they are restricted to applications with static databases or enough users to justify creating new disks periodically. These devices are called WORM drives and CD ROM. WORM stands for Write Once Read Many and CD ROM for Compact Disk Read Only Memory. Both use optical technology to achieve an extraordinarily high data packing density. A WORM cartridge is written by the physical ablation of spots by a high energy laser and read by differential reflection of light from those spots. Because writing involves irreversible physical changes, an update consists of rewriting the affected portions and ignoring the old version. However, the important point is that the writing mechanism is included in the drive and the user can initiate the writing and rewriting locally. A CD, although superficially similar in that information is contained in laser detectable pits, must be mastered and pressed in a plant, a complicated and expensive process. Moreover, it really is a read only medium. If updating is required, a new disk must be mastered and a pressing run initiated. Obviously, this is cost effective only for static, high volume items.

How one stores one's images depends on the size of the image database. As described earlier, images of moderate quality are quite large. However, there are compression techniques that reduce the size of image files. Depending on the image content, an image file can be compressed to between 60% and 10% of its original size without loss of information. Compression techniques can be classified as destructive or nondestructive, and the latter can be divided into methods that take advantage of an image's raster structure and methods that can be applied to any type of data.

Destructive compression techniques are usually applied to an image's colors; rarely are images compressed in the spatial domain. The reason is that an image's spatial resolution is usually fixed to be that of the graphic adapter that will display it. In the simplest case, an image is posterized. That can be accomplished simply by truncating or averaging the color code. The result looks very much like a poster with large regions of single colors bounded by abrupt changes. There are, however, smarter schemes that will sample the image and select an optimal reduced palette. Some of these schemes operate not on individual pixels but on tiles of, say, 16 pixels. There exists a proprietary processor add-in board that can do this swiftly in hardware and allows the user to select the degree of destruction. The results for some images are nearly indistinguishable from the original.

Of the nondestructive compression schemes, the simplest is run-length encoding. This takes advantage of the fact that an image is made up of lines and often these lines contain sequences, or runs, of identical color. So, an image can be stored as a series of doubles; one number is the color of the run and the other is the number of pixels in the run. It turns out that "natural" images, pictures of real objects, can be compressed only about 10% by this technique, although computer produced graphics are compressed anywhere from 50% to 90%. The problem with natural images is that there are subtle hue differences from pixel to pixel. For instance, an image of a white wall actually consists of small patches of blues, pinks, and various other unnameable shades. One way around this problem is to run-length compress by bit plane rather than by pixel. Of course, this is possible only with boards that have planar encoding schemes. In the CGA, blue is encoded by 0001, green by 0010, and the intermediate cyan (blue-green) by 0011. If adjacent pixels in a run were made up of these three colors in alternation, no compression could be achieved by considering them as individual pixels. But all three have the two higher order planes in common and so could be compressed by about 50% if [illegible] planes were collapsed into two doubles.

[illegible] several compression techniques based upon statistical an[illegible] age content. The original, and still popular, example of these is Huffman encoding (Huffman 1952). A first pass is made through the image data to determine the relative frequencies of colors. The most common color is encoded with the shortest code. The next most common color is encoded by the next longest code, and so on. The result is a table, called a Huffman map, of original color codes and their optimal new encodings. During the second pass through the data the new codes are assigned. To decompress the file, the Huffman map is used as a key. This is a time consuming process; on a 12 megahertz 80286 machine a 494k image compresses in 12 seconds to 26% of its initial size and decompression takes 9 seconds. To increase speed, boards have been developed to perform the process in hardware and to eliminate the analysis step. They depend on predetermined maps determined by examination of a large number of "typical" documents encountered in fax transmissions. This map has been dubbed Fax Group 3. It works fairly well if the images conform to Group 3 statistics, but not all do. Clearly this only applies to gray level images.

II. 5. Image display and output.

After they are stored, and retrieved for some specific purpose, images must be displayed.

The immediate, and many times, only, display device is a high quality color monitor controlled by a display adapter. The monitor is largely a passive device; the image is stored and manipulated in the adapter and the adapter determines its resolution. The standard PC Color Graphics Adapter has 640 pixels horizontally and 200 vertically when it is displaying 2 colors; the IBM EGA is 640 x 350 and Extended EGA's and the new VGA are 640 x 480 with anywhere from 4 to 256 colors displayable at the same time. Except for monochrome document retrieval applications, this is barely adequate resolution. Most uses will require either more colors or more pixels. For instance, professional Computer Aided Design (CAD) or medical diagnostic images have a typical lower limit of 1024 x 768 pixels but they require only 16 to 256 colors. For displaying real-world objects, a reasonable device is the TARGA 16 with 512 x 512 x 32768 colors. For somewhat more money, there is a new generation of adapters with programmable resolutions of up to 4k x 4k pixels with up to 16 million colors. These adapters are equipped with onboard graphic processors that make image manipulation quick and easy. Only a short time ago, these capacities were available only on mainframe or supermini systems that cost an order of magnitude more.

For comparison, a home TV screen in the United States displays about 480 rows and about 350 columns. This is not really very good, but it is made acceptable by the nearly infinite number of colors displayable in each pixel. The all-time champ for combined spatial and color resolution is photographic film. A 35 mm. color slide, normally thought of as small, contains about 6 million pixels or the equivalent of 2958 rows and 2028 columns. Moreover, each pixel can contain a nearly infinite range of colors.

The monitors that display images, and perhaps standard text as well, are of two sorts: digital RGB and analog RGB. The former is sometimes called RGBI, for Red Green Blue Intensity, or TTL for the kind of transistor logic that is often used. These monitors are designed to display only a few colors (or gray levels); the PC standard CGA displays up to 16. These colors are specified by a four bit code that determines which of the 3 colors is on or off and if the electron beam is bright or dim (Norton, P. 1985, 71-77). These monitors can be quite inexpensive since so little is expected of them, but the colors of images are hardly natural. Having said this, it also must be said that the limitations of 16 gray levels are much less apparent than the limitations of 16 "real" colors. This has to do with the inability of the human eye to discriminate between gray levels as well as it does between hues. In addition, the kinds of monochrome images that are usually displayed do not have a very wide dynamic range. Analog RGB monitors can potentially display an infinite number of colors because the amplitude of analog signals is infinitely variable. As a practical matter, the number of colors actually displayed is limited by the amount of display memory available for color information. Multisync or multiscan monitors typically have the ability to display analog signals as do multipurpose monitors such as the Sony PVM-1271Q and the new generation of monitors for the IBM PS/2.

Many applications demand display in other media. Cameras that transfer digital images to 35 mm. transparencies exist. Our experimentation with them show that they do the job very well. However, this type of device, like a high quality TV camera, is best shared by many users. It is not likely that a single user could keep it busy or would wish to spend the $3000 to $5000 it costs.

We have experimented with transferring color images to paper via special thermal and ink jet printers. This technology is still in a very primitive state and the technical problems are formidable. No printer we know of is currently a true production device; there are problems keeping the printers operating optimally, images take 5 to 10 minutes to print, and the colors, especially those produced by thermal transfer, are unsaturated. For the present, hard copy devices are best used to produce proofs before a final copy on film. Of course, the image may be printed in standard ways from the film copy.

II. 6. Image database management systems.

Perhaps it is because of our background, but there was never any doubt that database management systems (dbms) must be used for images. An unorganized collection of images, even if computerized, is like a shoebox full of snapshots. Try to find the one of Aunt Bertha at the beach in 1927. Fortunately, database management systems that integrate images with descriptive and categorical text now exist. Unfortunately, there seem to be only two sorts: fairly simple but fairly inflexible dbms' tacked on to a graphic front end and full function, fixed field, dbms' loosely bolted to image capture and display facilities. A common denominator of these products seems to be that they were designed in a vacuum with no regard for the user. We have tried to influence the design and facilities of these programs, but, with one notable exception, we have been largely ignored. However, we have great faith in market forces; as soon as the demand for image systems makes itself felt, the software houses will come to heel.

The first thing a system designer must realize is that an image can reside anywhere; it need not be on the same storage device as the programs that manage it or the text data that describe it. Thus, a practical image database management system must keep track of the volumes and drives that contain the image files. Most PC dbms products do not now have the capability to span volumes or know which drives the volumes are mounted on. Nonetheless, it is a problem that has long been solved in principal, as mainframe users will instantly realize.

In addition to physical structural flexibility, an image database must have logical structural flexibility. For instance, the capability to have more than one image per record is a necessity, although many current PC products do not allow this.

Apart from the need for extreme storage flexibility, image databases have the same functional requirements for their management as standard databases. An image database schema will be identical to one that contains no pictures except that the alphameric fields will be limited to a minimal set of descriptors. After all, the image contains most of the information in such a database and only those descriptors required for retrieval need be entered. Also, the familiar database functions of add, update, and delete all have image analogues. These analogues will differ on two counts from the ones we are all familiar with: they must cope with two-dimensional objects of variable size.

Addition of images to a database requires complex editing facilities and clever linking to text descriptors. In the standard dbms there are certain editing functions provided by hardware and software that are considered essential when entering text, such as deletion, insertion, overstriking of individual characters, and placement of individual characters within the field. These are simple because of the orderly, linear, left to right, top to bottom structure of western scripts. In addition, certain arbitrary but reasonable limitations are placed on the amount of text that may be entered. Two dimensional data are much more difficult to handle because of the transformations possible in the plane and because there are far fewer conventions that constrain those transformations. It is also true that there is a much less clear cut dividing line between record entry and record modification. For instance, a retailer may wish to provide its dealers with a database of parts for inventory and quick access. Each individual image "page" may actually consist of parts of several primary images: a picture of the part, text attributes such as part number, location in the storage area, and a diagram of where the part fits in the assembly. If the user has to first paste these up by hand in an art department, there is much less incentive to use electronic retrieval as a cost saving measure. An image editor should allow individual sub-images to be captured and then modified to form the final image ready for retrieval.

The simplest form of image editing is cropping. Except for certain archival applications oriented towards the 8 1/2 x 11 page, it is not acceptable to force the inclusion of an entire image as captured. Real estate, physical security, and inventory applications come readily to mind as requiring cropped images. Cropping is easy to do, is included in almost every database product, and, moreover, it has an important technical benefit: it saves image memory buffer and disk storage space.

To be really useful, an editor must include the three two-dimensional linear transformations that preserve shape: translation, rotation, and scaling. Most image database products have a translation feature, more or less well implemented. It allows the composition of a compound document and is rather easy to do. Some, but not all, image editors allow rotation, and those that do often restrict the angle to 90 degree increments. It is easy to program in principle, but rotations in other than 90 degree increments produce aliasing artifacts that are difficult to minimize. In most applications, rotation is used for correcting small misalignments in the captured image and, therefore it is essential that this function be well implemented. Scaling is the magnification or reduction of an image or part of an image. All image database products have this capability. Reduction is easy, but magnification is not. The reason is that the original was scanned at a 'bsolute resolution floor; there is no more detail to see. Therefore, either some sort of interpolation and smoothing must be added during magnification or the application must be able to tolerate the more obvious appearance of pixels.

A third class of image editing is annotation. This can take two forms: locator controlled, or keyboard actuated. This feature has some memory overhead due to mouse drivers and/or font storage, although, it is easy to do. Some, but not all, products can do this.

In addition to the simple editing functions discussed above, it is possible with some systems to provide full function image editing through extensive "paint" packages such as TIPS, PC Paintbrush, or Dr. Halo. This can be done if the dbms supplies the user with the names of scanned image files. The user can scan, store images temporarily, run a report that lists the file name assigned by the dbms with an explanatory or identifying field entered by the user, and exit the dbms. Then the user invokes the paint package and accesses, edits, and resaves the images. This process runs the risk that the user will save the edited image with a name unknown to the dbms, but an astute user should be able to maintain data integrity with a little effort.

Updating an image can mean replacing it totally or modifying the existing image in some fashion. In both cases it is nearly certain that the size of the new image will be different from the old. The database manager must allocate and reclaim storage space in an intelligent manner. Otherwise, massive inefficiencies can result. If the image is modified by the user, the comments made previously about editing apply here. Linkages to descriptors must also be maintained.

Deletion is relatively simple if two principles are applied. First, since descriptive data and images may be loosely coupled, it is important to ensure deletion of both elements. One can not exist without the other. Second, if the storage medium is rewritable, the large space occupied by the image should be reclaimed immediately. When images are measured in megabytes, waiting to reorganize a file could prove fatal.

III. Document retrieval: the Employment Application Tracking System.

Document retrieval is a natural candidate for image database use. It is not as flashy as other uses of image technology, but the potential payoff is enormous. There are literally forests of paper, that must be referred to, in files all over the university. These documents can only be filed sequentially by single descriptors so retrieval is tedious and expensive. Often these single descriptors are the wrong ones for certain important purposes. Worse, many are misfiled and can be lost forever or cost an inordinate amount to find. The data on most of these documents are not transcribed to a computer database because they are not easily codified and key-entered or the payback is not great enough to justify complicated encoding and processing.

Putting them on microform does not help much. There is a cottage industry producing so-called Computer Aided Retrieval programs for microform, but the encoding problem still exists and even if you have a reference you must still find the microform the document is on.

A classic example of a document that is difficult to manage is the application for employment. It has much handwritten information that causes key entry to be prohibitively expensive, especially since the value of the document is transitory. In some cases, a photo of the applicant is part of the document and must be retrieved too. Currently, applications are simply filed by job type and photocopies are mailed to all departments that are hiring that category. Employment representatives are assigned to deal with broad classes of jobs, upper clerical, for instance. When a department requisitions a job search, the rep maintains a local file of responding applications and includes all the applications from the central file that are possible to find. When the job is filled, all the applications are put into the central file for about 6 months, after which they are purged. The problems with such a system are obvious.

Our prototype document retrieval system provides much more capability and flexibility while reducing the demands on the employment rep. The operator first enters a small set of descriptors about the application in a menu driven form displayed on a PC monitor. The application itself is then placed on the scanner bed and a function key pressed to scan the form. If its appearance is satisfactory, another function key is pressed to store the picture of the page. At the same time, the dbms assigns the image a unique file name and links it to the descriptor data.

The system allows for multiple pictures per document, in this case, one for each of the four pages of the application. Retrieval is performed on the descriptors and has full relational capability. For ad hoc retrieval, the operator simply enters criteria into another menu driven form on the monitor. Alternatively, a query language can be used for complex searches and reports. Those documents that satisfy the criteria can be displayed on the monitor by simply pressing still another function key. A half page fills the screen, but the entire 8 1/2 x 11 inch page is viewable by scrolling using the Page Up and Page Down keys. The user can browse back and forth from page to page or cause the page to be printed. Alternatively, the pictures of the document can be sent over phone lines to the PC of another person for viewing.

IV. Color video image database: British paintings

The many objects in Yale's galleries, museums, and collections are among the most under-utilized resources of the University. Some may be on display, and certain others may be accessible, but a very small fraction of Yale's holdings are used for teaching or research. There are a few simple reason for this. Many are not catalogued. Even if catalogued, the objects' catalogue references have very limited information content. A person selecting items for a study collection must still find and examine candidate objects for relevance to the objective. In many collections, this is not an easy task. It is also true that some desirable, even essential, objects may not be available for examination when required. Finally, when objects are located and chosen, they must be photographed for presentation or examination, for only a few sorts of objects may be removed from storage. Photographing is time-consuming, technically complex, and expensive. Moreover, a single object may undergo this process several times, making the total cost to the University very large indeed.

Among the Yale institutions addressing these issues, the British Art Center has one of the most extensive, informative, and accessible catalogues in the Computerized Index of British Art. It contains a total of some 42,000 art objects located around the world, of which the Yale holdings are an important subset. Textual descriptions of the art are managed by a flexible database management system which also directs searchers to an entry in an archive of black and white photographs. Although this system is a major step forward toward addressing the problems of speedy and inexpensive access to a complete information source, there are still some very important elements to be added before it can be used routinely for teaching and research. Pictures of the art are obviously the most important.

A user must be able to perform ad hoc requests for information, browsing through the database to find the appropriate items. In order to determine the appropriateness of the objects, they must be displayed instantaneously for immediate acceptance or rejection. At present, a user must search for a quantity of candidate objects and, armed with a lengthy report, proceed to the photo-archive proper to search for and locate the images. A copy of the black and white prints of those works that are suitable is then provided the inquirer. Further cycles of enquiries and searches might be necessary to refine the final selection. In addition, the product, a black and white print, is not often the medium of choice for a teacher. Most often, color transparencies are required for classroom display. We have been working with the BAC to investigate how we might improve their capabilities in these areas and, additionally, develop them so that the result could be transferable to other organizations on campus. MIS has captured images of a small subset of the BAC's displayed paintings using a recently developed raster graphics adapter in a personal computer. Attached to a video camera, this adapter can digitize color images of moderately high spatial and color resolution. The images are then stored, currently on magnetic media, and displayed on a special monitor also attached to the adapter. The images can be manipulated in many ways by image processing software that MIS has obtained. MIS was a test site for a version of the database management system, that is used for the index, that is able to integrate text and these images. In addition, color transparencies and color prints can be output on demand. On the basis of this study, we have also determined that other Yale organizations need, want, and can use the system; a prototype has been developed for the silver collection of the Yale University Art Gallery and the Yale Babylonian Collection has applied for a grant to create a database of images of their cuneiform tablets.

V. Summary: Application Areas, Common Requirements, and Common Problems.

We have learned that there are four generic applications for computer based image systems: 1. image databases, 2. complex illustrations for lectures or publications, 3. creative graphic art, and 4. image analysis and enhancement. Of great importance is the fact that, except for perhaps the last, there are as many specific applications in the administrative areas of the University as in the academic. We have also learned that although one of the four may be a user's primary interest, at least one, and most often two, of the other categories will be required to support it. This means that multiple or integrated software packages are required and that there is an immediate community of interest among all users. This also means that the University could effect enormous economies of scale by providing centralized image capture facilities and concerted purchasing programs.

The weakest links in the technology are the design of the database management systems and the image storage devices. These are only engineering problems, however, and are certain to be overcome, perhaps within a year. Of greater concern in the application of the technology is the acceptance of it by the end user. The people who are likely to benefit most from it are precisely those who are least technically adept and aware. The sociocultural systems that are entrenched in the private university compound this problem. Patience, communication skills, and friendly systems are essential tools in an implementer's kit.

Image systems are affordable. An entire PC based workstation, including software, is in the $10,000 to $12,000 area. The expense is in the personnel costs for image capture. But, thankfully, this is a one-time cost and is more than offset by the savings afforded by swift and certain retrieval. The cost of finding a misfiled document has been estimated to be between $25 and $50. The cost of paper shuffling is mounting. The cost-benefit ratio of wharehousing unused and unseen objects is infinite. Can we afford not to use this technology?

REFERENCES

Huffman, David A. "A Method for the Construction of Minimum Redundancy Codes," Proceedings of the I.R.E., 1952, 40, No. 9, 1098-1101.

Norton, P. Programmers Guide to the IBM PC. Bellevue: Microsoft Press, 1985.

Sears and Zemansky. College Physics. Reading: Addison Wesley, 1960.

USING INFORMATION TECHNOLOGY FOR TRAVEL MANAGEMENT AT THE UNIVERSITY OF MICHIGAN

By
Robert E. Russell and John C. Hufziger
The University of Michigan
Ann Arbor
Michigan

Over the past several years, colleges and universities have begun to develop programs to reduce the cost of travel and improve the level of service to their travelers. These programs are in response to some significant changes within the travel industry brought about by airline deregulation, increased competition among travel agencies, and the application of information technology to the travel agency's "back office" operation.

In developing these programs, one of the most important objectives is to obtain better information about travel patterns. How often do travelers go to a specific destination? When do they go and how long do they stay? Is there a significant amount of business with a particular hotel chain or car rental firm? The information that is needed to answer these and other questions is available in airline reservation systems, travel agency accounting systems, corporate charge card information systems, and institutional data bases. The challenge facing college and university travel managers is to effectively utilize information technology as a major component in a travel management program.

Using Information Technology for Travel Management at The University of Michigan

The Emergence of Travel Management at Colleges and Universities

Over the past several years, a series of events in the travel industry has made it advantageous for colleges and universities to develop programs to reduce the cost of travel and improve the level of service to their travelers. The first event was the deregulation of the airline industry, which resulted in increased competition between airlines and lower airfares. Lower airfares meant lower commissions to travel agents, and, in order to gain a larger market share, travel agencies became more aggressive in competing for the business traveler. By offering services designed specifically for the business traveler, agencies hoped to increase revenue. Computerization of the travel agency was another event that provided the opportunity for savings to colleges and universities. While airline reservation systems have been in use for many years, it was only recently that the back office of the travel agency was fully automated. This automation has made it possible for travel agents to provide a wide range of management reports to their business travel customers.

Another trend in the travel industry that is becoming more commonplace in colleges and universities is the use of a corporate charge card. There are two primary reasons for implementing a corporate card program. First, it can provide another means of obtaining valuable information about travel patterns to be used in negotiating discounted fares and rates. Reports that are commonly available with such programs include expenditures by industry (airlines, hotels, etc.), by vendor, and by geographic region. Second, it reduces or eliminates the need for cash travel advances; these funds can then be put to more productive use.

Travel industry experts estimate that savings of up to 40% can be achieved by implementing policies and procedures to provide better control over travel expenditures. The amount of savings obtained will depend on how liberal the existing policies are and how restrictive the new policies might be. It will also depend on the volume of travel and the particular travel patterns of an institution's travelers. Institutions that have a very decentralized travel policy can expect minimum savings of 18%-20% in air fare expenditures by concentrating their business in a single off-premise, full-service travel agency that guarantees to offer the lowest applicable airfare. Savings of 30%-40% or more can be obtained if a large percentage of air travel is between a small number of city pairs, which would make it possible to negotiate bulk fares directly with an air carrier. Savings of 10%-20% in hotel and car rental rates can be achieved by negotiating rates based on expected use.

Travel Management at The University of Michigan

Within this framework, The University of Michigan implemented a Travel Management Program in 1985 designed to reduce travel costs and improve the level of service to University travelers. This program has three major components:

- Designated Travel Agents
- University-Sponsored Charge Card
- A Coordinating Office

In selecting designated agents, the University developed a set of criteria that was used to evaluate the ability of a travel agency to provide certain guarantees and an appropriate level of service to University travelers. Designated travel agents have guaranteed that they will meet the objective of offering travelers the best available airfare given the constraints of the traveler's schedule - commonly referred to as the lowest logical airfare. Designated agencies were also required to utilize a rate desk - which provides an independent review of all University reservations to insure that the best fare was obtained. Since more than 25,000 airfares change each day, the rate desk not only reviews every reservation before it is ticketed, but also regularly reviews tickets and reservations until the date of departure. If a fare increase is pending, reservations are ticketed. If a fare decrease has occurred for tickets already issued, or if clearance is obtained for waitlisting on discounted seats, the tickets will be re-issued at the lower airfare. On a monthly basis, each designated agency submits a magnetic tape containing billing and sales data.

The University of Michigan selected American Express to provide corporate charge cards to faculty and staff. The no-fee, no-liability program currently has over 2,700 cards in distribution. Each month American Express provides magnetic tapes that are used for reporting and for controlling cards.

The Travel Services Office was established to coordinate the Travel Management Program. This office serves as a liaison with the designated agencies, American Express, and University travelers. In addition, the office has the responsibility for negotiating discounted fares and rates with airlines, hotels, and car rental firms. A newsletter, Travel Tips, is published periodically by the office to keep University travelers abreast of industry developments, new corporate agreements, and other travel-related issues.

Information Resources for Travel Management

In the mid 1970's, travel agents throughout the country began to install computerized reservation systems. Now, according to Business Travel News, over 97% of this nation's travel agents are using some type of computerized reservation system. Although this market is dominated by American Airlines' Sabre system and by United Airlines' Apollo system, there is an emergence of several new vendors offering equivalent or enhanced systems. These reservation systems enable travel agents to make bookings with most major airlines, hotels, and car rental companies. The newest and most sophisticated systems allow the agent to search for the lowest airfares automatically.

While the majority of agencies are online with a reservation system, it has only been in recent years that agencies have begun to automate their back office functions. It is estimated that 41% of the travel agents in the United States are currently making use of a partially or fully computerized back office system. Many of the back office computer systems encompass several of the agencies' office functions.

Some of the back office systems include:

- accounts receivable, payable, & general ledger functions
- business forecasting
- commission tracking
- ticket/itinerary printing
- reporting capabilities
- passenger profile functions
- agency branch communications
- word processing
- electronic phone book, calendar, & reminder list

Of the above functions, the passenger profile systems and reporting capabilities directly affect travel management at the University. Passenger profile systems allow the agencies to store a list of preferences submitted by University travelers. The profile, which contains the traveler's preferred airline, hotel chain, car rental company, seat selection criteria, frequent flier numbers, credit card numbers, and other similar information is automatically retrieved when the agent books airline tickets, reserves hotel rooms, or reserves rental cars for the University traveler. The back office reporting capabilities enable the agents to extract a client's travel information captured by the reservation system and provide it to the client either in the form of management reports or actual booking data on magnetic media.

In addition to capturing the data at the time of the booking, Travel Services is able to obtain data that is captured at the time of billing. American Express, the University's current supplier of corporate charge cards, provides Travel Services with three monthly reports. The first report is a vendor summary report listing the total number of transactions and dollar volume spent at each vendor. This report is first broken down by the type of establishment, i.e. airlines, lodging, auto rental, etc..., and then by individual vendor name. The second report is a geographic vendor summary listing the same information as the first, but is instead broken down by state and city, and then by type of establishment and individual vendor. The last report lists all airline tickets purchased with the corporate charge card. This report includes the billing price, the name of the airline, and the origin and destination on the ticket. American Express gives the University the option to receive these reports printed on a hardcopy, or to receive the data files these reports are derived from on a magnetic tape. American Express also allows their corporate clients to sign on to the American Express computer system and run these reports online or create their own queries and reports.

Each month, American Express supplies the University with a magnetic tape containing a data record for each existing University corporate cardholder and for any newly opened accounts. This tape is used to automatically update the corporate cardholder data file maintained by Travel Services. In this way, Travel Services is able to keep accurate records of any accounts that have been added, suspended, or cancelled.

The final information resources accessed by Travel Services are the University's faculty/staff database and travel voucher history data file. The faculty/staff database is used to verify employment data and produce mailing labels for mass mailings by Travel Services. The travel voucher history file is used to retrieve the staff identification numbers of all employees who have submitted travel expense reports. This was the method used for contacting the faculty and staff who do the majority of traveling at the University.

All of these resources - computerized reservation systems, travel agency back office systems, corporate charge card data systems, and University data systems - create various opportunities in which the Travel Services' management is able to analyze the University's travel patterns and gather data that can be used to negotiate discounted fares and rates.

Systems for Travel Management

In order for the University to reduce travel costs and increase the level of service for its travelers, it became necessary for Travel Services to develop a system in which travel expenditures could be captured and analyzed in a more accurate and efficient method. When the Travel Management Program began at The University of Michigan, designated travel agents provided the University with hard copy reports. Although the reports were adequate in supplying information on the distribution of business between the travel agents, it was necessary to be able to look at the University's travel expenditures as a whole. Therefore, on a monthly basis, a clerk was required to manually consolidate the seven sets of agent reports into one set of summary reports. This was a very time consuming task. In addition to the large amounts of time spent on the manual manipulation of data, Travel Services was limited to a specific set of reports the travel agents were providing.

Based on the experiences gained in the first year of the program, new contracts were negotiated with the designated agents that required data be reported on magnetic media. Travel Services now receives two data files from each of the designated travel agents. One data file contains information regarding each of the airline tickets issued to University travelers. The other file contains data concerning all hotel bookings and car rentals made through the agent. These two files are downloaded from the agent's system to magnetic tape or floppy diskette. The files are then loaded onto Travel Services' computer system and run through a program which creates a master air file and a master hotel/car file. Since the seven designated agents use either American Airlines' Sabre reservation system or United Airlines' Apollo reservation system, a program to merge the unlike data file formats was developed.

Once the data is loaded onto the system, the travel coordinator has the ability to run several pre-programmed reports. Some of the reports include the following: air travel expenditures by cost center, destination analysis summary report, airline summary report, hotel booking summary report, rental car summary report, and minority vendor summary report. The system allows the user to either print these reports or display them directly on the workstation.

These data files contain all information pertaining to each booking, so the reports that may be generated can be quite detailed. One report that was created listed all round trips from Detroit to Washington D.C. and the number of nights stayed in Washington D.C. hotels. This information was used in negotiating discounts with hotels. In another example, a report listing the number and dollar volume of domestic and international flights was generated. These are just a few of the types of reports that are now available to Travel Services.

In addition to the travel agency report system being used by Travel Services, there is a corporate cardholder management system. This system is used to keep track of all current accounts, pending applications, and cancelled accounts. Each cardholder record contains several pieces of information: campus address and telephone number, cost center and organization code numbers, American Express account number, and preferred travel agencies. In the agreement with American Express, the University is required to notify all cardholders who are thirty days delinquent in their payment. This is accomplished by loading a tape produced by American Express at the end of each billing cycle and running a program that prints a dunning notice for each delinquent cardholder. The cardholder file is also used to produce mailing labels for the newsletter published by Travel Services and for any correspondence relating to one of the designated travel agents.

At this time, the vendor summary management reports received from American Express are in a hard copy format. A system is under development that will allow the University to receive the source data for these reports on magnetic tape. When completed, Travel Services will have the ability to generate its own reports and maintain a history of the vendor summary data on disk. Plans are also being made to allow online communications between the University and American Express. With messaging capabilities, routine requests could be sent electronically rather than having to wait until the University's assigned analyst at American Express can be contacted by phone.

Conclusion

Information technology has played a major role not only in the computerization of the travel industry, but also in the ability of colleges and universities to improve their control over travel expenditures. However, the benefits of improved control over travel are not just tangible savings. An institution that can demonstrate it has taken steps to reduce travel costs may have an advantage in seeking federal and state funding, research grants, and other sources of support. In addition, an institution and its travelers will benefit from the increased level of service that can be obtained.

On-line Access to University Policies and Procedures: An Award-Winning Administrative Information System

Bruce B. Harper and Wayland H. Winstead

Virginia Polytechnic Institute and State University

Blacksburg, Virginia

Abstract

As one component of a university-wide move toward the electronic office, Virginia Tech has implemented an on-line Administrative Information System. The system makes available to the university community, in a cost-effective manner, policies, procedures, and general management information in an electronic Fact Book. The information system is centrally maintained and has eliminated the need for every office on campus to keep paper copies of the Administrative Handbook and other policy manuals. The system has been in use for more than a year and won an honorable mention award from NACUBO for its cost savings.

This paper provides 1) a brief history of the development of the system, 2) a discussion of the design issues that were identified and addressed during implementation and testing, 3) an analysis of usage statistics during the first 16 months of operation, and 4) a demonstration of the system.

Introduction

The Administrative Information System (AIS) at Virginia Tech replaced a traditional systems and procedures manual by taking advantage of the university's significant computing and communications resources. The new system, which has been in operation for 16 months, was designed to resolve audit comments regarding the timely availability of current administrative policies and procedures. Though developed outside of the university's normal administrative data processing environment, the AIS was also viewed as an extension of the administration's commitment to office automation.

This paper provides a brief overview of the development of the AIS, the necessary conditions of its successful implementation, the design issues raised and resolved during development, and usage statistics for the first full year of operation.

Prerequisites

The development of AIS would not have been contemplated had there not been support of extensive office automation through universal departmental access to the university's IBM 3090 computer. Development of the AIS was also predicated on both a strong commitment to office automation by the entire executive administration and a high level of acceptance of office automation by staff and faculty. The level of acceptance among staff was considered to be especially critical since clerical and secretarial staff were typically more directly involved with administrative procedures than faculty. The administration was committed from the outset to an on-line system. This commitment was evidenced by the fact that the decision to implement AIS was taken without any cost/benefit analysis. In large measure, these factors have contributed to the positive acceptance of the AIS. In the absence of these factors, the system probably would not have been successfully implemented.

Progenitors

While the university's primary information systems were based on IMS, which had a long history of user training and security control, by 1985 the university had already begun to implement administrative applications under CMS. Almost all of these applications had been developed by departments outside of the normal administrative data processing areas.

Like most systems, the AIS had several progenitors that influenced both the decision to implement an on-line system and the system's design. In 1982 a prototype system was developed by the Computing Center to display the *Faculty Handbook* at a user's terminal. This system displayed simple text files by selecting the appropriate section from a "point and push" table of contents menu. The system represented a proof of concept prototype but it was never developed beyond the prototype stage. In addition to this system, the availability of on-line HELP under CMS and Computing Center News items offered under a customized CMS HELP menu prompted development of other systems that influenced the design and implementation of the AIS.

Independently, Institutional Research and Planning Analysis (IRPA) developed and implemented an *Electronic Fact Book*. Based on the CMS HELP facility, this system provided on-line access to standard reports available in print in the *University Fact Book*. The *Electronic Fact Book* displayed simple text files from a series of "point and push" menus that mimicked the look and feel of the basic CMS HELP facility. This system was developed, tested, and installed by IRPA during 1984 and operated as an independent application until it was incorporated into the AIS. After introduction of the *Electronic Fact Book*, the Admissions Office installed the *Admissions Information System* that made weekly admissions summaries available on-line. This system was also based on the CMS HELP facility and offered an enhanced system that monitored user access in order to evaluate system usage.

A number of other departments also offered on-line "systems" that permitted users to view text files containing their standard operating policies and procedures. Like the *Standard Operating Procedures* offered by Sponsored Programs, these displays frequently amounted to little more than a listing file that the user could view with standard CMS commands such as XEDIT or BROWSE.

All of these systems required a user to link to a CMS mini-disk and execute a command; to establish the link in the PROFILE EXEC and remember the appropriate command; or to create a custom exec file that linked to a mini-disk and executed the appropriate command. Only those systems based on the CMS HELP facility offered a consistent and familiar "look and feel."

There were several progenitors of AIS that set precedents for on-line access to administrative information. These systems influenced the administration's objectives for the AIS and its design criteria. These progenitors also anticipated some of the problems with on-line access to administrative information under CMS that have yet to be resolved.

Getting Started

One of the initial difficulties encountered in the development of the AIS was the lack of an appropriate "home" for the system. Administrative data processing at Virginia Tech has been decentralized for many years. As a consequence, no single administrative department had a clear responsibility for the entire system. While it was clearly recognized that the Vice President for Administration and Operations had the responsibility for the *Administrative Handbook*, his office had no systems development or programming support. In addition, few administrative departments had developed or wanted to develop systems under CMS, since their primary experience was in IMS.

Under the direction of the Vice President for Administration and Operations, each department was trained in basic DCF/GML tags and assigned the responsibility of preparing a source document that would be incorporated into a single Policy Digest. The original intent was to provide access to the Policy Digest under CMS and to make it available as a monolithic printed reference. Based on its experience in developing the Electronic Fact Book, staff in IRPA were assigned the task of researching design alternatives, developing the display system and supervising its implementation.

After initial review of the development of the policy and procedure documents, IRPA staff identified a critical need for an editor to provide technical writing assistance and to supervise the markup of each document. By January of 1986, an editor was hired and the development plan completed. The development plan called for initial system testing on July 1, 1986 with full implementation the following September.

In common with most of its progenitors, the AIS system was largely developed outside of the normal data processing departments. It was not until July of 1987 that the AIS system was formally assigned a permanent staff and placed under the control of the Office of University Services.

Design Issues

Given the decision to replace traditional systems and procedures manuals with an on-line system, several design issues were identified. These issues evolved as the system was designed and were not part of the decision to implement an on-line system.

Single-Source Files

One of the earliest decisions was to design a system that utilized a single-source file to produce both on-line files, supplemental printed versions of the policies, and typeset-quality text where necessary. This decision reflected a recognition of the resource requirements to maintain multiple files and a desire to avoid errors and omissions in several file versions. DCF/GML (IBM's SCRIPT) was selected as the basic text programming language. Basic printed documents were to be provided on the 3800 page printing system. In addition, IBM's 4250 printer provided the capability to produce professional-quality typeset text where this was desired. The system was successfully developed using the single-source document concept.

Display Text Files

The decision to use a single-source document in DCF/GML dictated a design of the on-line display system based on the storage and retrieval of electronic page images. Sections of each document were stored as text files under CMS and the AIS software was designed to select the appropriate text file based upon the system menu and use input. Virginia Tech's Systems Development department provided a basic Display Management System panel, which was used as the AIS main menu. This was the only part of the AIS developed by Tech's data processing professionals. Primary displays in the AIS were based on IBM's XEDIT full-screen editor with customized edit profiles that limit the commands available to the user.

This design decision led to a large number of files, over 1400 at this writing. However, the algorithm to create the display files from a single Script source file and the basic display algorithm was quite simple. By keeping the mechanics of the display system simple, we were able to focus our efforts on the readability of the basic documents and the consistency of text markup from one document to the next.

Responsibilities

Each department issuing policy was assigned the responsibility for its own document and was asked to prepare the initial source file. The AIS editor was assigned the tasks of editing the department's original material and developing a consistent markup style for all documents. The initial objective was to ensure that each document was written at the 10th grade reading level and satisfied generally accepted standards for technical English. Our intent in attempting to achieve the 10th grade reading level was to make the reader's task as simple as possible. We felt that the on-line display posed enough challenges without expecting the reader to comprehend text written at higher reading levels. We believe that this decision had a significant impact on user acceptance of the on-line display.

These responsibilities were established early in the development process and have worked well. Since a consistent markup style for all documents proved to be an essential element in the AIS system, we have been successful in achieving this goal in almost all of the documents available on-line. Improved readability was not one of the administration's original objectives for the AIS, but it has emerged as one of the better unintended benefits. While we have not yet achieved the targeted reading level in all documents, we have made significant progress. Most of the documents available under the AIS are reasonably close to the targeted 10th grade reading level. We have encountered some resistance to lowering the reading level, especially in documents such as the *Faculty Handbook*. It has also proven to be difficult to achieve a consistent text markup in documents such as the *Faculty Handbook*. Where resistance has been encountered, the AIS Editor has yielded to practical realities and merely suggested less cumbersome wording and more consistent text markup.

Printing

An initial design objective was to minimize the amount of printing done through the AIS. One of the primary objectives of an on-line application was the ability to update policies and procedures without the delays normally associated with systems and procedures manuals. It was readily apparent that one of the possible drawbacks to this approach was the possible existence of out-of-date printed documents. The traditional systems and procedures manuals remedy this problem by collecting all of the out-of-date material as verification of appropriate updates to the manual. This approach was clearly not feasible for an on-line system. To date we have not experienced problems with out-of-date policies and procedures, but we do not have sufficient experience to determine if this will continue to be the case.

After some review, it was decided to support three levels of printing. First, draft printed copies of the contents of each display file would be provided using the XPRINT command under XEDIT. The draft print facility can be invoked from a PF key while viewing any of the text displays in the AIS. A second level of printed distribution is provided in which full copies of each document may be printed from a "point and push" menu. The basics of this display were borrowed from the Computing Center's Documentation System (DOCS) and the user interface improved so it was similar to the Table of Contents menus in the AIS. These documents, which are stored in an MVS library, are printed on IBM's 3800 Page Printing System and delivered to the user's output distribution box. Delivery can usually be expected with one hour of a print request, though the user can control print priority, which determines both delivery time and printing cost. A third level of printing involves the production of camera-ready copy that can be used to print large numbers of distribution copies. An example of this type of printing is the *Traffic Rules and Regulations* brochure, which the university produces each year and distributes to students, faculty, and staff. With the installation of IBM's 4250 printer, the university's ability to provide high-quality camera-ready copy has been significantly improved.

While we have not monitored draft printing, we have maintained statistics on the number of documents printed under the AIS. Over the past 16 months, we have printed on average about 128 documents per month from the AIS. The total number of documents available for printing on the 3800 printer from the AIS has grown from 16 when the system was first installed to 30 documents at the time this paper was written. We have provided camera-ready copy for only one publication, *Traffic Rules and Regulations*. It appears that the availability of printed copies on the 3800 page printer has reduced the demand for more traditionally printed documents. It may well be that the next revision of the *Faculty Handbook* will not be provided in any form other than that available on the 3800.

Off-campus users

As a major research university with a traditional land-grant mission, Virginia Tech has departments, off-campus instructional centers and Agricultural Research Experiment Stations throughout Virginia. For these remote departments, an on-line system has not proven satisfactory. The problems we have encountered are largely due to the relatively high cost of telecommunications services and the spotty quality of communications service available over the state's wide area telephone service. For off-campus departments, AIS did not provide a satisfactory means of documenting administrative policies and procedures. For these departments, the university periodically prints updated policies and procedures and ships the documents to off-campus users. Other universities considering the development of a similar on-line system would be well advised to consider the issue of off-campus access during the initial stages of system planning.

CMS or PROFS?

At Virginia Tech, the user community has evolved into two groups; those who use PROFS as the predominant application and those who use CMS. Many of the most sophisticated users had a significant commitment to CMS long before the university's formal commitment to office automation and the concomitant installation of the PROFS system. These sophisticated users made infrequent use of PROFS and preferred the native CMS environment. On the other hand, there were large numbers of users who knew virtually nothing about computing other than the facilities provided in PROFS. Unfortunately the look and feel of these environments differed considerably.

It was not considered feasible for AIS to support both of these conventions and one of the most difficult initial design decisions required the selection of one set of conventions. The PROFS conventions were selected because it was felt that the least-experienced users would less difficulty learning how to use a system based on PROFS conventions. Many of the least experienced users were clerks and secretaries who were expected to be the system's most frequent users. The initial design decision was to make AIS available from one of the PROFS menus and to provide a seamless transition from PROFS to the AIS. Consistency with PROFS conventions was, however, not maintained in the "point and push" selection of items from the Table of Contents menus. The overall system design would probably have been improved by maintaining strict consistency with either CMS or PROFS conventions. The issue of "look and feel" was, however, not limited to the AIS system alone.

How many user interfaces?

The PROFS interface decision reflected part of a larger question raised by the proliferation of CMS administrative applications. How many user interfaces were to be permitted? In effect, what was the total amount of user training/learning required to function in automated office environment? This issue has not yet been resolved at Virginia Tech. CMS-based administrative applications have continued to proliferate. At this time we have not developed a formal policy regarding the conventions these systems should use nor have we attempted to coordinate security or electronic signature controls in CMS administrative systems.

Other institutions considering the development of on-line administrative applications should give serious consideration to this issue. In theory it should be easier to decide upon a consistent "look and feel" and to develop applications to this standard. The establishment of a consistent "look and feel" standard should also minimize the amount of time user's spend learning to use administrative applications. Over time, the absence of a consistent standard at Virginia Tech may limit the acceptance of on-line CMS administrative applications.

Security

Surprisingly, security was not an issue in the development of the AIS. From the outset, the intent was to foster universal access on the part of faculty, staff and students. Any user may access the system without special authorization and view university policies and procedures or print a copy of a document. Security precautions were limited to specific XEDIT profiles that do not file user changes to the policies displayed on the screen. To date we have had no problems with mixed student, faculty and staff access.

How much information to display?

Despite our efforts to keep things simple, we encountered typical design issues that had a big impact on the novice user. Among these were decisions on how much information was to be contained in each of the display files. We found that one- or two-paragraph display files often presented information out of context. This led either to multiple user selections from the menu in an attempt to gain the context for a particular policy, or to misunderstanding of the policy or procedure due to a lack of context, or to complete user frustration evidenced by immediate termination of the session. On the other hand, we found that providing too much text made it difficult for users to find what they needed to know quickly, thus obviating one of the advantages of an on-line system. We settled on major subheadings (e.g., section 1.1) as an appropriate compromise, but this decision required considerable care in developing a consistent style among documents prepared by many departments. In retrospect, we could have saved considerable time by identifying and resolving this issue before we began the preparation of the initial source documents. We could then have trained each department in the development of policy and procedure documents under a consistent style. Institutions contemplating similar on-line policy displays could learn from our experience.

Emphasis and organization

Emphasis and organization also proved to be a markup issues that required consideration in light of on-line video display. Many of the documents originally had underscores for emphasis, but on a CRT display, underscores took a full line (approx 5%) of the display. We also found that text justified to both the right and left margins was more difficult to read. We settled on CAPS for emphasis based on capital letters in the on-line display and ragged right justification. We also found that it was important to eliminate the blank lines produced by IBM SCRIPT at the end of some of the display files, and that the inclusion of positive top and bottom of file indicators helped users to maintain their orientation in the file.

Index

We also found that an Index was extremely helpful in finding the appropriate section of a document in the on-line display. The basic GML Index tag, however, provided page references which were useless as an index to the on-line display. We solved the problem by writing a REXX EXEC that converted page references into section references (e.g., 1.1). Section references have provided a convenient Index for on-line users. The Indices would also be more helpful if we had developed a consistent policy regarding index references at the outset. Since each department was responsible for its own document(s), the use of keywords or index references varied from one document to another. The documents in the AIS would be easier to use if we had established a consistent policy regarding index references and trained each department to implement this standard. While the administration had originally envisioned a single, monolithic document with a single comprehensive index, the AIS system abandoned that concept early in the development process. A monolithic document proved to be unmanageable since minor revisions to one policy impacted the entire document. We have attempted to provide a reasonable index to each document, but have not provided a master, comprehensive index for all documents.

Absence of Forms

The AIS could not display exact images of many of the administrative forms used on the campus. Most systems and procedures manuals have numerous copies of institutional forms that can be referenced in the manual. With the obvious technical limitations of a CRT display, this was not possible under AIS. While this represents a significant shortcoming when compared to traditional systems and procedures manuals, we have not had major problems with this as of this time. Our Employee Relations Department runs training programs that cover each of the major administrative procedures and our Internal Audit Department has not taken exception to the absence of exact replicas of these forms in AIS.

Archives

One direct benefit of AIS has been the implementation of historical archives of institutional policies and policy changes. Heretofore, the university had no central summary of policy or procedure changes. The AIS display contains a Revision Status section for each document. Detailed notes are provided in this section on any changes that have been made to the document. The system archives also contain complete copies of each document that preserves an historical record of policy changes.

System Usage Statistics

To determine if the system was being used and to provide departments with information to departments about usage of their sections, an enhancement was added to the system that monitors usage. For the past 16 months, each time a user has viewed a section or has printed a complete document, the usage monitor has extracted the user's ID, the identifier of the policy being viewed or printed, along the date and time. This information has been monitored routinely to gauge the system's effectiveness. Since the implementation of usage monitoring, we have been able to track usage by department as well as individual user.

The accompanying tables illustrate system usage over the last 16 months. During a typical week, over 100 individual users have accessed the AIS. Total system usage has averaged over 200 calls per week. During this time over 2000 documents have been printed from the AIS Print-a-Document menu. System usage varies with academic sessions and holidays, but this variation is typical of most administrative systems and overall computer usage as well. To date the administration has been satisfied with overall usage statistics.

Virginia Polytechnic Institute and State University Administrative Information System
Weekly System Usage Since Startup

Week		Accesses	Userids
June 30, 1986	July 6	150	101
July 7	July 13	211	138
July 14	July 20	147	89
July 21	July 27	86	48
July 28	August 3	114	66
August 4	August 10	127	75
August 11	August 17	112	65
August 18	August 24	118	73
August 25	August 31	73	51
September 1	September 7	64	46
September 8	September 14	140	79
September 15	September 22	160	105
September 22	September 28	107	67
September 29	October 5	141	89
October 6	October 12	109	65
October 13	October 19	144	83
October 20	October 26	140	87
October 27	October 31	168	93
November 1	November 9	195	99
November 10	November 16	204	102
November 17	November 23	172	82
November 24	November 30	148	77
December 1	December 7	238	127
December 8	December 14	201	117
December 15	December 21	202	97
December 22	December 28	61	35
December 29	January 4	54	30
	1987		
January 5	January 11	328	167
January 12	January 18	291	144
January 19	January 25	227	112
January 26	January 31	242	97
February 1	February 8	385	128
February 9	February 15	282	133
February 16	February 22	331	167

Week		Accesses	Userids
February 23	February 28	290	143
March 1	March 8	269	151
March 9	March 15	457	218
March 16	March 22	369	199
March 23	March 29	357	172
March 30	April 5	345	181
April 6	April 12	270	153
April 13	April 19	383	177
April 20	April 26	298	161
April 27	May 3	361	176
May 4	May 10	357	180
May 11	May 17	338	200
May 18	May 24	455	178
May 25	May 31	241	154
June 1	June 7	257	144
June 8	June 14	227	123
June 15	June 21	190	104
June 22	June 28	272	138
June 29	July 5	203	118
July 6	July 12	195	113
July 13	July 19	180	118
July 20	July 26	199	123
July 27	August 2	240	141
August 3	August 9	217	124
August 10	August 16	177	116
August 17	August 23	195	125
August 24	August 30	199	124
August 31	September 6	228	128
September 7	September 13	212	121
September 14	September 20	216	144
September 21	September 27	207	145
September 28	October 4	216	134
October 5	October 11	198	130
October 12	October 18	215	144
October 19	October 25	204	131
October 26	October 31	193	125

Virginia Polytechnic Institute and State University Administrative Information System
Print-A-Document Requests, July 1986 to October 1987

	1986						1987									
DOCUMENT	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**
AIS User Instructions	27	7	6	9	3	3	8	2	7	4	8	5	3	4	2	5
Faculty Handbook	12	6	9	7	8	8	14	22	13	5	11	6	22	12	15	4
Proposal Preparation - Sponsored Programs	12	6	5	6	2	3	5	2	3	1	11	2	1	1	3	4
Student Life Policies	4	4	0	2	3	0	4	2	2	0	2	3	1	4	0	1
Laboratory Safety	9	5	5	8	1	5	3	10	13	25	9	1	0	13	0	1
Radiation Safety	4	5	3	35	3	5	8	5	4	3	5	1	11	17	2	2
X-ray Safety	3	5	2	13	1	0	1	2	3	5	1	1	0	1	1	1
Safety Rules for Jobs & Tools	5	2	2	1	1	1	2	1	2	3	0	1	0	2	2	1
Animal Research Policy	6	4	0	3	0	1	2	0	2	2	2	4	0	3	1	2
Physical Plant Dept.	9	7	12	4	0	3	5	1	4	0	1	5	1	4	1	4
University Services	12	4	2	6	1	1	3	1	1	1	3	6	2	2	4	3
Communications Network Services	11	7	5	8	2	1	5	1	7	5	6	4	4	4	2	6
Purchasing Handbook	11	5	18	14	5	2	6	7	10	7	6	8	6	6	6	4
Finance Handbook	15	8	10	13	10	3	9	7	5	5	8	6	4	9	13	5
Traffic Rules	6	2	2	2	1	1	2	1	2	0	4	1	0	1	0	2
Employee Relations	14	13	11	10	4	2	7	5	11	1	24	9	9	8	1	3
Graduate School Policies			3	7	4	1	3	2	6	2	7	8	1	4	0	3
Central Stores General Catalog					6	3	14	9	101	23	37	15	11	17	25	19
Central Stores Physical Plant Catalog					3	0	6	4	41	8	22	8	8	6	13	9
Biosafety Handbook							3	0	0	3	0	0	0	1	1	1
Space Allocations									7	0	0	1	1	0	1	0
Computer Equipment on State Contract									17	31	20	10	17	4	13	43
Chemistry Stockroom Catalog									5	2	13	0	2	3	3	2
Employment Interviewing Handbook										7	15	6	5	2	4	2
Faculty Recruitiment										4	2	1	0	1	3	0
Handicapped Student Services										3	0	0	1	0	0	1
Vet Medicine Student Handbook										3	1	1	0	1	3	0
Care and Use of Research Animals														5	1	1
Honor System Constitution															1	0
Academic Policies															2	8
TOTAL	160	90	95	148	58	43	110	84	266	153	218	122	114	137	123	137

Synergy

The AIS system began life as the "Policy Digest" since its original intent was to provide policies and procedures. Its mission was, however, soon expanded to include the Electronic Fact Book, Admissions Information, Presidential Policy Memoranda, Governance System Commission and Committee Memberships, Governance System Minutes, and Summaries of Space Allocations. These systems have remained a part of the AIS while other systems have been developed using similar user interfaces.

Within months of its implementation, AIS contained lists of surplus chemicals available free from the Safety Department and chemicals available in the Chemistry Department Storeroom. These were soon followed by a catalog of Central Stores supplies and equipment that featured on-line order preparation. (On-line orders were not developed due to internal control and security considerations raised by our Internal Audit Department.) These systems have been segregated into stand-alone applications.

Summary

While AIS began as a system available from a PROFS menu, the increased number of CMS administrative applications soon led to the installation of the INFO System, which was developed by the Computing Center. Since the INFO System was based on CMS conventions, its introduction led to the demise of the seamless transition from PROFS into the AIS. Departments have continued to develop administrative applications under CMS and the number of distinct user interfaces has continued to grow. This growth has been reflected in the increased numbers of applications and sub-menus available from INFO.

The system received a sixth-place cost-reduction incentive award in 1987 from the National Association of College and University Business Officers (NACUBO). Despite this award, the AIS must still be considered an experimental system. It was developed in a typical "skunk works" manner, incorporating elements from existing systems and working out design issues and problems as they arose. It was during its development a low budget system and it continues to be a low budget operation at this time. The system has been successful in achieving the major objectives established by the administration. How the system will fare over the long run and the eventual fate of other administrative applications under CMS will have to await the verdict of staff and faculty users in an increasingly complex automated office environment.

AFFORDABLE TOUCH-TONE PHONE STUDENT REGISTRATION AND SELF-REGISTRATION WITHOUT MORTGAGING YOUR COLLEGE

Paul G. Bosse
Dean of Student Development

Louis A. Herman
Dean of Information Systems

Waubonsee Community College
Illinois Route 47 at Harter Road
Sugar Grove, Illinois 60554
312/466-4811

This paper describes one institution's innovative approach to providing inexpensive registration methods without over-extending a college's financial situation. Both touch-tone phone registration and self-registration systems are reviewed.

AFFORDABLE TOUCH-TONE PHONE STUDENT REGISTRATION AND SELF-REGISTRATION WITHOUT MORTGAGING YOUR COLLEGE

BACKGROUND

Waubonsee Community College, a two-year public institution of higher learning, was established in July, 1966 and is located approximately 50 miles west of Chicago, Illinois. The area served by Waubonsee Community College encompasses approximately 600 square miles and includes twelve public school districts. The College's name, meaning "early dawn" or "early day", was chosen to honor a Pottawatomi Indian chief who lived in the Fox River Valley during the 1800's.

Waubonsee officially opened its doors for classes on September 11, 1967, to an initial enrollment of 1,603 students of whom 403 were full-time and 1,200 were part-time. The College has continued its growth pattern and the fall of 1986 showed 5,304 students enrolled of which 1,057 were full-time.

A 183-acre tract of land located approximately two miles north of Sugar Grove on Illinois Route 47 was chosen and a permanent campus constructed. Seven buildings were constructed with the eighth building, the new College Center, being completed in the fall of 1982. In 1983, planning was begun for a major extension center in Aurora, where approximately one-half of the population of the district reside. A three-story building, which formerly housed Carson, Pirie, Scott and Company (retail clothing store), was renovated for educational purposes.

TOUCH-TONE TELEPHONE REGISTRATION SYSTEM

Waubonsee Community College is utilizing a touch-tone telephone registration system that was implemented in May, 1987. Student registration calls are routed through a modem card in an IBM/AT compatible, which in turn communicates with the on-line student system (HP-3000). Each modem card can handle up to four telephone lines. Waubonsee is utilizing five lines. Four modem cards can be inserted into an IBM/AT. The modem cards and PC software used in Waubonsee's touch-tone registration system was provided by Computer Communications Specialists, Inc. (CCS) of Norcross, Georgia. See figure A for CCS costs.

Any student who has ever attended Waubonsee previously has the opportunity to use the phone registration system. The system can handle registrations for multiple semesters at one time utilizing a four-digit coding system for each class. Touch-tone registration is available 24 hours a day, 7 days a week, allowing for a short back-up time every night. Students must call from a touch-tone phone which has touch-tone service.

Full-time and part-time students can register for both credit and/or non-credit courses. The system has the ability to check any of the following: required applications, required assessment testing, registration overloads, minimum age requirements, prerequisite authorizations for specialized courses, outstanding financial obligations, parking tickets, or library fines. The system can be modified to fit Waubonsee's changing needs. New program changes and the corresponding voice messages can be modified in-house without the additional cost and time of using an outside service. The College was able to utilize existing audio visual and PC equipment.

Waubonsee first offered phone registration service to the public in May 1987 for the Summer semester. One percent of students enrolled for summer used the system. Three percent of the students enrolled for the Fall 1987 semester have used the phone system to register. It is anticipated that the percentage of students using the system will continue to grow. Surveys indicate that the students have enjoyed the convenience of registering by phone, whether at home or work and intend to use the system again. About one-half of the students would like to use the system to pay their tuition by credit card.

Students can add a course, drop a course, check for open courses, check their schedule, or check their current balance due by phone. They are only charged a user fee if they add or drop courses. The system and script are both user-friendly and provide self-help menus and instructions.

TIME LINE

July 1986	Initial inquiry about CCS registration system
August 1986	Dean of Information Systems visits CCS in Norcross,Georgia
September 1986	Presentation to adminstrative staff
September 1986	Presentation to Board of Trustees
December 1986	Final contract signed
January 1987	Arrival of equipment
January 1987	HP3000 interfaced with CCS equipment
February 1987	Script
March 1987	Testing
April 1987	Promotional advertisement
May 1987	Phone system made available to public
June 1987	Final round of surveys
October 1987	Second round of surveys

Overall Hardware and Software Configuration

Overall hardware for the college includes:

3	HP-3000 computers with 142 ports
1	IBM-4361 with 32 ports
+200	Personal Computers
2	386 computers
1	Dytel Automated Attendant System
1	AT&T Dimension/400 Phone System
1	AT Dytel Voice Mail System

The major philosophy of Waubonsee's Computing Plan is to maintain a distributive computing network of multiple, small, powerful, user friendly computers that support and communicate with each other.

Waubonsee has invested in 4th generation software that has allowed the development of its own administrative applications. The Hewlett Packard Data Base Management System and the Cognos Powerhouse software has made Waubonsee many times more productive. In our type of environment, it is usually wiser to purchase software that makes us more productive in application development, rather than purchasing turn-key application packages.

The (3) HP-3000 computers have (142) ports and support over (90) personal computers. Files can be up and down loaded from the PC's to the HP-3000's, as well as doing normal on-line and batch activities. The HP-3000's all run the same operating system and are fully compatible to each other. They back each other up in case of an emergency. We have never had to switch over to another HP-3000; but, if needed, this is part of our Problem Management Procedure. One of the HP-3000's is located in another building, the Learning Resource Center. This HP-3000 primarily serves the Library System with on-line circulation and cataloging. But, it also serves as a "hot site" for the other two HP-3000's, and is an important part of our Disaster Recovery Plan. The second HP-3000 is used for all administrative production computing. The third HP-3000 is utilized for academic computing, a high school network, and administrative systems development. The IBM-4361 is primarily an academic computer. See figure B for configuration overview.

Waubonsee's computing philosophy is to use personal computers whenever possible, utilizing the larger computers only when necessary. Word processing is an example of this philosophy. We have word processing on the HP-3000's, but almost all word processing occurs on the PC's.

Touch Tone Registration Hardware & Software Configuration

Waubonsee's Touch Tone Registration System follows the computing philosophy in that PC's are utilized with the larger computers only when necessary. Outside telephone calls come into a Dytel Automated Attendant System. The Dytel provides (5) phone extension lines into (2) CCS modem cards in an IBM/AT personal computer. See figure C.

The IBM/AT:

1. answers the (5) phone lines.
2. speaks the desired messages under program control back thru the phone line.
3. receives input from the student's touch tone phone.
4. sends records to the HP-3000 Student Data Base.
5. receives records from the HP-3000 Student Data Base.
6. digitizes voice messages through a microphone and stores it on the 30MB hard disk.

The HP-3000 takes a request record and processes it against the Student Data Base, and sends back the record to the IBM/AT. The HP-3000 thinks it is simply communicating with a terminal. All communication is asynchronous and ASCII.

The following is a brief description of adding a new message to the system:

1. Record the desired phrase using a microphone into the AT using the RECORD program. Example file name PK046.DAT which is our welcome message phrase.

2. Update the file name PK046.DAT into the phrase file named WAUBONSEE.DIR

3. Run the program VLIB. This inputs WAUBONSEE.DIR and outputs a combined phrase file called WAUBONSEE.LIB

4. Run the program MESSAGE. This defines a message that can be made up of one or more phrases. A unique message number is assigned.

5. Update the COMMAND.DAT file to include the new message number.

The COMMAND.DAT file provides the logic to the main operating program. See figure D. Each line of the COMMAND.DAT defines items like: current command number, next command number, message number, number of digits to accept from the touch tone phone, location of the data in the transaction record, and branching based upon the touch tone digit entered.

The HP-3000 host program is written in COBOL. It is written to take records from a terminal and process them against the Student Data Base, and then return a data record back to the IBM/AT with the next command number to execute on the IBM/AT.

An example is a student who calls in to register, but has an unpaid library fine. The student enters his social security number and access code through his touch tone phone to the IBM/AT. The IBM/AT under program control sends a request record to the HP-3000 COBOL program. The COBOL program checks the Student Data Base and finds the student has a "hold" because of an unpaid library fine. The COBOL program sends back a record to the IBM/AT telling it to execute a command number that speaks the message that the student has an outstanding financial obligation that must be paid before he can register. After thanking the student for using the Touch Tone Registration system, the IBM/AT disconnects the line.

SELF-REGISTRATION SYSTEM

In order to provide easy, convenient access to course information and the registration process, a self-registration system was designed. See figure E. Based on the concept of self-service, the system allows anyone to check for open courses, course time and course location. Full-time and part-time students who have attended Waubonsee previously can register for either credit or non-credit courses. Students can check their current schedule or courses completed, check their current financial statement, and receive pertinent information regarding the semester calendar.

During peak registration times, self-registration terminals are available in the Admissions and Records area and also in Counseling. Future sites include the extension campus and the Learning Resource Center. With a telephone line, a modem, and a portable CRT, registration sites are unlimited.

TIME-LINE

February 1986	Brain Storming
May 1986	System Design and Programming
June 1986	Testing
July 1986	Self-registration Available for Use

SUMMARY

With these inovative concepts, the old methods of maintaining records and financial accountable have drastically changed. These systems promote a paperless office environment. Due to the lack of paper "back-up", the computer generated listings of detailed transactions (audit trails) have become a crucial part of record keeping. Registration staffing probelms have decreased with the expanded availability of self-service registration systems. Part-time staff hirings have been virtually eliminated, with the full-time staff able to handle.

Other advantages of using these systems include: reduced salary budgets, expanded accessability to academic and registration information, expanded service hours without increasing the building/staff utilization costs, and providing a needed service for a growing student body.

With the flexibility of the self-service systems, future inovations are more easily adopted. Advertising course availability through the Waubonsee Instructional Television Fixed Service (ITFS station) where students can view selections, call in and register by touch-tone registration. Offering a credit card payment service through the touch-tone registration system. Allowing students to register through their home computer systems via the self-regtistration system.

CCS Costs

System DOS Platform Includes host-interface HW/SW, not mainframe program.	$ 7,000
(4) Line Module Card Max (4) cards per DOS Platform	$ 9,000
Record Facility	$ 4,500
	$20,500
Option: Credit Card Verification	$ 4,500

* Prices Subject to Change

** Maintenance 12% of purchase/year

figure A

WCC Configuration Overview

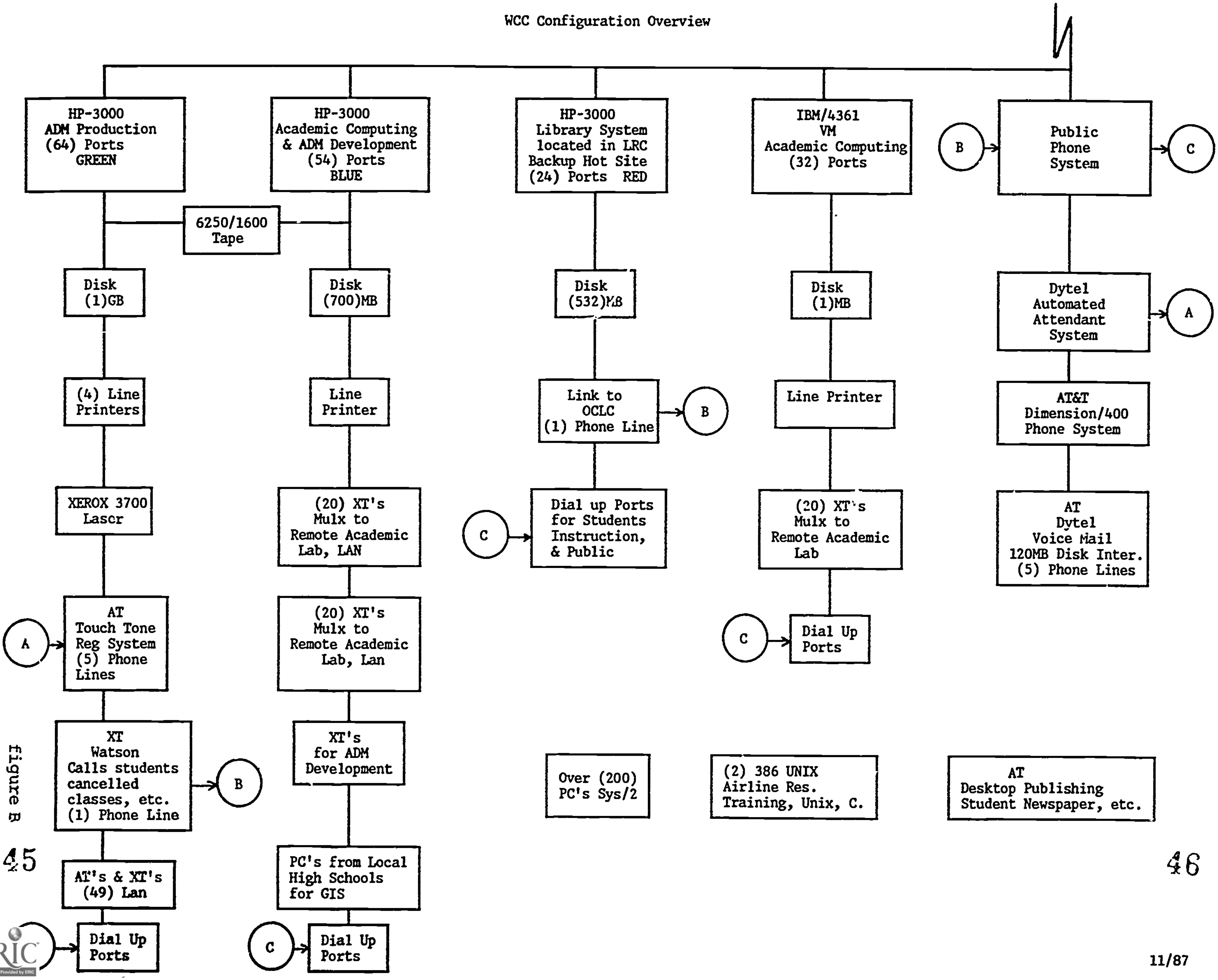
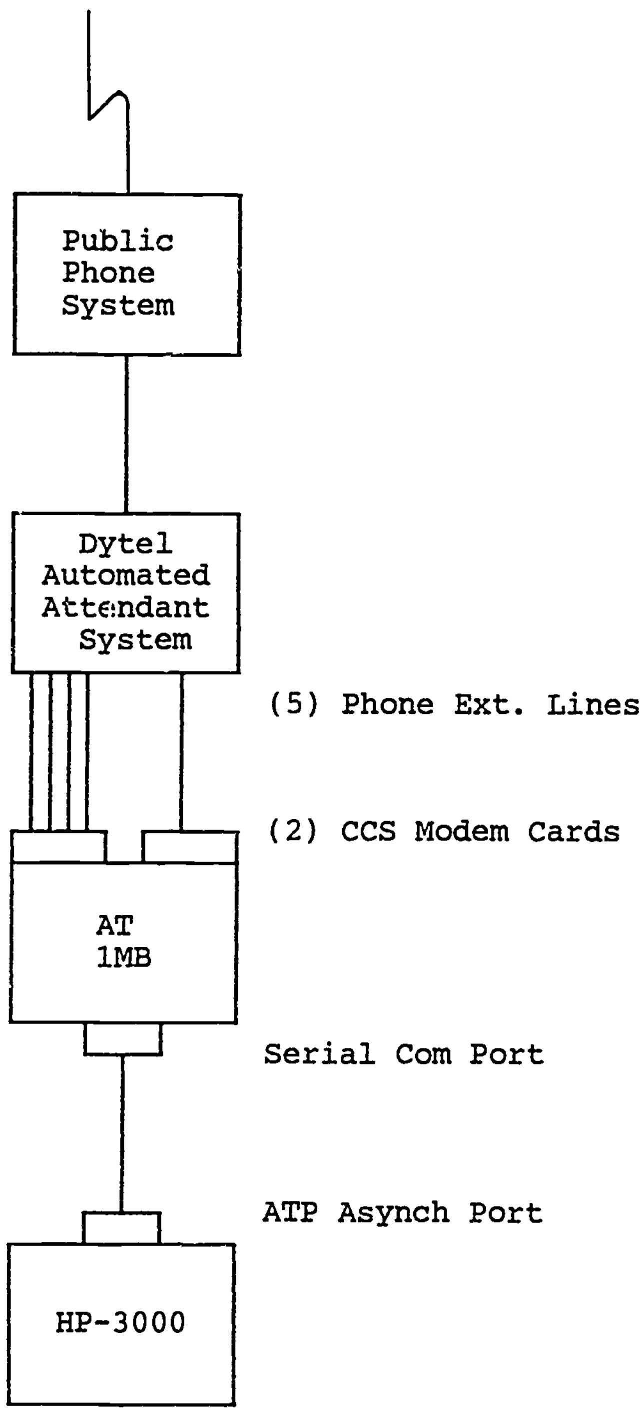


Figure B

11/87

WCC Touch Tone Registration System



11/87

figure C

file=COMMAND.DAT

CUR	NEXT																
COMMAND		MSG#															
001	002	001	00 00														Welcome Msg.
002	004	002	09 34## ** *# 001														Enter SSN
003	002	003	00 00														Invalid SSN
004	HHH	004	06 44## ** *# 038														Enter A-CODE
005	002	005	00 00														Invalid A-CODE
006	038	006	00 00														Fin. obligation
007	009	007	00 00														Out Dist,Reg
008	038	008	00 00														Out Dist.NoReg
009	010	009	00 00	0	1	2	3	4	5	6	7	8	9	#	*		Fin. Aid Messg.
010		010	01 34## ** *# 038	010	011	028	HHH	HHH	037	038	010	010	010	010	010		Menu
•																	
•																	
•																	
038	999	038	00 00														Goodbye
039	038	039	00 00														Bad SSN, Bye

figure D

882 SPRING SEMESTER 10/08/87

W E L C O M E T O

W A U B O N S E E C O M M U N I T Y C O L L E G E

SELF REGISTRATION AND INFORMATION SYSTEM

CHOICES
1 = Check Open Classes
2 = Register + Student Info
ENTER YOUR SELECTION: 2

Please enter your social security number in the format shown.

XXX-XX-XXXX

QUIT

---

882 SPRING SEMESTER 10/08/87

Joe C. Waubonsee

You Have The Following Choices Joe

1 = Register For A Class
2 = See Current Schedule
3 = What do I Owe?
4 = Check Open Classes
5 = See Past Grades
6 = Finished

ENTER YOUR SELECTION

ADD A CURRENT SEE CHECK SEE PAST QUIT

figure E

CUDA
An Adventure in Distributed Computing

Louise Marie Schulden
Cornell University
Ithaca, New York

ABSTRACT

With the availability of personal computers and the escalating information and reporting needs of universities, college administrators are increasingly developing their own systems on microcomputers. The Cornell University Distributed Accounting (CUDA) system is an attempt to institutionalize this trend, provide departments a software tool for better managing their finances, create microcomputer standards, create a vehicle for better administrative microcomputer support, and insure local systems are consistent with central computer systems.

CUDA currently consists of 5 modules: accounting, budgeting, personnel/payroll, purchasing and reporting. The system provides standard management information reports and allows administrators to develop customized reports. The data can be downloaded from the central systems or entered locally.

Background

During the past six years there has been a major effort at Cornell to computerize the central administrative functions. The university has been successful in providing computing for many central offices, but until recently has paid little attention to departmental administrative computing needs. With much of the central system development work complete, Cornell Computer Services (CCS) is taking a close look at departmental information needs. Since funding and financial decision making is decentralized at Cornell, the accounting office was one of the first to recognize the need to improve the quality of information provided to departments.

The central accounting system meets the needs of accounting personnel who understand and take full advantage of the information provided by the system daily. It does not fully address management information needs outside the accounting office. Information is disseminated to departments monthly in reports. This dated information, along with unneeded data, has proven to be too much and too infrequent for departments to make timely decisions. Standard accounting reports are often considered difficult to read or insufficient by departmental managers. Since a substantial effort would by required by data processing staff to create special reports to satisfy over 300 departments, many departments have had to do without.

To alleviate this problem, almost all of the departments maintain manual records, and some have computerized their financial record keeping. These departments were rekeying data from monthly accounting reports so that the data would be in a more usable format. Some of the departments hired their own data processing staff to write special reports and provide a mechanism for keeping data not collected by the central system. Because of restricted access to the accounting files, the need for special reporting capabilites and the need for more timely information, independent systems have been developed and have flourished. These local systems often caused more problems than they solved. They resulted in inconsistent information between the departmental and central accounting systems, and duplications in effort. There was a clear risk that if better services were not provided centrally, more departments would go in their own direction with the danger of misinformation and mismanagement of departmental funds.

To meet departmental needs, the accounting office formed a committee to execute three goals. The first goal was to provide on-line mainframe access to current data. The second was to provide the capability to download data for departmental usage. Central financial data has been available for use on microcomputers for a number of years, but it could only be used by those administrators with relatively good computer skills. Procedures for downloading the data were complicated, data reformatting was necessary for use in software packages (e.g., LOTUS), and familiarity with microcomputer software was necessary.

The third goal and topic of this paper was to provide standards, a support network and a functioning micro-system so the downloaded financial data would be efficiently used and correctly interpreted according to the guidelines of the central system. Instead of designing a central system that would be all things to all people, the intent was to make the central system information easily available and, at the same time, provide the departments with the ability to decide for themselves what data they wanted and how they could manipulate it to meet their local needs. With downloading, duplicate data entry was no longer necessary, and time could be spent more productively. Many departments were also developing software to meet their needs. This often led to the university paying for redundant programming. It is hoped CUDA will displace this practice.

Starting the Project

So began CUDA, Cornell University's Distributed Accounting. The CUDA project seeks to provide a foundation for local departmental financial systems. By providing a foundation, the departments would be assured of having central system data locally available, a basic set of procedures and software for using the data, and a common starting point for their local system. The departments could build on the foundation of common file layouts and programs to meet needs specific to their department.

The CUDA project is guided by a committee formed by the Controller's office. This committee consists predominately of Cornell administrators, representing large and small, endowed and statutory, non-enterprise and enterprise departments. Their funding sources (and consequently tracking/reporting needs) are as varied as their personalities. They decided what systems were needed and developed the specifications for those systems. CCS and the central university administration also had representation on the committee.

The committee identified the objectives and defined the scope of their study. The overall objectives of the project were to provide the departments a solid foundation for building their local office management system which would be compatible with central systems. Functional areas to be implemented would be accounting, payroll/personnel, receivables, purchasing, budget, inventory. The departments would be given access to central system data and an easy to use download procedure. Departments would be encouraged to share software, computer knowledge, and financial knowledge.

Scope of the Project:

1. To decide on appropriate hardware and software.
2. To work out an easy downloading procedure and ability to select and format data in a user specified way.
3. To define conceptual and technical specifications for accounting , payroll/personnel, receivables, budget, purchasing, and inventory.
4. To work with central administrative offices to agree on data to be downloaded from the central systems and the presentation of the data in local screens and reports.
5. To set programming and program documentation standards for all PC CUDA programmers, including non-Cornell staff.
6. To provide clear documentation, microcomputer training (CUDA and general), security, and back-up procedures.
7. To allow for additional files and data elements to be used by the local systems.
8. To provide a core set of programs to handle data entry and reporting and data extraction and downloading from central system ADABAS files.
9. To provide a hotline for problems and questions, help available on microcomputers, mainframe, CUDA, accounting, payroll/personnel, writing custom software.
10. To start a bulletin board and software library for administrative users where new software, helpful tips, and financial news can be posted.
11. To form a CUDA users group to share ideas and software.
12. To establish a procedure to evaluate CUDA.

The committee of departmental administrators gathered a list of departmental needs that resulted in a system of 6 functional subsystems---accounting, accounts receivable, budget, payroll/ personnel, purchasing, and inventory. Each functional module was given to 2-3 committee members to write a conceptual design and specifications. All the designs were put together into a specifications document and the entire committee reviewed the document for completeness. Once the committee was satisfied with the conceptual design, administrators, deans, directors and department heads were invited to review the project's specifications.

Once the conceptual design was complete it was obvious to all that the project and time/resources needed were too large. Accounting and Budgeting modules became a manageable phase one. Payroll/Personnel would be phase two followed by Purchasing. Committee members aided in the development of technical specifications from their conceptual design. Lists of needed files and their data elements were created. Central system files for accounting and payroll/personnel were reviewed for data elements needed by the local system.

Armed with file descriptions (data elements, size of record, number of records in worst case) and system specifications, the hardware and software options were investigated and requirements set. When considering hardware for this project it had to be produced by a stable company, have a large base of users on the Cornell campus, have a lot of software available, be reasonably priced (under $5,000), expandable, and CCS supported. The IBM-AT filled these requirements and has the power necessary to run the system. In addition to the IBM-AT, several IBM compatible also met the requirements.

When considering database software for this project it again had to be a stable company, have a large base of users on the Cornell campus, reasonably priced, easy to use, would support networking, and, if it was a programming language, it should be able to be compiled. The database users on campus were split between RBASE and DBASEIII. The ones seriously considered were RBASE, DBASEIII, PCFOCUS, and PARADOX. PCFOCUS was disqualified because of cost. PARADOX was disqualified because of newness of the company. RBASE and DBASE were very similar, but DBASE was chosen. RBASE was easier to use than DBASE and slightly faster, but DBASE had such a following on campus and in the general market that it was felt that Ashton-Tate and other vendors would improve and supplement the DBASE software.

The final and most important job of the committee was to keep the departments abreast of the project's progress, get suggestions from the departments and manage departmental expectations. This was done by periodic questionnaires, interviews of users, and open review sessions. It is important that departments understand what the project is trying to accomplish and when.

Software Development

Four people were involved closely with the software development. Business manager for the Johnson Graduate School of Management served as chairman of the CUDA committee and, on a daily basis, answered system specification questions for the computer staff. The Johnson School of Management also provided a full-time programmer with a background in micro-systems. The Controller's office provided a full-time person to test and document the system as it was being written. Computer Services provided a full-time analyst/programmer with a background in mainframe financial systems and a hobbyist's interest in microcomputers. The four people were housed in the Johnson School which served as one of the four alpha sites and provided the computer staff close contact with a user.

Early on, standards were set for CUDA programming. The goal was to achieve consistency in outward appearance of the system and internal programming code. To that end, standards dictated the use of:

1. Naming conventions for programs, files, variables, etc.
2. Centralized source code and log of changes.
3. Generalized program routines (i.e. error handling).
4. Consistent special key handling (i.e. CTRL-HOME adds a record).
5. A restriction to use only DBASE program code; no use of DBASE exits to call other programming languages including use of features that were exclusive to look alike products such as Clipper and FOXBASE.
6. Programming standards such as the use of "IIF" (immediate if) over "IF...ENDIF" because of faster execution time except if program readability was jeopardized.
7. Use of indentation and capitalization to aid in program readability.

As programs were finished they were given to the alpha sites. The alpha sites were now part of the project committee. At bi-monthly meetings, the project team reviewed problems and enhancements with the alpha sites. The committee decided work priority. For several months, this iterative process occurred: programming, release to alpha sites, requests for change or fix, committee review, scheduling the work, programming, and so on. When most of the requests were for enhancements and not bugs or problems, then preparation began for beta testing.

Coordination with the central systems

As a bi-product of the CUDA committee came some standardization of terminology. As the systems technical specifications were written and reviewed by departmental managers and central administrators a common vocabulary was agreed upon.

Access to central accounting files is granted based on a department having a mainframe computer userid. That userid has read access to specific account information. Departmental users can request central accounting to give them access to information concerning their departmental accounts. If accounting approves the request, the computer userid can then be used to access central accounting information for downloading to their local system.

Alpha and Beta Testing

The alpha test sites had to satisfy several criteria. Their business manager (user of the system) had to be well versed on Cornell's financial practices and procedures. Someone in the office had to be computer literate. The office had to have the equipment necessary to run the system and perform the downloading from the mainframe. Most importantly, the alpha site had to understand and accept the fact that the software was bound to contain some errors. The beta sites were chosen to represent every college at the university and to form as diverse a group as possible.

Both the alpha and the beta sites are responsible for testing and using the software and reporting any problems or enhancements desired. All test sites are given forms to fill out to request changes or report problems. If a problem occurs they are requested to also call, so action can be taken as soon as possible. Requests for changes or enhancements are taken up in committee meetings.

The computer personnel currently includes 2 technical consultants and 2 analyst/programmers. The 2 technical consultants are responsible for user assistance, system documentation, training, general communication (newsletters, demonstrations), and some maintenance programming. The analyst/programmers continue fixing problems and new development. The goal when a problem is reported is to fix it within 48 hours. Another group goal is to have someone knowledgeable covering the phone from 8:30 to 4:30. This sounds trivial, but with microcomputer systems much of the work has to be done at the user site, taking staff away from their office.

Short and Long Term Support

The computer support staff for this project currently consists of 2 technical consultants and 2 analyst/programmers. It is predicted that this level of staffing will be needed until the major modules (the 6 modules originally defined) are completed. After this time only the 2 technical consultants will be required. Currently these consultants spend most of their time preparing documentation and training users. The time required for this is expected to dwindle and be replaced with maintenance and enhancement programming.

This may seem like insufficient staffing for a system that could have over 300 users. It is hoped that from the project committee and from the alpha and beta sites will spring a user support network. There are indications that this is already happening. A goal for the 2 technical consultants is to provide a focal point for this activity, to help the network formation along, and to give the group a communication link into central computer services when greater computer technical expertise is needed. It is also expected that the project committee will continue to offer guidance to the systems users, encourage the user network, and provide a communication link with central administration to voice departmental needs.

Problems

The most obvious problem with the system is response time. DBASE is not noted for its speed. When the budget data entry programs were complete they were tried on an IBM-XT. They ran painfully slow. Thus the requirement of an AT was made. Compiling the programs helps and products such as FOXBASE (a DBASE look alike) greatly improves the execution time of the code (3-9 times). With improvements in the software and larger, faster machines becoming the status quo, this will no longer be a problem.

Another problem is that of maintaining current source code. Though installation disks are currently used, the programs are changing quickly and it is impractical to send floppy disks with updates to all the user sites. Instead, program code is uploaded to the mainframe, and made available for downloading. This has the drawback of making the user responsible for getting and keeping their local software current. A bulletin board on the mainframe informs users when and which programs have changed.

Access to the mainframe data is controlled by userid. Once that data is downloaded it is the user's responsibility to see to it that data is in a secure place. A public machine is no place for financial data. Right now, CUDA has no way to limit where that data is stored. Whenever the system is set up at a new site, file security, machine security, and the confidentiality of the material is stressed. The security of the information relies heavily on the attitude and precautions taken by the particular office. There have been no incidents to date, but we are vulnerable in this area. Programs for hard-disk locking and securing are being investigated. To date none appear worthwhile.

The synchronization of central systems can not be guaranteed unless the user is religious about downloading or locally entering all information. For example, if a user forgets a week's download then their local month-end bottom line will not match the central reports. Most departments do run the CUDA reports that match the central system to compare bottom lines before running their special local reports. CUDA is a local system, under departmental control, so the department has to take responsibility for the data in the system being current and correct.

The final problem was a bit of a surprise: free-lance sabotage. CUDA was not meant to do away with departments employing free-lance programmers. It was supposed to reduce the amount of redundant free-lance work that the university was contracting out. Non-Cornell programmers were told about the project and the source code was shared with them in the hopes that if they did customizing work, they would follow CUDA standards and integrate the work closely into the system. If the work was of general use it possibly would be incorporated into the general system to be used by other departments. Some outside programmers viewed the system as a threat and proceeded to criticize it to their departmental clients. Some of the heaviest criticism CUDA received was not from departmental users, but from outside programmers hired by the departments. Time will cancel any bad press they caused.

Successes

One of the major contributions of CUDA was the preparation of more flexible financial management reports. And if CUDA did not provide the needed report, the means to write a custom program. Many of the CUDA reports are table driven. The department sets up object codes, budget categories, etc. the most meaningful way for their department and the reports print, subtotal, extract, etc. that way. In addition to table definition by the departments, several local data fields were added to the files. These too are used to customize reports. Better reports, more in step with the particular department's needs means better use of financial information. This, in turn, should help the departments make better financial decisions.

The departments are more tolerant of the shortcomings of this system then any other I have worked on. I believe the reason for this is twofold. First, it is their system. From conception, many departmental managers were involved in the conceptual design, the technical specifications, the testing, and the documentation. They got to observe and have input into the development at every step. Computer staff worked as technical advisers and aides to create the system that business managers were imagining. If we went up a blind alley it was a user who sent us there. Secondly, the departments have been tolerant because we have built in the flexibility for growth and change. If additional reports or additional data fields are needed, users have been given the ability and right to add both to the system. The openendedness and control over the ultimate system has made the departments very satisfied.

Departments still have local information which the central system does not keep, nor will keep in the future. But with the downloading of data, the departments are not rekeying information and are more aware of how the central accounting system views their financial position. With the more flexible reporting, the additional local data fields and the downloaded data, departments are more and more regarding central accounting records as their records. They are more aware when central records are wrong and are more willing to take action to correct not only their local records, but also central records.

By-Products of the Project

A number of standardizations have occurred as a result of this project. DBASE has become the database for many administrative users at Cornell. DBASE may not be the best microcomputer database on the market, but having a standard makes support and future system compatibility possible. Standardization of financial software on the microcomputers is being achieved. Standardization of terminology and general knowledge of computers is helping us communicate with each other more effectively.

The local system is helping departmental administrators analyze and project their future needs. They are using the CUDA committee to communicate those needs back to the central administration. This is helping central administrative offices to become more responsive.

Finally, business managers in general are becoming more computer literate. With this exposure to microcomputers, many are branching out and automating other aspects of their operation.

Future

The pace of the CUDA project has not slowed down. Work continues on the other modules and incorporating enhancements to existing work. One of the major enhancements in progress is budget development software that allows different financial scenarios. Work already done by departmental programmers is being reviewed to see if it should be included in the system. When such software is found the programs are reviewed and modified, if necessary, to be compatible with the overall CUDA software and the corresponding central system (if one exists).

Other hardware/software options are continuously being investigated. With several companies coming out with DBASE or DBASE look-alike software for the Apple Macintosh, CUDA will hopefully be running on the Macintosh before the end of the year. In addition, FOXBASE has been found to run DBASE code with no modifications but 3-9 times faster than DBASE. We are in the process of converting CUDA users to FOXBASE.

In addition to microcomputers, larger offices have expressed an interest in CUDA on minicomputers. And finally the topic of uploading is being discussed for budget preparation. It is too early to say how that will develop.

Conclusions

This is clearly a large project with great opportunity for success and failure. Though possibility of failure is great, success will save the university a great deal. Microcomputers are now available to almost every department on campus. Not directing the use of these microcomputers in administration will cost in wasted administrative resources and poor management of departmental finances.

The benefits of this project are many. Some have to do with financial information and management and others have broader impact. It is difficult to describe, let alone calculate, all of the benefits derived from the project because financial information touches all areas of the university.

Downloading of data saves time for departments who were rekeying information from central system reports. In addition, the procedures and techniques developed for easy selection, downloading, and formatting of mainframe data can be applied to data other than financial.

Second is a structure which administrators can follow to become familiar with microcomputers and their use for things other then CUDA. CUDA has had an opportunity to set some standards for microcomputers in administrative use. For many administrators it will be a way to gain familiarity with microcomputers in their world and expand computer usage.

Microcomputer software and downloading will give offices a foundation to view central financial information without always accessing and paying for connect time on the mainframe. In addition, the provided programs will give examples and set programming standards to help the departments with their own custom programming.

Departments often complain that there are additional data elements that they would like to track. The data elements can be added to the local system and used in conjunction with downloaded data from the central system. Also departments complain of the timeliness of data. There will always be some time lag between a department's records and the central system. This cannot be helped, but with the local system, departments can flag information as pending until it clears. That way a record exists. Of course, having the data available on a microcomputer provides every department the opportunity to develop reports that fit their needs and allows a department to keep as many years of historic data as it wishes.

THE FOUR YEAR ID

Roth Aymond
Louisiana State University
Baton Rouge
Louisiana

The development and the integration of a Student Records Data Base and the Human Resource Management System made it possible for LSU to provide current status information about students and employees to nearly every administrative department on campus. Online access eliminated the need to record status information i.e. major, year classification, fulltime/parttime status, etc. on the ID.

Having online access and adopting the ANSI standards for Bar Code and Magnetic Stripe technology on the same card made it possible for LSU to design one, permanent ID card for all known and anticipated ID card applications on campus. This discussion will highlight the design of the Four Year ID and its application for Football Ticketing, Food Service, SGA Elections, Library Circulation, Building Security, Time and Attendance Reporting and other applications.

INTRODUCTION

Louisiana State University, the flagship institution of the LSU System, was founded in 1860 as the Louisiana State Seminary of Learning and Military Academy in Pineville, Louisiana. The school was moved to Baton Rouge in 1869 and in 1870 was renamed Louisiana State University. LSU supports approximately 28,000 students with a faculty and staff of about 4,500.

The LSU administrative computing environment is served by an IBM 3084-QX mainframe. Most administrative applications have been developed using COBOL in conjuction with IBM's IMS DB/DC, an hierarchical data base/data communication product. Two very important applications utilizing this product are the Human Resource Management (HRM) system, a payroll/personnel data base, and the Student Records and Registration (SRR) system, a student information data base. Both were essential to the development of the Four-Year ID System. New development in these areas are continuing with design interfaces to DB2, IBM's relational data base management system.

The Four-Year ID system was designed using the IMS product and is integrated with the HRM and SRR systems. The Four-Year ID is a very important tool used throughout the campus environment. LSU has many departments which interface with or are interfaced by the Four-Year ID. This discussion will focus on the ID Office, Records and Registration, Personnel Office, Athletic Department, Student Government Association, Food Services, and the Library.

The integration of the Four-Year ID with the University information base creates a very useful and powerful asset. The key to integrating the ID into the mainframe environment is the automatic identification technology which allows data to be entered without keystrokes (keyless data entry). This "keyless access" to the information base can take many forms. One of these forms is the "machine readable" ID card.

For the purposes of this discussion a "machine readable" ID means any ID which contains information which can be read and interpreted by a machine without human intervention. There are currently three major types of media specifically designed for this purpose: OCR, bar code, and magnetic stripe. OCR (Optical Character Recognition) is a special type font designed to be read optically. A bar code is an array of rectangular marks and spaces in a predetermined pattern recognizable by a bar code scanner. Magnetic stripe is very similar to an 8 track tape in that the magnetic material can contain several tracks and each track can be encoded with information.

The purpose of an ID containing the machine readable media is to allow functions to be performed without having to manually keystroke the data. Therefore, the information encoded on the ID card must at least logically relate to the data being retrieved or updated. The index or key used most often by an institution will be the most likely candidate for use on the ID.

BACKGROUND

For many years LSU had issued ID's in the fall semester to enrolled students. This ID would be used throughout the academic year. In the succeeding fall semester a completely new ID would be constructed and issued. Every year nearly 30,000 IDs had to be produced. The cost of producing these ID's was significant. One of the reasons LSU had not gone to some type of career ID card is that the athletic department used the card for football admission. The ID card had a row of numbers along the bottom which were punched with a hole whenever a student picked up a football ticket. The hole signified that the student exercised his privilege for that particular game. By the end of the football season the ID was punched to pieces. Student Goverment elections and Homcomeing elections also required the row of numbers to indicate that a privilege had been exercised. In addition to this the Library punched the hollerith code into the card. The hollerith code was used by the library circulation system. After a year of this type of destructive encoding, the card became virtually useless. It was then replaced, and the process started over.

Another contributing factor involved a decision by the administration to automate many of the functions of the library. The library purchased a proprietary software package called NOTIS (Northwestern Online Totally Integrated Library System). NOTIS contains a library circulation module which requires that a patron have some form of machine readable identification. NOTIS recommends using one of the major bar code symbologies such as Code 3 of 9, Interleaved 2 of 5, or Codabar.

OBJECTIVES AND METHODOLOGY

In 1985, the Chancellor of the University decided it was time to modify its existing ID design and procedures. Therefore, university managers agreed to change and the following overall objectives were established:

* Produce the ID in "machine readable" form,
* Enable an individual to retain the ID throughout career,
* Provide a means for greater security and control,
* Utilize existing data currently residing on the mainframe.

The introduction of a new ID on campus can be a very involved logistical problem. The initial stages are very critical and cooperation across departmental boundaries is required. The mass production and distribution of the new ID must be carefully planned and executed. Proper controls must be exercised during the initial distribution in order to insure data integrity and security.

The coordination of a project like the Four-Year ID is very complicated because it crosses so many departmental boundaries. It requires a very strong sponsor. The Chancellor was the executive sponsor of the ID project. He set the objectives and delegated the responsiblity and authority to a project leader. With this type of backing, disputes between departments were easily diffused.

The development methodolgy used at LSU is a modified version of a method developed by IBM. There are six steps to this development process. Each step builds upon the previous one and allows management several checkpoints to review and consider the project as it develops.

1) Requirements Definition
   The functions of the organization are analyzed and the scope of work is defined.

2) External Design
   The Requirements Definition is used as a blueprint to develop the overall conceptual design of the system that will carry out the objectives of the scope.

3) Internal Design
   The data base struture is defined and program specifications are prepared.

4) Program Development
   The application programs are written and tested.

5) Demonstration and Installation
   The users are trained and the application is implemented.

6) Maintenance
   Continued analyst support for the lifetime of the system.

Most of the projects associated with the Four-Year ID have been completed within very short time frames. Unlike most development projects, which are strictly software projects that rely on existing hardware configurations, the Four-Year ID required extensive research into available automatic identification technology. Because of Louisiana purchasing laws, complex bid specifications had to be written. From the outset, it was decided that it would be expeditious to reveiw the available hardware/software at the same time the requirement definition and external design were being written. This analysis enabled the project leader an opportunity to prepare a cost/benefits proposal early in the development process.

SYSTEM FEATURES

There is a very strong correlation between the system objectives and the system features. The project, from the start had a very real purpose and direction.

LSU produces its own ID cards. This has proven to be very cost effective and expeditious. Cards are produced at registration, which is a mass production type process, and again during the semester to replace lost IDs, new employees, etc. LSU issues no temporary cards.

The process used at registration is for new students. Prior to registration, a label is printed for every eligible student. The data label is 1-1/2 inches tall and 2 inches wide. The label is then affixed to a "carrier card," which is a fan folded card stock with a blank label. The label is printed with the students name, student id number, and bar code representation of the id number. The label information is obtained from the Student Records data base used to produce registration packets. The label is printed on a Printronix 4160. The printer is connected to the mainframe via IBM 3274 control unit and QMS wedgebox. If a student has registered late or has lost his ID, the label is produced at registration using the Printronix printer with a PC as the host. During the semester, ID's are produced online from the IMS ID update program. The Printronix printer is used in this configuration also.

At the present time the carrier card is stuffed in the student packets which are picked up at registration. The new students need to bring the carrier card and fee bill to the ID station at registration to have their ID made. The ID station takes the student's picture, peels off the label from the carrier card and affixes it to the ID chip, then they die cut the picture, place it in the ID chip cutout, the student sign's the card, and then the card is run through a laminator. The chip is a polyester laminate which has a cutout for the picture, and the magnetic stripe is affixed to the back layer of the laminate. The ID cards are electronically validated by updating the ID data base with an interface program to the Student Records data base.

During the Spring of 1989 the old auditorium registration procedures will be replaced by the Telephone Registration system. The carrier card will still be used, but it will not be stuffed into the packet. Procedures are defined which will allow the new student an opportunity to have their ID card made at the Student Union, a central geographic location. The student will be required to present the registration confirmation document. The Telephone Registration system is another major step for the University. It demonstrates the advantage of integrated systems.

The Four-Year ID is the only ID card produced and used on campus. It is used for all applications which require some type of identification. One set of data is maintained on these IDs for each individual who has been issued an ID card.

The ID data base contains a segment (or record) for each ID card issued. It eliminates the old cumbersome manual card file that was kept to verify that a student was issued an ID card. The major relationship between systems is the ID number symbolized by the bar code. With this number any data contained in the Student Records data base or Human Resource Management data base can be accessed through the use of the ID card.

The ID number is composed of the student or employee number, a type code, a sequence number, and a check digit. The type code is a one digit identifier between employee, students, and other defined groups. The sequence number is a one digit code identifying the number of ID's an individual has had. The sequence number is very important because it uniquely identifies each ID. The check digit is used to assure data integrity.

The Four-Year ID data base is an IBM IMS DB/DC data base. The data contained in this file can be accessed by either online or batch programs. The LSU ID office has the capability to online update the ID data base. This enables all applications using the ID data to obtain the latest information. It also allows the ID office to print the ID labels from the same online program. When a new ID is produced the data base is automatically updated. The data is always available for immediate access and the information is current.

The most important feature of the Four-Year ID card is its use of two types of electronic identification technology - bar code and magnetic stripe. The bar code has a high read rate (99%), can be read from a distance, is inexpensive to produce on demand, and its low error rate compared to other means of data entry is significant. The magnetic stripe is 5/8 inch, and can contain all three ANSI defined tracks. The magnetic stripe is able to be encoded with information in a high density and the data on the stripe can be altered.

The card size is important because it accommodates the industry standard specifications on card reader hardware. The majority of automated teller machines, security access devices and various data collection devices require that the card meet ANSI credit card size specifications.

The physical properties of the Four-Year ID are all defined by the American National Standards Institute (ANSI). The card is credit card size, the dimensions (length, width, and thickness) are defined by the Institute within tight tolerances. The size of the magnetic stripe, its location on the card, the location of the tracks on the magnetic stripe, the format and location of the data on the tracks, and technical encoding specifications are all defined by the ANSI publications. The bar code symbology, Interleaved 2 of 5, used by the Four-Year ID is also covered by Automatic Identification Manufacturer's specifications as well as the ANSI standards.

The use of ANSI standards is extremely important to the writing of bid specifications for the procurement of equipment. Because most manufacturers design their equipment around the ANSI standards, it is advantageous to design the ID card to work with standard equipment. Another important aspect is that the specifications are so tight that it is very unlikely that a manufacturer will bid a piece of equipment that does not meet the specifications.

Information about the ID is stored for as l _ as necessary. The fields which deal with dates of issuance, last update, and expiration date are very important and are retained for the conceivable life of the ID card, which is determined only by the proper care of the card. Of course, the IMS data base must be purged periodically.

The ID data base is a separate and distinct entity but it accesses several other data bases in its day to day operations. This information from other data bases is used to determine privileges, elgibility, and status. Redundancy is reduced through this means. Other applications utilize the information stored in the ID data base. These interfaces are very important and add a measure of security which were not previously available.

INTERFACES

The integrated application computing environment at LSU promotes the usefulness of the Four-Year ID system. The ID system interfaces with many of these systems. The ID data base was designed to interface with every anticipated application. The source of this ability is the coded information on the card. The information represents the index configuration used in all of our data base structures.

The Registration interface is very simple in principle. ID data cards are produced for eligible students from registration system information. At registration time, ID cards are constructed and the information is loaded to the ID data base. Immediately after walk-thru registration, information from the registration system is used to electronically validate the ID data base.

Information from the Student Records data base is used in many phases of the ID system. Full/part time status with respect to hours carried, athletic privileges, and SGA voting privileges are updated constantly. For many of the subsystems this information is captured online. The ID update screen used by the ID office contains online information from the Student Records system which is used to determine eligibility and status.

Employee (Faculty/Staff) information is captured by the ID system online for the verification and production of employee ID's. There is current development work in progress which will utilize the HRM data base and the ID data base in conjuction with the Four-Year ID for employee time and attendance tracking.

An unique interface came about as the result of automating the policies and procedures associated with the ID hole punching by the LSU Athletic Department. The interface was required to adhere to the following objectives:

* Allow students to purchase season tickets,
* Allow students to select the game(s) desired,
* Allow students who did not receive season tickets to purchase the remaining tickets,
* Check the status of the students at the student entrance gates at game time to insure only full-time students are entering.

The Season Ticket System required a combination of several different technologies. For example, a ticket application is filled out on optical scanning sheets. These sheets are read and data sets are built. Student elgibility is checked via inquiry to the Student Records Data Base and priorities are established based on LSU hours earned. Seats are matched to students and a tape is prepared which is sent to a ticket printing vendor and tickets are produced. The information used to create the ticket tape is also used to produce a file of the cost of the individual student season ticket packages. This file is downloaded to an IBM PC/AT micro computer and is used in the purchase/pickup operation.

The purchase/pickup operation utilizes bar code technology. When a student purchases his ticket package, the ID card is scanned and a flag is set indicating that student paid for the ticket package. This information serves two purposes:

* Accounting information is recorded for audit and balancing purposes,
* Ticket information is recorded to insure students are only able to exercise this privilege once.

Remaining tickets are sold on a first come basis. Student eligibility is checked online under IMS using laser wedge readers as input devices and this ticket information is stored along with previous season ticket information.

The game admission operation at the student football gates utilizes bar code technology. Student status is obtained from the Student Records Data Base and downloaded to an IBM PC/AT at the stadium. Bar code readers are attached to the PC/AT and student status information is transmitted to the reader display.

The SGA Voting System is very similar to the online Ticket System. Each voting station has a terminal connected to the mainframe and each teminal has a bar code wedge reader attached to it. When a student requests a ballot the ID card is scanned. The scan invokes an IMS online program which checks the eligibility of the student and flags the student as having voted. Any subsequent scan would reveal that the student has already voted.

The Food Service system is a very sophisticated meal plan access system. It utilizes the magnetic stripe for its cafeteria access method. The system is a hybrid between a micro computer and the mainframe. The CBORD software/hardware package contains all of the communication and access programs necessary to control admission to the cafeterias. The mainframe is used to load the meal plan access master file at the beginning of the semester with eligible students and their biographical information. It is also used to store the daily transactions for historical reporting. All of the communication to the mainframe is accomplished through 3270 emulation protocol. Communication from the PC to the cafeterias is performed with line bridge/amplifiers and modems. Modems are built in to the magnetic stripe reader hardware.

The NOTIS (Northwestern Online Totally Integrated Library System) package purchased by the University has been implemented with much success. Before NOTIS, library circulation was a problem. The old ID's were void of any type of security and the check out procedure was time consuming and cumbersome. The NOTIS system is a bar code system which utilizes the Student Records, HRM, and ID data bases to build and maintain the Patron data base. The Four Year ID is scanned to pick up the patron ID number and is associated with circulating books. The Patron data base is updated weekly during the semester, but can be updated on demand.

SYSTEM BENEFITS

The introduction of the Four-Year ID has had a significant impact on the University environment. The benefits are many as it has allowed the implementation of innovative applications which have benefited both the students and administration.

Because the card is not tied to the status of the individual it need not be replaced each time the individual's status changes. This fact eliminates the long lines previously associated with the mass production problem of redistributing ID's each year. The machine read capabilities allow applications to accurately and easily process the card for various fuctions.

The use of the ID sequence number gives a measure of security not known before. It uniquely identifies each ID. When an ID is lost, the ID Office is notified and the lost ID can be invalidated immediately through the online update screen. All applications which interface with the ID system at that point know the status of that ID. This prevents abuse of the ID in those applications such as Library circulation, Football ticketing, SGA elections, or any system that interfaces with the ID data base. A hard copy of the carrier card is kept which validates the fact that the individual was issued an ID card. The ability to query and update the ID data base in an online mode and receive the answer immediately gives the user the latest verifiable information.

The Four-Year ID is not tied to any particular system or individual status. Its key is the same key on the data base which allows it to be used by any application. For low cost operations there is still a visual validation sticker applied to the ID card each semester. An individual's status can be verified online and through the visual validation sticker. The computer validation is done at registration each year.

The ANSI standards used allow for the continued growth and built-in flexibility of the Four-Year ID. The University will continue to take advantage of the new technology adhering to the ANSI standards, build on them, and use them in the future as we embark on innovative applications.

CURRENT DEVELOPMENT ACTIVITY

Time and attendance is probably the next major development interface. The hardware and software to integrate the Four-Year ID into the Payroll System is available. The requirements structure is being defined at this very moment. Another proposal being prepared right now is for restricted building access. It will use the magnetic stripe and a personal identification number (PIN) with a stand alone reader/keypad. Departments will code their own restrictions. Other applications such as check cashing and debit card use are feasible and the Student Union is interested in both of these concepts, but resources have not been assigned to these projects. The Student Health Service is investigating the use of the Four-Year ID card in conjuction with a medical records system.

CONCLUSION

The implementation of the Four-Year ID has been very successful. It has generated enthusiasm for many other applications and continues to do so. The concept of the Four-Year ID being a "career" type card has allowed the University to build upon the original design. The importance of meeting the original objectives has positioned the University to take advantage of an excellent tool that is gaining momentum and importance in the campus environment.

The Development of a Successful Microcomputer Network Operation: Winthrop College's Novell NetWare LAN's

William J. Moressi
C. Brown McFadden

Academic Computer Center
Winthrop College
Rock Hill, SC 29733

ABSTRACT

Implementation of a high-speed, Local Area Network (LAN) can provide the educator with a very valuable teaching tool for information processing. However, there are many pitfalls and subtle, but significant ramifications inherent in the selection, installation, and implementation of such a system. Experience is an excellent teacher when it comes to networking microcomputers and Winthrop College has had its share of that form of education. The Academic Computer Center currently operates three networked, instructional laboratories with over 85 nodes.

This presentation will include our reasons for choosing a LAN- type system, development of specifications and selection of a particular type of LAN. The technical aspects of installation and implementation will be reviewed. Recommendations from experience and statistics on usage will be discussed with some comments on our plans.

Microcomputers are pervasive not only in government and industry, but also in colleges and universities. The impact of this segment of the computer revolution is changing the educational process with the aim of integrating computers into every part of the system. The intent is not only to provide for a student's smooth transition to professional practice, but to enhance the student's learning process in all areas of education.

Winthrop College has undertaken this challenge of integrating computers into the educational process with the implementation of several very successful LAN applications. The Southern Business Administration Association has presented Winthrop's SBA an honorable mention award for the project "An Innovative Approach to the Acquisition and Integration of Microcomputers into a Business School Curriculum." This report will review some of the major steps taken in our effort to computerize the curricula at Winthrop College.

Evaluation and Selection

<u>Why a LAN?</u>

The Department of Computer Science and the Academic Computer Center at Winthrop College are organizationally under the School of Business Administration. Two faculty committees, one from the Computer Science department, the other from business departments, were formed to evaluate how best to use current tools of information technology in their respective curricula. Two members of the Academic Computer Center served on both committees for technical support and coordination purposes.

The Computer Science committee focused primarily on its commitment to teaching computer literacy to non-majors and beginning computer science majors. The committee representing business departments chose to be as diverse as possible in their considerations by including their entire curriculum.

Of the many facets of computer literacy education, two items were common to the faculty committees' deliberations. These were to provide the students with the ability:

1. to describe the components, operation, and uses of a computer, and
2. to use major application software effectively in problem solving.

Several other aspects of computer literacy were determined, but not common between computer science and business. As an example, computer science wished to teach structured programming to its majors. These additional requirements posed no difficulty in establishing our criteria for selection. However, it was important that the LANs selected be able to execute all functions designated by the respective committees.

Micro-based system laboratories with major application software in database, spreadsheet, graphics, and word-processing were determined to be the most effective vehicle to support these objectives. There were to be three laboratories, two for business education and one for computer science. Two laboratories, one business and one computer science, were designed for scheduled classroom use. Each of the two labs included an instructor's workstation and color video projector monitor. The third laboratory was planed as an open, walk-in facility with no scheduled classroom use.

Based on the nature of the software selected and on the course laboratory structure, several major characteristics of the microcomputer laboratory workstations and the laboratory environment were determined.

The microcomputers were:

- to be complete computer systems with such features as maximum memory and processor speed to handle major software applications.
- to have both parallel and serial communications, enhanced graphics capabilities and high resolution color monitors.
- to be able to share several expensive resources such as hard-disk storage, high-speed printers (laser and dot matrix), and plotters.

The micro-based system laboratory was to have:

- a very fast response time in downloading major application software packages.
- a menu-driven turnkey system with security provisions.
- the capability of quickly spooling printer files to a large buffer where they could queue to high speed printers.
- the ability to send electronic messages, transfer files, and protect software and data at various levels.

The above features describe the automation of "internal" data communications within a cluster of microcomputer workstations. These features identify what is often termed "local area networking". We determined that this type of solution best met our needs in teaching computer literacy.

What type of LAN?

Local area networks are most often classified by bandwidth, topology, and protocol. A brief description of each of these network types is :

- **Bandwidth** - the data path or channel capacity of a network. This is a measure of the network's ability to transmit and receive information.

- **Topology** - the physical network structure. Network topology describes the arrangement by which the workstations are physically and electrically connected. The star, ring, tree, and bus are four geometrical structures most commonly employed. There are physical (hardware structure) and logical (signal paths) approaches to these topologies where combinations of the star, ring and bus are possible.

- **Protocol** - the rules by which data communications are controlled. These rules are primarily communications standards by which information is transmitted and received within and across network boundaries. Protocols include data communications procedures and conventions such the as International Standards Organization (ISO) seven layered model for communications standards and methods of data packet transmission such as Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA), Collision Detection (CSMA/CD) and token passing.

There exists a variety of LAN technologies from which to choose. Three fundamental network technologies with several of their associated characteristics are:

- **PBX or Private Branch eXchange** - mostly uses in-place twisted-pair wiring, can support star or tree topology, and can provide for data, integrated data and voice, and facsimile transmission.

- **Baseband** - uses twisted pair wiring or coaxial cable, will support a star, ring or bus topology and can provide for data, voice, and digital facsimile transmission.

- **Broadband** - uses coaxial or fiber optic cable, will support a tree or bus type topology and can provide for video, voice, data, and security device transmission.

The basic characteristics of our laboratories were 25 to 35 microcomputers in local clusters, a need for only data transmission, high data transmission rates, a non-complex installation, and low cost. The baseband technology appeared to meet these features most effectively. Some major LAN's which use the baseband technology are Xerox's EtherNet, Datapoint's ARC, Digital Equipment's 3Com, IBM's PC Network, Quadram's QuadNet IX, and Corvus's OmniNet.

Which LAN?

The type of microcomputer and LAN configuration was based entirely on the application software and laboratory structure. The software and laboratory structure was, in turn, based on the aims of the computer literacy courses as determined oy faculty committee consensus.

Our laboratories, unlike most office environments, involve a large number of people "downloading" the same application software simultaneously. At the end of class sessions there is a large queue of tasks at the printers. The Novell system, with its combination token passing, ring-of-stars design and system software for handling file-server I/O, fit this requirement very well.

A token passing protocol is more efficient than CSMA/CA and CSMA/CD with increasing numbers of workstations added to the network. On the other hand, token passing, based on a ring structure topology, can be a problem. If a node were to fail, the entire network would be halted. Novell has worked around this by providing a star-shaped ring design whereby workstations are connected in a star fashion via wire centers. System integrity is maintained when a workstation fails or is disconnected.

Also, the NetWare's method of handling file-server I/O enhances system performance under heavy load. NetWare's hashing of directories reduces file look-up time, disk caching for often used files improves access time, and use of the position of disk head to influence the ordering of disk read/write requests reduces seek times.

A limited time schedule and budget prevented us from evaluating most major LAN systems. Several vendors had announced systems which were not available at the time for demonstration. While we were receptive to a vendor's literature and presentations, we held very dearly to the tenet that real-time demonstrations of the network performance with our major software and selected workstations was essential.

With these essential criteria in mind, we selected:

- network:
  Quadram's QuadNet IX
  Novell Advanced NetWare/286
- fileserver:
  NCR PC-8 AT microcomputer (2048 Kb)
  30 Mb Fixed Disk
- workstations:
  Leading Edge Model-D microcomputers (640 Kb)
  STB enhanced graphics cards
  Amdek 722 high resolution color monitors
- printers,main:
  Okidata 2410's

Procurement

A specification fact sheet

We set up specification sheets for our microcomputer workstations, file servers and for our network. A sample specification sheet for the Quadnet IX system is provided in Appendix I.

Provisions for support:

The diversity and complexity of current, local area networks require a level of expertise not available in many institutions. Experienced help is initially required for consulting and educational support.

An agreement or contract was negotiated for support in the installation and implementation of the network with the following areas addressed:

- background and essential conditions of the project
- scope-of-work with specific directions for the consultants.
- consultant's responsibilities (methodology, work schedule, provisions for education on network).
- college's responsibilities (access to data, personnel, facilities).
- ownership of work products (property of the College).
- payment (work accomplished, verification, schedules).

Several vendors bid on the consulting contract. We were fortunate to have the vendor of the LAN system successfully bid on the consulting and education contract. Having the consulting service, hardware, and software from the same vendor proved very valuable. This gave us a common access to assorted experts and avoided conflicts resulting from vendor quarrels over responsibility for problems.

Installation

Hardware and topology:

The major network hardware consisted of file serv~ s, workstations (microcomputers), cables, streaming backup tape and Uninterruptible Power Supplies (UPS's). An abbreviated listing of installed hardware includes:

- network file server
  - processor (80286)
  - system console (monochrome)
  - disk subsystem(s) (30 Mb)
  - printer I/O (serial/parallel)
  - expanded memory (2 Mb)
  - network interface card
  - software key card
  - Uninterruptible Power Supply (UPS)
- network workstation (PC)
  - processor (8088, ipx80 processor family)
  - expanded memory (640kb)
  - network interface card
- network cables
  - type I or type VI (shielded dual twisted pair)
  - wire center
- streaming backup tape system (Alloy)

A star-shaped-ring topology determined the electrical configuration of the laboratory with the wire centers acting as "hubs" to the workstation. We contracted out for electrical work in our laboratories with our systems engineer overseeing the project. We also provided for support from a network consultant in the installation and implementation of the system. Our systems engineer was responsible for the major portion of the software installation, system implementation, and its maintenance.

The biggest problem we encountered in the installation was that resulting from the cable connections. If cable strands were broken or frayed such that a full wire connection was not made, intermittent problems would occur and the network would perform erratically. All connections had to be true and firm. Also, we placed all cable into secured conduit or trays so that movement or inadvertent bumping would not dislodge it.

System software

Systems software was installed by our systems engineer. Consultants were brought in to fine tune the network parameters. They also made valuable suggestions on adjusting parameters for our custom applications. System software consisted of Novell Advanced NetWare/286 with the following features:

- supports up to three parallel and two serial network printers.
- token passing, updates token list for new users automatically.

- security system with multilevel protection for both users and files.
- memory-to-memory transfer of data.
- allows connection for up to 255 nodes in a "ring-of- stars."

Menu and security profiles must be established and installed for proper use of the applications systems in the student laboratory environment.

Application software

For the Fall '87 semester, we had 20 software packages on the LAN's and 31 courses formally using the laboratories. Table 1 provides some information on the kinds of application software used by the academic departments. Software applications are categorized as spreadsheet/graphics (SSG), database management (DBM), word-processing (WP), business/business games (BBG), statistics/graphics (STG), compilers/interpreters (CI), and communications (COMM). Some overlap exists in the specified categories. As an example, several of the software packages listed in the spreadsheet category are template-oriented with direct business applications. Other, miscellaneous software items are not listed. Major academic departments are Management (MGMT); Marketing, Economics, and Fashion Merchandising (MAR/ECO); Accounting and Finance (ACT/FIN); and Computer Science and Quantitative Methods (CSC/QM). Each entry in the table represents the number of software packages used by category and department.

Table 1

Software packages by academic department and category

SOFTWARE CATEGORY	ACADEMIC DEPARTMENT MGMT	MAR/ECO	ACT/FIN	CSC/QM
SSG	1	1	5	1
DBM	1	1		1
WP	1	1	1	1
BBG	6	4		1
STG		1		1
CI	1			3
COMM				1

Data in Table 1 does not provide information on the extent of usage of any particular software item. We hope to quantify such information with the use of a LAN management accounting package. From general observation, spreadsheet (LOTUS 1-2-3)[1] and word-processing (WS2000)[2] are two of the most used software packages on our systems.

Implementation

Training for systems and applications support is crucial for the proper implementation of the LAN laboratories. In our agreement with the LAN consultants, we provided for twenty hours of on-site educational seminars. These seminars were provided for computer center personnel and key faculty in the business and computer science areas. The faculty then held classes for faculty and staff end users and for student tutors.

Problems occurred, but were not so catastrophic. The education and training provided seems to have made them more manageable than they might have been otherwise. Education and training should be a regularly scheduled exercise.

Use of the LAN's

Policies and procedures

Of critical importance in the use of the LAN's is the establishment of guidelines and rules. As is most often the case, those not technically responsible are less concerned than computer center personnel over security and maintenance time and press for more open access. However, a balance must be maintained between security provisions, maintenance time, and open access.

The academic computer center is responsible for the physical inventory, systems, and operations support of the LAN's. The Associate Dean of the School of Business schedules the use of the labs and decides which applications are placed on the systems. In this manner, the academic computer center is removed from making decisions on the relative merit of academic applications.

Each LAN application must have its own set of guidelines. Responsibilities for the administrative and technical management of the center should be clearly defined.

---

[1] Lotus 1-2-3 is a registered trademark of Lotus Development Corportation, Cambridge, MA.
[2] WS2000 is a registered trademark MicroPro International Corporation, San Rafael, CA.

Usage statistics

We are preparing to evaluate several accounting packages that can be installed on the LAN's that will allow us to keep accurate statistics on usage. We have recorded manually some data on laboratory usage by having student operators make head-counts on a hourly basis in walk-in laboratories (WI) and by recording course enrollments for classes regularly scheduled in instructional laboratories (IL). While the data is at best "rough", it does provide us with an approximate measure of usage. All data has been reduced to student-hours per laboratory per semester (Table 2). Fall and spring semesters are 15 weeks in length, summer session is 10 weeks.

Table 2

Student-hours usage of LAN laboratories

	Business		Computer Science		
Semester	Lab 1 (WI) 28 wkstns	Lab 2 (IN) 28 wkstns	Lab 3 (WI) 29 wkstns *	Lab 3 (IN)	Totals
Fall '86	9,831	10,000		13,789	33,620
Spring '87	12,915	8,477		11,676	33,068
Summer '87	3,318 **	2,692		50	6,060
Fall 37	9,291	7,512	5,101	12,927	34,831

* other workstations (wkstns) are connected to file servers, but not located in the labs. These are not included in lab counts.
** estimated value based on relative walk-in, instructional lab use.

Plans for future development

Use of the LAN's has stimulated both interest in and use of computers. For the present, we have also experienced a decrease in the number of accounts on our host system resulting from a shift of basic computer work to the LAN's. Host system usage, however, is increasing by way of more sophisticated applications not available on the microcomputers. Juniors and seniors, without structured exposure to the microcomputer laboratories, requested the opportunity to retake a computer literacy course under the current regimen. A 200 level course using the LAN's was developed for these people.

Faculty and student usage of the LAN's has increased their productivity in the areas of class administration, assignments, research projects, papers, and theses.

There is a user demand for enhanced and additional facilities. Our plans are to:

- link the three LAN laboratories via fiber optic cable and bridges.
- provide gateways to host processors.
- establish more laboratories.

In conclusion, both the users and support people are very satisfied with the general performance of our LAN's. This is especially apparent from their requests for more access to the systems including office connections to the LAN's. We owe the success of these laboratories primarily to faculty/staff involvement at the initial stages of course and laboratory design, system-evaluation that included site demonstrations, and adequate provisions for consulting and educational support.

Appendix I

Local Area Network: QuadNET IX

Marketed by:

Quadram Corporation
4357 Park Drive
Norcross, GA 30093
(404) 923-6666

Retail Prices:

Starter Kit	N/A
Workstation	$795.00
Server Station	$1,495.00
Dedicated Server	N/A
Coaxial Cable (per foot)	$.95
Connector (4 Stations)	$95.00
Repeater	N/A
Four Station Configuration	$9,265.00

Hardware Capabilities:

Number of Servers	1
Number of Workstations	256
Server Type	IBM/AT

Memory Requirements: [Min/Max]

Dedicated Server	256/16Mb
XT Server	356/640K
Workstation	128/640K

Peripherals Supported:

Serial Printer	YES 2
Parallel Printers	YES 3
Plotters	YES
Hard Disk	YES
Tape Drive	NO
Other Mass Storage	NO
Modems	NO
RAM Disks	NO
Other Communications	NO
Other	NO

Backup Support:

Vendor Supplied	YES
Disk	YES
Global	YES
Other	NO

Network Description: Token Passing

Architecture	Ring/Star
Type	Baseband
Speed	9.92Mbps
Server Type	XT

Security Provided:

Logon ID	YES
File Passwords	NO
File Protection	YES
Record Protection	YES

Diagnostic Supported:

Cable	NO
Server	NO
Workstation	NO
Network/Station	NO
Auto ReRoute	NO

Software Capabilities:

Operation System: PC-DOS

Disk Caching	YES
RAM Disk Support	NO
Systems Manager	YES
Other	YES

Application Software Included:

Electronic Mail	YES
Chat	NO
Utilities	YES
RAM Disk	NO
Other	YES

Print Spooler Features:

Variable Buffer	YES
Disk-Based	YES
Change Paper	YES
Printer Commands	YES
Multiple Copies	YES
Queue Inquiry	YES
Purge Queue	YES

BIBLIOGRAPHY

Information on LAN's:

Bolton, Tony. "Local Area Networks: They're not all alike." The Office, April 1985, pp. 68-71.

Buckland, John A. "The Information Center Institute checklist for Local Area Networks.", Information Center, December 1986, pp. 47-48.

Dickey, Sam. "LAN landscape: Is success on the horizon ?", Today's Office, November 1987, pp. 15-22.

Durr, M. Networking IBM PC's: A Practical Guide, Indiana: Que Corporation, 1984.

Feldman, F. "Local Area Networks help machines to communicate.", The Office, April 1985, pp. 128-130.

Hald, Alan and Grant, Bruce "LAN mines for the unwary.", Information Center, December 1986, pp. 38-39.

Jordan, Larry. E. and Churchill, Bruce, Communications and networking for the IBM PC, Maryland: Rober J. Brady Company, 1983.

Levin, David. "Evaluating generic Local Area Network technologies.", Small Systems World, January 1985, pp 15-16,41.

Ruef, A. "Cost benefits aren't the best LAN justification.", PC Week, 3 February 1987, p. c/31.

Vacca, John R. "The network mess.", Information Center, December 1986, pp. 30-40.

LAN Magazine, 12 West 21 Street, New York, NY 10010 (published monthly).

Information on Quadnet IX and NetWare:

Cowart, R., Kanzler, S., and Rosenthal, S. "Quadnet IX", PC Magazine, 5 February 1985.

Krumrey, A. "NetWare in control", PC Tech Journal, November 1985, pp. 103-119.

Information on computer literacy:

Friedman, E.A. "The wired university", IEEE Spectrum, November 1984, pp. 115-120.

Golden, R.E. "Caution and skepticism are needed on the road to computer literacv", The Chronicle of Higher Education, 7 December 1983, p. 80.

Goleman, D. "The Electronic Rorschach", Psychology Today, February 1983, pp. 38-43.

Price, Barbara A., Archer, Clark B., and Moressi, William J. "A successful approach to computer literacy", (accepted for publication), ACM SIGCSE Bulletin.

Render, B. and Stair, Jr., R.M. "Managing the microcomputer movement on campus", Information & Management, North-Holland: Elsevier Science Publishers 8(1985), pp. 253-259.

Van Dyke, Carolyn. "Taking Computer Literacy Literally", Communications of the ACM, May 1987, pp. 366-373.

Changing Administrative Database Philosophy; Network to Relational

Becky King

Baylor University
Waco, Texas

This last year was the beginning of a major transitional period for Baylor University Administrative Computing. Not the least of the changes was that of acquiring IBM's relational DB2 as the database for all future development. This required a complete rethinking of application design and integration philosophy because all existing database systems employed a CODASYL network database. This paper discusses the background and implications of this major software change as well as lessons learned through the first year of implementation of SQL-based relational systems.

Changing Administrative Database Philosophy; Network to Relational

Baylor University, located in Waco, Texas, is the oldest university in continuing existence in Texas. The approximately 11,500 students are spread throughout the College of Arts and Sciences and the Schools of Business, Education, Law, Music, and Graduate Studies in Waco and the School of Nursing in Dallas. There are also affiliated graduate programs with the U.S. Army Academy of Health Sciences in San Antonio. Baylor is under the patronage and general direction of the Baptist General Convention of Texas and its mission, as stated by President Herbert H. Reynolds, is "to be an institution of higher learning where education may be gained under Christian influences and ideals". Dr. Reynolds has defined several major goals for the late twentieth century, one of which is to "achieve a state of computer literacy within the faculty and student body". This charge from the top influences all systems development and implementation. It lends support to the effort to integrate and enhance the entire database of University information.

Baylor Computing Environment

The Center for Computing and Information Systems, under the leadership of the Director of Information Systems, is composed of the Academic Computing Section, the Administrative Computing Section, the Communications Section, the Office Automation Section, and the Microcomputer Store. The Administrative Section includes two associate directors, two systems programmers, a database programming coordinator, four programmer/analysts, four student programmers, and a microcomputer support person as well as operations and production services personnel. Administrative computing has been handled by a Honeywell computer since 1968. Through several hardware upgrades the University has been well-served by this environment, developing many inhouse systems including a respected on-line registration system. Several years ago a commitment to the database philosophy for new software development was made, and implementation of Human Resources and Alumni/Development Systems followed using Honeywell's IDS-II network database management system. However, as the educational arena became more competitive, the funding for new staff tightened, the demands of more computer-literate clients multiplied, and the number of third party software packages available increased dramatically, the administration became convinced it was time to re-examine the administrative computing situation and the philosophy of developing all software inhouse.

After much study and work by various appointed committees composed of faculty and staff, several major hardware and software decisions were made in 1986 by the administration and Board of Trustees. An IBM 4381 was purchased and MVS/XA was chosen as the operating system. The VSAM version of Information Associates' Student Information System was also purchased and implementation begun. The Computer Associates Unicenter software support products were acquired. And finally, IBM's relational DB2 was chosen as the database to be used for all major system development. These critical decisions forced the Administrative Section into a difficult conversion situation. The influx of new products also compelled the staff to learn many new tools and concepts while continuing support of current Honeywell systems. However, everyone involved, while sobered by the work ahead, believes the results will put Baylor in position to become a leader in university administrative computing.

DBMS Decision

In considering the database selection, we remained committed to the database approach to systems development. Our current database systems are successes, and we are sold on the integration of data and the tools that come with a DBMS. Because the IA Student Information System had been chosen, we were primarily looking at database management systems compatible with that software. At the time IA had versions running under ADABASE, IDMS, and VSAM on the IBM, but we learned of plans to introduce an SQL version in the future. This information, along with some questions about the current IA database versions of the SIS software, led us to look very carefully at DB2 and ultimately select it. Some of the major reasons for this decision were:

- We were attracted to the relational technology for its flexibility. The ability to add elements to tables and define new tables and indexes fairly simply was a very big plus. Also, we felt system development in general would be a faster process with a relational DBMS.

- Relational systems are the easiest to understand. The terminology is simple. Clients can more easily grasp the concepts of tables, rows, and columns than records and sets.

- SQL is becoming a standard. Many vendor software products now have SQL versions. Therefore, any tools we might want to purchase in the future would be available.

- Finally, IBM is touting DB2 as its database of the future. And DB2 has been well received by critics that rarely laud

IBM undertakings. This reinforced our feelings that most products available in the future will work with DB2. Also, we liked having the same vendor for hardware and software.

Implementing Relational Technology

After our DBMS was chosen, we had to decide what to do with it. What would be our first DB2 application? We selected the Student Payroll System, a relatively small system with a limited group of primary users. The current system was a completely batch one written in COBOL-68 which caused headaches each month for all involved with it. The programs had been patched for years and produced inconsistent and unpredictable results. And because it had to interface with the newly purchased Student Information System, Student Payroll would need to be one of the first systems converted to the IBM anyway. So not only did we have a smaller system on which to learn about DB2, but we could also improve our service to the student body by rewriting a poor system which impacted many of them.

We then began reading manuals - many, many manuals. We invested in two IBM DB2 classes, one on database administration and one on system administration. These were especially helpful in learning DB2 terminology and design techniques for improved performance. Because SQL is so simple to learn and because our programmer/analysts were already familiar with a much more complex data manipulation language (DML), we decided against programming classes for the staff. We have been happy with this decision. Our people have picked up SQL and its use with COBOL very quickly.

Designing the Student Payroll relational database was a new and exciting task. The major process was defining all the data elements and normalizing them into tables. The resultant database has nine tables and nine indexes. The student I.D. number is repeated in all but one table and the student account number is repeated in several. This repetition of key fields without referential integrity in place is a troubling aspect of relational design in DB2. However, the design process itself is greatly simplified by having to consider only one data structure. In our database, after consultation with IBM and other DB2 users, we chose to define one table per tablespace and to do our own VSAM management rather than let DB2 handle it through its storage groups. The consensus seemed to be that these two choices were the most efficient and provided us the most control.

COBOL programming in SQL, while fairly simple to master, did require some adjustments and initial study. The major differences we have found include:

- Rather than accessing the information a record at a time within a program, a "set" of data is retrieved based on the SQL requirements coded. Then a cursor is used to fetch succeeding rows from this "set". But because a knowledge of record and set structures is not necessary, our staff found this much easier to use than the CODASYL DML. For example, the FIND statment in IDS-II has eight very different formats to be used depending on how the data is to be accessed.

- The size of the source listing is tremendously increased by the lines generated by SQL includes and calls. This makes the listing harder to read.

- To be made ready to execute, an SQL program must be run through two additional steps. Before the compile, a DB2 precompile must be done. This phase does some editing of SQL statments and produces a database request module. The second additional step is the bind step which produces an application plan used to allocate DB2 resources and support SQL requests during execution. Therefore the process of creating an executable module takes somewhat longer than with non-DB2 programs.

- Within an SQL statement field names cannot be referenced which are part of copy members to be copied into the program. These fields are not copied into the source until the compile step. Therefore, when the precompiler is verifying the SQL syntax, those field names are undefined and result in error condition codes.

- Special programming considerations are required in our network system when enlarging variable length fields. If a modify return code indicates there was not enough room on the page for the extra data, the record containing the field must be deleted and re-added by the program. In DB2, the system will move the enlarged row to the nearest page with sufficient free space and set up a pointer in the old position. This simplifies programming but does not relieve the need for periodic data reorganizations.

The design and programming on the new Student Payroll System went very well. It consists of 23 batch programs and 22 CICS programs. We had originally planned to go "live" with the first payroll of the fall semester. However, we switched over to the IA SIS in September and had to use all available manpower on tasks supporting this critical project for much of the past several months, thus delaying the Student Payroll implementation. Also, balancing reports from the new and old systems has been an even greater job than anticipated because of a multitude of program and data inaccuracies in the old system. We did not truly realize how badly we needed this conversion. We have been running parallel systems since mid-October and expect to discontinue the old system in December. Our clients using the new programs in running the parallels are enthusiastic and anxious for the changeover.

Relational/Network Contrasts

The experience on this first DB2 system has taught us a great deal about differences between the network DBMS that we have been using for several years and the new relational DBMS. Much re-thinking of the whole database design and definition process has been required. Major points in our comparison of the two types of DBMSs include:

- In a network system, information about the data is coded into the structure through the sets. Database navigation is more complex because a knowledge of the set names, structures, and order of storage is required. Also, the programmer must be aware of record, set, and realm currencies in all data manipulations. The relational structure is easy to understand - tables as opposed to records and sets. And navigation is strictly by field values. It does, however, require extra columns in the tables to provide the links implied in the network structure.

- A relational system is much more flexible than its network counterpart. New tables are easily added to a relational database as are new fields to existing tables. Indexes can be created and dropped as needed. These updates affect only the application programs that reference the changed or added objects. Usually a restructure is needed to add new fields, records, and sets to a network database.

- As relationships between entities change, these changes are easily defined based on the data in a relational system. In a network database, a restructure is required to define new set structures for these additional relationships.

- In a relational system, a user can be given a logical window into a database through a view and can even become his own DBA and define further views.

- SQL is a high level language used by the DBA, programmer, and user. It includes built-in functions like SUM, ORDER BY, COUNT, and AVG which are not available in the CODASYL DML. The consistency of using the same easy-to-understand language to define and manipulate data is an advantage over network systems.

- We can now, with our relational system, access tables from more than one database in a single application program. This is a limitation of our CODASYL environment that requires us to use calls to other executable modules to access more than one database.

- DB2 security is more extensive than that in our network system. Using SQL commands, privileges can be granted and revoked as required. Through the use of views, this access can reach down to the field level and be based on field content. Also, privilege must be granted to execute database utility and administration functions. Our network system allows the use of subschemas to limit views of the data but subschemas are very cumbersome and do not provide the granularity of security found in DB2.

- The consistency and integrity of data across tables has to be maintained by the application programs in DB2. There is no referential integrity. In a network database, some of this integrity can be handled by the set structure.

- Whether or not an index is used to access data is determined internally by DB2 rather than explicitly stated by the programmer as in a CODASYL environment. This requires that SQL statements be formulated correctly if use of an index is desirable.

Future Administrative Computing Plans

The Administrative Computing Section has a tremendous amount of work ahead that must be done as quickly and efficiently as possible but not without much thought and planning. We have established the policy that all inhouse development will be done in DB2. We have begun design work on conversion of our IDS-II Human Resources system to DB2. Included in this process will be some important enhancements that our clients have requested such as an applicants subsystem. And we are spending time in analyzing how we can make this new system more helpful to the University's executive level. This will be a major thrust of all our future development - to support our decision makers with relevant, timely information in useful formats. Two committees composed of a cross section of members from across campus are winding up studies of potential Financial Information Systems and Alumni/Development Systems. The committees' recommendations and the University's decisions in these two areas will help decide the direction of our work effort in the next two years. A primary consideration in evaluations of vendors' software will be present or future availability of SQL versions. We are facing a very challenging time. A relational database system like DB2 gives us a more flexible, easier to use tool than we have had in the past to aid in accomplishing the tasks before us. As Dr. Reynolds stated in the November 1987 issue of Cause/Effect, "Our plan is to literally try to have the most up-to-date information systems that we possibly can, to lead our people where they have not been before, or where they have not even anticipated going." Administrative computing will be a major factor in this information revolution and in the continued striving to better serve Baylor's students, employees, and friends.