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ABSTRACT

The 1993 CAUSE Conference presented eight papers on the use of information technology to support the mission of colleges and universities. Papers include: (1) "Institutional Imaging: Sharing the Campus Image" (Carl Jacobson), which describes the University of Delaware's campus-wide information system; (2) "Electronic Paper Flow" (Eloy Areu and others), which discusses the University of Maryland's model for electronically simulating the flow of paper; (3) "Networked Deiivery of Multimedia Information" (Robert Brentrup), which discusses multimedia plans of Dartmouth College (New Hampshire); (4) "Lessons from the Berkeley Museum Informatics Project" (Barbara H. Morgan); (5) "Campus-wide Degree Audit" (Emil O. Hanson), which describes a Weber State University (Utah) program to evaluate progress toward degree candidacy; (6) "The Information Arcade: A Library and Electronic Learning Facility for 2000 and Beyond" (Anita Lowry), which describes an integrated electronic information system developed by the University of Iowa; (7) "The Digital Textbook: A Look at the Next Generation of Educational Materials" (Don Hardaway); and (8) "Providing Students and Visitors with a Kiosk-Based Campus Information System" (Kathryn Neff and Judith W. Leslie), which describes a program of Sinclair Community College (Ohio). (Some papers contain references.) (JDD)

Managing Information Technology as a Catalyst of Change

Proceedings of the 1993 CAUSE Annual Conference

TRACK VI

INFORMATION DELIVERY TO SUPPORT THE INSTITUTIONAL MISSION

December 7-10
Sheraton on Harbor Island
San Diego, California

Track VI

Information Delivery to Support the Institutional Mission

Coordinators:* *J. Bradley Reese
Sharon Rogers

The success of information technology is ultimately judged by how well it supports the institutional mission. Dovetailing the direction of IT with the goals of the institution is increasingly important to those who plan for and manage technology, and those who evaluate its effectiveness. How can information professionals deliver a wide variety of information in support of teaching, learning, scholarship, and research?

Institutional Imaging: Sharing the Campus Image

Carl Jacobson
University of Delaware
Newark
Delaware

The University of Delaware's campus-wide information system, *U-Discover!* uses the Gopher client-server software developed by the University of Minnesota, to provide an easy-to-use, wide-reaching information service.

Delaware is currently integrating photographic and document imaging with *U-Discover!* text to provide an exciting and effective new level of service. One such application provides access to institutional photographic and historical records. A library of two-thousand 35mm color slides, depicting campus facilities, programs and activities, has found a home in *U-Discover!*

This library may be browsed by faculty, staff and students to locate and identify slides for use in publications or presentations. Text-to-image links allow full-text description searches to return color images across the campus network to PC, Mac and UNIX workstations.

Using inexpensive hardware and freely-available software, Delaware's campus-wide delivery of institutional images is easy, inexpensive and highly effective and has become a model for future multi-media services on our "electronic campus".

The National Information Super-Highway

In recent months, there has been a great deal of press regarding the National Information Infrastructure proposed by the Clinton Administration. Information technologists in institutions of higher education will certainly make important contributions to this ambitious endeavor.

For this national information network to properly serve the public interest it must be a "pedestrian" offering. That is, although this is to be a high-powered, high-technology data highway, it must reach out to our homes and offices, schools and industries in a "common, ordinary" manner. It cannot be reserved for super-scientists, well-heeled corporations, or those with technical or financial advantage. To meet its stated goals, this highway must be well travelled, by many, from all walks of life. It must deliver utility and services to student and farmer, teacher and law-maker, expert and novice alike.

The technical and logistical challenges of this undertaking will require a great deal of time and money invested at the national level. But another challenge requires more immediate attention. As institutions of teaching, research and public service, we must begin to understand the implications of our roles as information providers. While the details of a information infrastructure are debated, we must look inwardly to identify our valuable information holdings and to determine how they might be easily shared on a national network designed to serve the public interest.

Campus Information Highways

While the national effort will insure that the network is far reaching and "pedestrian", we must insure that the information content is useful and valuable. As "form follows function", even in terms of information technologies, then rich content implies the need for rich information types. We must be prepared to deliver more than record-oriented, character-based data. Our challenge is to capture, prepare and distribute information resources of many types; text, rich text, image, animation, audio, full-motion video and more.

There are many issues associated with the "care and feeding" of these information types. And while parallels may be drawn between the familiar, traditional information technology methods and the methods required by these newer technologies, there will also a great deal of new ground that must be broken. Where do we start?

Information Type: Image

The University of Delaware has begun to take steps to better understand what the future holds. To learn more about the delivery of "non-traditional" information services, we have initiated several institutional imaging projects.
An informal survey of imaging projects on today's campuses indicates that most fall into the category of document imaging; that is, storing images of paper-work; admissions applications, purchase requisitions, and the like. Furthermore, these documents are found to reside primarily on departmental servers; delivering service in support of departmental processing requirements.

Quite recently the cost of this type of imaging has plummeted... $1000 personal computers with $500 software on inexpensive local area networks can deliver document imaging services at a very low cost-per-seat. However it is difficult or expensive to "scale up" such applications to make these image services available to many or all members of the campus community. When planning for a digital highway of a pedestrian nature we must "start at the top" with a campus-wide distribution scheme and then, if necessary, hone in on departmental needs to focus effort, add security, and enhance functionality.

Pilot Project: Photographic Images

Our initial pilot project found it roots in a collection of 35mm, photographic slides owned by an administrative department, the Office of Public Relations (PR). The PR slide library holds over 20,000 photographic slides which are used in campus publications and presentations and chronicle the history and events of our institution. The scope of the initial project focused on a collection of 2,000 actively used, "exemplar" photographs, to be called the *"Campus Collage"*.

Prior to our pilot, the PR slide originals were filed in loose-leaf notebooks and indexed in a flat-file database. This single-user, PC database contained a short description and identifying information for each slide. In order for a campus user to locate needed slides, a PR staff member would perform simple keyword searches against the database to retrieve slide numbers.

These slides would then be physically retrieved from the collection of 20,000 for previewing. Once a needed slide was found, the slide number was recorded and slide copies were ordered directly from PR. This process was time-consuming, labor intensive, and restrictive, and required the physical handling of the original photographic masters.

Objectives of the pilot project included: opening the library to a wider audience, providing for remote access and self-service browsing, and reducing the amount of handling of the original slide masters. These objectives were to be achieved by digitizing the exemplar collection, loading the collection for accessibility on the campus network, and linking text descriptive and identifying information with the image collection to facilitate location of needed slides.

Establish Common Denominators For Wide-Spread Access

To reach the widest possible audience with an effective level of service, several common denominators were identified. *U-Discover!*, Delaware's campus-wide information system was already well established thanks to the many strengths of the University of Minnesota's Gopher protocol. Gopher client and server software was widely distributed among campus information users and data providers.

CompuServe's GIF (Graphics Interchange Format) was selected for the storage of campus images. The GIF standard was designed to be a public domain offering for low-overhead transmission of images to CompuServe subscribers. It is a commonly used format, supported by a following of free or low-cost software.

The Super VGA (SVGA) image resolution of 640x480 pixels, 256 color palette, was adopted as a display standard to take advantage of the large number of SVGA capable equipment on campus, while placing limitations on the reproduction of these copyrighted images. A GIF image displayed at this resolution looks nearly photographic and is suitably handled by lesser quality VGA and gray-scale monitors.

Digitize Photographic Slides

Two methods of digitizing slides are employed at the University of Delaware. A service bureau may be used to place digitized slide images on CD-ROM, or a self-service approach may be taken using PC-based slide scanning hardware.

The KODAK Photo CD service was selected for the *Campus Collage* pilot. The KODAK Photo CD process allows up to 100 35mm color slides to be stored on a single CD-ROM. This service is provided for under $1 per slide at nearly any local photography store.

The KODAK process stores a single, very-high resolution file for each slide. The file is formatted in such a way that it may be retrieved in any one of 5 different resolutions. This allows low quality versions of the image to be quickly retrieved while providing for the storage of large, publications-quality images. Advantages of the KODAK process include the outsourcing of the labor-intensive slide handling as well as the creation of permanent, image masters. The shelf life of digitized images is considerably longer than that of slides.

While the KODAK process targets home as well as commercial use, small jobs are easily handled. A collection of two dozen slides may be placed on a Photo CD on one occasion, and an additional slide collection may be added to that physical CD at a later date, up to the 100 slides limit. Turnaround for this service varies from three-days to one-week.

Nearly a quarter of the PR photographic library consists of 2 1/4" format, however the Photo CD process currently supports only 35mm format. KODAK has announced plans to support 2 1/4" format by the end of the year.

For small slide libraries, or those requiring a more hands-on approach, inexpensive, high-quality slide scanners are now available. The Nikon CoolScan slide scanner has been used with great success at our institution. At approximately $2300 the slide scanner provides an economical alternative, producing a high-quality digital image in about 5 minutes. Currently the Nikon scanners support only 35mm format.

Prepare Digital Images for Storage

We are pleased to be able to pay a service provider to do our digitizing, because even with a Photo CD in hand, there is still a considerable amount of work to be done to prepare 100 images for loading.

Each image is retrieved from the Photo CD in a mid-level resolution at 768x512 pixels, using Adobe's Photoshop software. The picture is visually reviewed for color, brightness, and contrast. Photoshop allows adjustments if necessary, but they are rarely required. The orientation of the image is confirmed. On occasion we have encountered images scanned upside down. The Photoshop software selects a 256-color palette that best meets the requirements of the picture and saves the image in a GIF file, reducing the resolution to 640X480 pixels.

A single image production station was configured to support the preparation of images. This modest workstation consists of a 33Mhz Intel 486sx with 8MB of RAM, 170MB local disk, a Toshiba CD-ROM player, a Nikon CoolScan slide scanner, Adobe Photoshop software and an ethernet connection. Most of today's CD-ROM drives support the Photo CD standard.

As the PR images are property of the institution, a copyright statement is added to the margin of each image. KODAK has announced plans for providing this service by the end of the year. In addition a black background is added to frame the picture and fill any unused portion of the screen. Both of these additions can be done manually, using software such as Photoshop, but we have automated this process. Both copyright and black mat are added programmatically after the image files are stored on the server.

The reviewed and edited image is stored on a shared network drive on a UNIX server to later be loaded into a Gopher directory. Each image is stored as a single file. These files are arranged in Gopher directories using pointers. Gopher allows several such pointers, or Gopher links, to reference a single information item. In this manner slide images may be organized in several different categories.

Prepare Associated Text For Storage

Each slide image is described in some detail in a brief narrative. Information such as subject, photographer, date, location, slide number, and CD-ROM number is included in this description.

A wordprocessor file is created documenting each image. Macros and scripts are used to automate the creation of an ASCII-text file for each image and build descriptive file names for both text and image files. These long UNIX file names consist of a 38-character slide title, date, and number. While both text and associated image files have identical names, they are placed in different Gopher directories.

WAIS indexing software, a tool commonly used by Gopher administrators, is run on both directories to create full-text indexes against the written descriptions and the image titles. A full-text search item is added to the slide image directory allowing these descriptions and image titles to be searched.

Load Images and Text on Server

Inexpensive workstations from Sun Microsystems are employed as text and image servers at Delaware. Such servers commonly range from low-end Sun IPC and Classic models priced in the $3500-$4500 range to larger, more powerful Sun LX and Sun 10 models. Magnetic disk capacity may be added to these servers for less than $1000 per gigabyte. At 100KB per image, 10,000 images require 1GB of image storage.

While the Sun workstations have become the standard for such servers on our campus, the Gopher software is suitable for other platforms, including inexpensive and popular MacIntosh workstations.

Software required to support the server function includes Gopher sever software and WAIS indexing software, both in the public domain.

Distribute Client Software

The University of Delaware supports Gopher client software for each popular campus platform. For DOS users; UGopher from the University of Texas. For Windows; Martyn Hampson's HGopher from Imperial College, UK. Mac users employ TurboGopher while UNIX users employ the UNIX Gopher client, both developed by the University of Minnesota.

Image viewers must be associated with each Gopher client to enable the display of GIF images. Public domain, or site-licensed viewers were selected to allow widespread distribution to students, faculty and staff. DOS Ugopher users employ CompuShow from Canyon State Systems, while Mac TurboGopher users have adopted JpegView developed by Aaron Giles. Users of the Windows HGopher client use LView, freeware from Leonardo Loureiro and UNIX XGopher users are running the XV X-Windows viewer.

To address software update and version control concerns, current versions of Gopher clients and GIF viewers are available to members of the campus community across the network using Gopher itself. Directories for DOS, Windows, Mac and UNIX users contain self-extracting archives which store the program files for each application in a compressed format. Selecting such an item from a Gopher directory causes the program files to be loaded across the campus network and uncompressed on the hard drive of the client machine.

Several local modifications have been made to the Gopher clients we distribute to our campus users. These range from authenticated access of student records information, to support for our campus-wide electronic forms system. Whenever possible these changes are made external to the Gopher client using "viewers".

Such changes have been made in support of the imaging effort and are exemplified by a modification to the UGopher text viewer that enables an automated linking of text with image. An index search returns text, the press of a key displays the associated image.

Limitations

While the goal of this information service is wide-spread access, there are most certainly limitations to the scope of service.

Connectivity--The Gopher client/server protocol is an Internet protocol so that an ethernet connection to the campus backbone is required of all clients. Character-based gopher clients are provided on campus for users of central time-share system, but image retrieval is not available to these users.

Resolution--As standard display monitors operate in the range of 70-90 pixels per inch, the SVGA image of 640x480 pixels, 256 colors provides an image that appears nearly photographic. The SVGA resolution of our digitized images cannot match the quality of original film images, however it is better than video and certainly suitable for today's personal computers.

Projection--When overhead projection of digital images is employed, the success or failure depends on the degree of loss of resolution, color and brightness. Currently available projection equipment is limited to SVGA resolution with loss of brightness being a common complaint. While projection of such digital images may not yet be appropriate for applications requiring detailed, true-to-color reproductions, many routine presentation needs can be met.

Generation Loss--Generation loss refers to the incremental degradation of picture quality that takes place with the making of each copy: a photocopy of a photocopy of a photocopy... While the digitizing process produces a loss in resolution and color, once an image has been digitized the file can be transferred, copied and reproduced digitally without further loss. It is important that, whenever possible, film originals are used to create the digital masters.

Network--At 100KB-200KB each, our *Campus Collage* photo images are quickly and effectively delivered across our current network. We have an 80MB fiber-optic campus backbone, with 10MB ethernets in each building. All residence halls are wired for ethernet and by the end of the year, the saturation wiring of classroom and offices will be completed.

One limiting factor of our current network is an older router technology that causes information to pass through our network gateways at less than 1000 packets per second. Currently available technology would allow this rate to approach 180,000 packets per second. The replacement of these slower routers is planned for the near future.

Compression--Compression is the process of reducing the file size needed to store or transmit an image. Larger images, or images of higher resolution require higher network speeds or data compression. Effective image compression is available today in image formats such as JPEG (Joint Photographic Expert Group). JPEG compression and decompression can be performed by software, or with the assistance of compression accelerator boards. Generally speaking this type software compression slows the file transfer process significantly, necessitating the use of JPEG compression boards. However, recent developments in JPEG compression routines have shown improvements in software compression.

While our "Campus College" is deliberately restricted to SVGA resolution images, if the future calls for the delivery of higher-resolution images our Photo CD masters ensure the availability of such images.

Security and Access--*Campus Collage* is accessible from any location on the Internet. Text and image collections may easily be restricted to on-campus-only access, or to access from a physical network subnet or node. Restricting access by individual user is not easily administered using current versions of Gopher software but it is possible to write Gopher servers to provide authenticated access.

Copyright--The slides in our PR library are property of the institution. We have opted for widest distribution and therefore retain little control. We protect our rights in two ways, one technical and one legal. The images made available on the network are moderately low-resolution images and therefore have little reproduction value. High-resolution images are kept off-line on the original CD-ROM for use by campus publications.

A copyright statement "Copyright UNIVERSITY OF DELAWARE, All Rights Reserved" is placed on every PR slide image and delivered across the network. Instead of preventing access to the images, we make our work available and expect property rights to be honored.

For images needing more protection there are several options. Access restrictions may be placed on servers limiting access to on-campus locations. Lower resolution, or "thumb nail", images may be distributed for browsing. Watermark statements, such as "PROOF" may be placed across the face of the images making them unusable.

Features--Minnesota's Gopher is a wide-reaching but general-purpose implementation. It cannot compete in the arena of image features, with LAN-based, vendor-produced image librarians.

However, the allure of Gopher lies in its ability to provide wide-reaching, democratic access. And, in fact, as Gopher clients are built on the principle of "object viewers", there is no reason more sophisticated image-aware gopher clients cannot be created. Special-purpose gopher clients could allow display of thumbnail images in directory format. Or a "Presentation Gopher" could be used to delivery "Internet slideshows" in the classroom. A "Touch-screen Gopher" could enable campus kiosk users to easily browse a collection of annotated photos for a tour of campus.

While current Gopher-based image libraries might be described as feature poor, they are distribution rich... distributing rich information resources to even the "poorest" of our network users.

Other Applications

While the *Campus Collage* was created to facilitate browsing of the PR slide library, it has already been used to deliver live, across-the-network presentations. Our president has made two such presentations, one to members of the Board of Trustees. Additional "administrative" imaging applications have been identified.

Internet Slide Show--Delaware recently re-engineered the student services business processes and in doing so, created a new student services building which has been widely heralded by the student population. Neighboring institutions have shown considerable interest in this successful project and we have hosted many visits.

An "Internet tour" was developed to allow interested institutions to learn more about the project without setting foot on campus. This tour, which includes annotated slide images, sample screen images from our student kiosks and text to providing an overview of our approach, was created in one afternoon. This is an "administrative" use of Internet delivery of image and text resources, however, similar use may deliver academic services.

Digital Photography--While our initial pilot targeted the conversion of 35mm slide to digital images, currently available still cameras can produce digital pictures more directly. The efficiency and utility of this equipment places it high on the list of "data capture" hardware for a campus photo-image service.

At Delaware product review has begun leading to the replacement of the current ID card production equipment with a digital-photography system. This would create a database of identifying photos of all students, faculty and staff that could be used in conjunction with many campus information functions.

The university's facilities and construction department conducts regular project reviews of campus construction projects. In addition, the president and other university executives share the progress of such projects with interested committees, parent and student groups. For the most part, the progress of the construction projects moves at such a pace that 35mm slide shows are quickly outdated. The use of digital photography would enable images to be disseminated on the campus network as a "same day" service.

Document Imaging--*The University of Delaware: A History by John A. Munroe* is a 448 page book that chronicles the history of our institution. As the University owns all rights to this text, there are no copyright issues preventing electronic distribution. The book was scanned twice, once to capture the actual page images, with photos and illustrations, and once for OCR (Optical Character Recognition) input to create a text-only version of the document. The text-only file allows full-text searching against the document and is linked to the page images. Therefore a topic search returns the text and the press of a key display the actual page image.

Academic Applications--While the first pilot projects at Delaware target "administrative" information, the methods and results may easily be transferred to "academic" applications. With ethernet connections in every dormitory room, classroom and public computing site, image delivery targeting students, faculty and researchers have great utility. Investigation of such applications are now underway with the preparation of slide libraries from several academic departments.

Summary

This practical application of technology delivers useful and significant service to members of our electronic campus. Institutional imaging is easy, inexpensive and wide-reaching. The pilot project serves as a model for the management of other non-traditional data types and has begun to lay the foundation for our digital future.

Electronic Paper Flow

Eloy Areu, Barbara Hope, Jeffrey Lemich, Jennifer McDermott, Timothy Munn
University of Maryland
College Park
Maryland

CAUSE 93 Abstract

A year ago, the University of Maryland at College Park began to automate the process for the appointment of faculty and academic staff. A major challenge that arose during system design was how to simulate electronically the flow of paper through the various stages of approval. With several hundred academic units and sub-units on the campus, and varying numbers of review and approval stages, the proposed mechanism would have to handle the most complex of situations.

Realizing that there would be other campus-wide applications requiring a similar flow of documents, it was decided that the routing mechanism developed for academic appointments should be generic enough for use in applications such as purchasing, travel, and payroll. It should also provide information across various platforms.

This presentation describes in detail the routing model developed, illustrating its use in the academic appointment process. It also addresses issues of implementation and maintenance.

ELECTRONIC PAPER FLOW

Every year the University of Maryland at College Park processes approximately four thousand faculty and associate staff level appointments. Each appointment is represented by a form that travels tnrough a complex and exhaustive system for review and approval. As with any paper-based routing system, the academic appointment process encounters numerous delays due to various difficulties with communication, inadequate or incorrect data, unnecessary duplication and the typical problems associated with locating forms in transit. By the spring of 1992, it became evident that a paper-driven system could no longer serve all the appointment activity of a large institution. Thus, the Office of the Vice President for Academic Affairs and Provost charged Academic Data Systems with developing an on-line computer system known as the Academic Resource System (ARS) that would handle all aspects of the appointment process. A team consisting of a project manager from Academic Affairs and a technical manager and two systems analysts from Academic Data Systems began this undertaking.

From the onset, the developers understood that for an electronic appointment system to be successful, it had to incorporate the complexities of the paper system. This paper system included a routing structure that, depending on the department, was either simple or extremely complex. In many cases, forms did not just travel forward; rather they traveled through an intricate network of specific reviewers and approvers. The developers concluded that a successful electronic appointment system could not function without a versatile routing mechanism that could handle the current process yet be flexible enough to deal with anticipated re-engineered processes. Better yet, if a routing mechanism had to be developed, why not make it generic so that it could be applied to similar systems across campus? The result of these efforts is the Routing and Notification System (**RNS**).

The **RNS**, as applied to the Academic Resource System, has now been in use since May of 1993 and has been well received by the user community. Its generic properties make it an ideal system that can be easily applied to virtually any form-routing structure. The purpose of this paper is to discuss the development of the Routing and Notification System and describe the various applications that has made it a versatile and functional system.

How paper flows

To emulate, let alone improve, a form routing process, it is first necessary to examine how paper forms flow. In our case, this meant analyzing how the appointment papers route to the various levels for review and approval.

The University of Maryland at College Park is a large institution comprised of over one hundred and fifteen academic departments reporting to thirteen colleges. Within this structure, some departments are very small; others are very large and contain sub-departments (centers, research laboratories, etc.) that function as separate entities. Each sub-department has its own routing process tailored to its specific needs. For example, the Physics Department has fifteen different sub-departments that process hundreds of academic appointments.

Within a department or sub-department, forms may be passed back and forth between people at various levels. Each person normally has at least one back-up or proxy. Forms do not always travel upward; rather they may be passed backward to different individuals within the department for review or revision. Sometimes forms need to bypass departments or include additional stops. Depending on the application, forms may travel along simple or complex paths. In addition, people in the routing path also need to be informed that a form is ready for processing and may need to attach notes or instructions to the next person receiving the form.

Attributes

The **RNS** was developed to encompass these complexities. The attributes necessary for such a system are the following:

- It must be user friendly and allow the user to perform the same routing activities that were possible with the paper system.
- It must be flexible and easily adaptable to the variations existing within a large institution.
- It must be generic so that it can be applied to any form-routing structure.
- It must provide security by designating who has the authority to view, create, review, approve and/or reject a form.
- It must prevent the forwarding of any logically incomplete forms.
- It must maintain a routing history or path record of each form.
- It must provide notification information that is distributed to all users along the routing path.
- It must be able to inform users via electronic mail that there is a form waiting to be processed.
- It must allow users to send private or permanent notes to the next person along the routing path.

The Routing and Notification System possesses all of these attributes. The generic nature of the system allows it to be adapted to virtually any form-oriented structure. Generality in the **RNS** is achieved by using a table-based routing definition rather than a methodology that involves hard-coding. This technique allows the **RNS** to mimic accurately the complexity of the various academic units.

One important attribute of the **RNS** is that it allows for customization where needed. For example, in the faculty appointment application, a rejection feature available in the **RNS** was customized to attach a rejection reason to the form. An application-specific table of rejection reasons is used in this instance. Similarly, the "logical completion" of a form has one meaning in the context of academic appointments, but can represent something quite different within the context of another system.

Elements of RNS

The **RNS** was developed on an IBM 9021-500 using CA-Ideal as the programming language and CA-Datacom/DB as the database engine. This was done to make the system available to any campus-wide mainframe application. The **RNS** provides a set of tools that are available to any application that follows the standard system architecture developed by Academic Data Systems. This base architecture includes: navigation tools to move between screens, tools to minimize re-entry of key data between screens, security to manage access to the various applications, a text editor and note storage system to handle comments, and a subsystem that provides online help. The elements used in **RNS**, however, could be applied to other hardware and software platforms.

One of the main factors that went into the development of the **RNS** was incorporating levels of authority into the routing process. In a paper system, forms travel from individual to individual for different functional purposes (eg. creation, review, approval). However, in order to create an electronic routing system, this individual-based model had to be re-structured. What emerged was a new model based on the routing of forms from *group* to *group* rather than individual to individual where the group represents the functional structure. This group concept allows the **RNS** manager to place users in appropriate groups, and the system passes control of the form from group to group. Through a combination of user security, group definition, and user attributes, the system determines who can view, create, review, and/or approve forms.

The **RNS** is comprised of a database and a series of online programs and subprograms that are invoked by a specific application. The specific elements of the system include:

1. An On-line Program and Database Table For Defining Units and Groups (See figure 1)

   An **RNS** administrator is required to secure each application of the system and specify the following criteria for each group:

- The type of group being created. Groups may be defined as one of three basic types:

  Creator groups are restricted to creating new forms. They may not access any form they did not create or that was not forwarded to their group. Creators may not route forms to groups outside their department.

  Reviewer groups may review and reject forms within their department. They may also create forms if specified in their group definition. Reviewers may not route forms to groups outside their department.

  Approver groups, in addition to being able to approve or reject forms, may also pass forms to others within their department or another pre-defined office outside their department.

- The route the form may take, including the primary path and alternate forwarding locations. It is possible to use pattern matching and wild card characters to tailor intricate paths.

- An indicator to check if a group may be bypassed. This mechanism is used to skip specified groups along the path if they are not required to participate in the routing process.

- An indicator to check if forms are logically complete before forwarding to the next group.

- A processing level that may be used by the application program to protect or un-protect sensitive fields on the form as it moves through the various levels of the process.

- Notification Control to specify if notification should be sent to a group. This can apply to rejections, final approval, or final implementation.

2. An On-line Program to Assign Specific Users to a Group and Define Users' Attributes (See figure 2)

   The **RNS** administrator specifies the following criteria for each user:

   - Users are placed into a group or groups (as defined in the previous section) depending on their functional role in the department.

   - Individual users can also receive electronic mail notifying them of certain routing events pertaining to their group. For example, on our campus, the majority of our users do not receive email on the administrative mainframe. For each group assigned, a flag can be set to activate an email message notifying them that there is action to be taken on the mainframe.

- For each group, a restriction may be placed to prevent the group from updating or processing a form, yet still allow notification of routing actions and viewing of forms associated with the group.

3. A User/Group Selection Sub-Program

Although the majority of users belong to one group, a user may be a member of multiple groups. The **RNS** provides such a user with an online mechanism to select a specific group within the application.

4. A Transaction Capability Sub-Program

Based on the user's current group definition and the form's path records, only the group that has control of the form is able to process it. This security function is handled by the transaction capability subprogram. If path records do not exist, the processor verifies if the user belongs to a group capable of creating new forms. Any group along the routing path but not in control of the form may view it. For example, an application may allow all members of college groups to view forms created by their departments even before the forms reach the college.

5. A Processing Sub-Program (See figure 3)

This subprogram is called by the application program to allow users to approve, forward, hold, or reject a form. It also maintains path and notification records. In forwarding a form, the subprogram uses information stored in the group table to display a list of possible destinations ranked in logical path order. Below is a list of capabilities provided by this module:

- This module provides the ability to bypass up to nine units in the path definition. If bypassing is requested, the subprogram skips the specified groups and searches the path list for the next group that is not to be bypassed. For example, when handling faculty appointments, those for international applicants are sent to the International Education Services (IES) office before continuing to Academic Affairs. If the faculty appointment processor determines that the appointee is a U.S. citizen, then it directs the subprogram to bypass IES and forward the form to Academic Affairs.

- A component of this module also provides the ability to prevent the forwarding of a logically incomplete form. When groups are defined, the **RNS** administrator can set a flag indicating the level of logical completion. It is then the responsibility of the application program to determine if a form is logically complete at that given point. This information is then passed in the form of a parameter to the sub-program, which compares it with the flag in the group definition table. If the form is incomplete, the sub-program will return an error code which the application program attaches to the form indicating what action must be taken. This feature allows an incomplete form to be passed back and forth between several groups within a unit, yet insures that the form is complete and correct before it leaves the unit.

- This sub-program also gives users the ability to attach private and permanent notes to a form. Private notes are sent to the next group on the routing path and then destroyed when the recipient forwards the form to the next group. A user who rejects a form may attach a permanent note that can be read by anyone who has access to the form.

- When an action is taken, this sub-program also returns a series of parameters to the calling application containing notification information that is to be distributed to the appropriate groups by electronic mail. It is up to the calling program to use a suitable mechanism to initiate the electronic mail transmission. On the IBM MVS platform, SMTP provides this vehicle.

6. A Path Record Sub-Program (See figure 4)

This sub-program displays the path record or history for each form. The path record includes the name of each person who took action, the status (forwarded, approved, held, pending, or unread), and the date action was taken. The path record fosters accountability among users since any user with viewing capability can call up the form and see the path and status at any time.

7. An In-box Sub-Program (See figure 5)

This function allows the application program to alert the user that there are forms that need an action to be taken. An entry is provided that contains the following information for each form: date/time the form reached the user, note status, description, and group name of the sender.

Conclusion

This paper has described the various elements that make the Routing and Notification System a success. Efficiency, accountability and accuracy are all hallmarks of the **RNS**. The versatility and functionality of this "paperless" system has enabled the campus to overcome a number of delaying factors that occur when routing paper forms. Because the forms are electronic, there is no wasteful duplication of paper, forms are not delayed by campus mail, nor can they be misfiled or viewed by an unauthorized user. Most importantly, since electronic forms are easily tracked, they are never "lost" in transit; thus users no longer have to play "phone tag."

Using the **RNS** as a base routing system, the University of Maryland at College Park will have eliminated the manual routing and approval of over 4,000 academic appointment papers via the Academic Resource System. With the same base system we will shortly implement a payroll approval system that will eliminate over 50,000 pieces of paper annually. Likewise, we are also considering applications in the areas of travel approval and reimbursement and financial aid, both paper intensive processes with multilevel approvals.

Despite its obvious success and acceptance by the user community, we must face the fact that a totally mainframe-based routing system is only an interim solution to the routing of forms. Increasingly administrative systems are moving, under appropriate circumstances, to smaller distributed systems. Forms processing is certainly an application that does not require the power of a large mainframe, although limited access might be required for information validation. In addition, users would prefer to access any forms application directly from their desktop rather than the more traditional mainframe logon. Thus we will be looking at porting of **RNS** to a more open distributed systems environment so that we can take advantage of new technology maintaining our investment in a proven activity.

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APPENDIX

```
RNS201P1            UMCP/RNS Routing and Notification System           11/05/93
JKL-LB85                 Group Creation/Definition                     ARSGROUP
==========================================================================
Group ID: System: ARS  Unit: 11A010    Group: __

Group Title   : AGRIC ENGR Chair                       Status: _ (' '=OK C=Old)
Appl Level    : 20   (Used by the application for allowing access to fields)
Bypass Unit   : N    (Y/N Indicates if this Unit may be bypassed based on data)
Capability    : S    (C-Create R=Review S=Submit I-Implement A=Auto Implement)
Create Forms  : Y    (Y/N May this group create a new form)
Complete Req  : Y    (Y/N Form must be complete to goto Approver or next Unit)
Notify Reject : Y    (Y/N Notify group if form is rejected)
Notify Approv : N    (Notify on Approval       - N=No, A=All, F=Final Only)
Notify Implmt : F    (Notify on Implementation - N=No, A=All, F=Final Only)
Terminus      : N    (N-No, A=Last appr > Impl, B-Last appr stop, I=Last Impl)
Next Group    : System: ARS  Unit: 11A       Group: 1?    (Wild cards allowed)
Fwrd Group    : System: ARS  Unit: 11A010    Group: *     (Wild cards allowed)
Link Appl     : APTU      (Application menu item associated with this group)
                          Inserted: 03/29/93 Modified: __ ____ by JKL
==>
F1=Help     F2=Clear     F3=Menu                              F6=Print
F7=Prev Grp F8=Next Grp F9=Cmd Ln  F10=NewGroup               F12=Cancel/Delete
Make changes to the group information.
```

Figure 1. Screen for Defining Groups

```
ARS201P1                  Academic Resource System                      11/05/93
JKL-LB85                Notification Group Management                     GRPMGR
==========================================================================
User ID: JKL Lemich, Jeffrey Keith (ADSJKL)
Email->JLEMICH@ADS1.UMD.EDU
                                              -----BLOCK-----
 Unit    SubGrp Translation                  Rcv Rej App Imp Level   Mod Dt   Usr
11C      ____   COLL ARHU Dean                N   N   N   N   50    05/12/93 JKL
11K020   1001   CHEM&BIOCH Creator            Y   Y   Y   Y   50    09/13/93 JKL
________ ____
________ ____
________ ____
________ ____
________ ____
________ ____
________ ____
________ ____
________ ____

==>
F1=Help       F2=Clear      F3=Menu                              F6 =Print
                            F9=Cmd Ln                            F12=Delete/Cance
The last group record is displayed.
```

Figure 2. Screen For Assigning Specific Users to Groups

```
RNS905P1              UMCP/RNS Routing and Notification System              10/28/93
JM7-0003                            Process Form
=====================================================================================
                              1994-Kanobi, Ben Obi Wan
Forwarding Choice # ____
There is a note attached.
#### --- Possible Destinations ---------------------------------------------------
    1  Approve and Submit to COLL LFSC Financial Officer
    2  Forward to CHEM&BIOCH Chair (Alternate)
    3  Forward to CHEM&BIOCH Reviewer
    4  Forward to CHEM&BIOCH Creator
    5  Forward to CHEM&BIOCH Creator (Alternate)
    6  Forward to CHEM&BIOCH Chair Reviewer




F1-Help  F2=Hold  F3=Return      F4=Read Note     F5=Send Note     F6-Print
F7=Prev  F8=Next  F9=Show Path  F10=Top          F11=Bottom       F12=Reject Form
Place cursor under selection and press ENTER.
```

Figure 3. Screen Of Possible Forwarding Destinations

```
RNS907P1              UMCP/RNS Routing and Notification System              10/28/93
JM7-0080                             Path List
=====================================================================================
                                                    Press F8 for more codes...
                              1993-Adams, Abigail
    1  HUMAN DEV Creator 1                          Forwarded 05/19/93 05/20/93
       McDermott, Jennifer Anne
    2  HUMAN DEV Bus. Mgr.                          Forwarded 05/20/93 05/20/93
       Mattingly, Maribeth
    3  HUMAN DEVEL Chair                            Approved  05/20/93 05/20/93
       Hope, Barbara B.
    4  COL EDUC Reviewer 1                          Forwarded 05/20/93 05/21/93
       Areu, Eloy
    5  COLL EDUC Dean                               Approved  05/21/93 05/21/93
       Lemich, Jeffrey K.
    6  ACAD AFFAIRS Approver                        Approved  05/21/93 05/24/93
       Andrews, Sylvia B.
    7  HRS Personnel Office                         Implement 05/24/93 05/24/93

F1=Help                          F3=Return                              F6=Print
F7-Prev          F8=Next                         F10=Top       F11 Bottom
Use a function key to scroll through the data.
```

Figure 4. Path Record Or History For Each Form

```
ARS26.F.                   Academic Resource System                        10/28/93
JM7 00.                 Notification of Appt. Activity                     ARSNOTE
<<<<  ---------------------------------------------------------------------- >>>>
Group: CHEM&BIOCH Chair

  Date       Time    Status   Description                          Note From
  ----       ----    ------   -----------                          ---------
10/26/93 10:03 AM New    Process - (G1) Kanobi, Ben Ob Yes CHEM&BIOCH Revie
10/26/93 08:25 AM New    ARS-Rejected Appt-Skywalker,  Yes COLL LFSC Financ
10/01/93 10:   AM Read   Process - Solo, Han               CHEM&BIOCH Revie
10/01/93 10:   AM New    Process - Darin, Robert            CHEM&BIOCH Revie


F1 Help        F2-Clear       F3=Menu    F4.<<<Groups F5.>>>Review  F6-Print
F7-Scroll Up   F8=Scroll Down            F10=Detail                 F12-Delete
Use the cursor key to select and F5 to review a note.
```

Figure 5. Notification of Appointment Activity

CAUSE '93
Networked Delivery of Multimedia Information

Robert Brentrup
DCIS Project Director
Dartmouth College Computing Services
6028 Kiewit Computation Center
Hanover, NH 03755-3523

Abstract

Multimedia information sources present exciting possibilities for increasingly sophisticated and evocative presentations of material in many fields of education. Widespread use of this technology has implications for the campus computing infrastructure, local network capabilities and the services provided by libraries. Dartmouth College is expanding its campus-wide information system beyond textual resources and is researching how best to provide broad-based access to and support for multimedia for a large community of users in a cost-effective manner.

This paper discusses current plans to incorporate image, audio and video media into a networked information system, outlines the technical and organizational issues that have been identified and describes work in progress toward this goal.

Networked Delivery of Multimedia Information

Networked Multimedia Benefits

For faculty and students, multimedia resources can add new dimensions to the learning experience. Most concepts are easier to present and comprehend when words are complemented with images and animations. Learners retain more when a variety of senses are engaged in delivering information. The "intensity" of the experience aids retention and recall by engaging social and emotional as well as intellectual responses.

Unlike paper books, networked electronic media can allow many people simultaneous access to the same materials. These resources are available all the time, from office or home. More sources can be consulted and relevant information can be obtained immediately. More time can be spent on content, not locating information.

Most topical special collections include material in a variety of forms such as drawings and photographs. This information has not been as readily available in computerized form since the technology has not yet been appropriate. Recent advances in workstations, networks and storage technologies are providing a new opportunity to create an even more sophisticated information system, one that will contribute to the widespread use of multimedia applications in the community.

These are the most important benefits we hope to realize in adding multimedia to the Dartmouth College Information System (DCIS).

Selecting a Multimedia Delivery Technology

Multimedia information can currently be delivered via broadcasting, analog cable TV, laser disks, digital networks or CD-ROM disks. For some data sources or uses, particularly long video programs, existing digital networks are not yet an adequate delivery method. However, technical, economic and political developments are all pointing in the direction of digital networks which will eventually integrate the capabilities of alternative delivery mechanisms.

Technically there is much interest and activity around the merging of television and computing devices for several reasons. On the end-user's desktop it is certainly preferable from the standpoints of cost, maintenance and complexity to integrate information delivery on a single screen and network connection versus having both analog and digital screens and networks provided in each delivery location. Once these capabilities are combined by common data formats and displays, many interesting applications become possible.

The need to equip each workstation with the proper players for CD-ROMs or laser disks as well as handling the disks when a large number of people are involved, makes these approaches relatively unattractive at present and into the near future. Analog television's current absence of uplink capability and the need for analog to digital conversion at each workstation makes this approach similarly unattractive relative to a digital network.

Cable television and telephone companies are plunging into the digital network business with huge deals, mergers and projects to capture part of the fast growth of networked information sources and delivery to homes and businesses. The attraction of an exponentially growing market is irresistible compared to their relatively mature and slowly growing primary businesses. This activity will certainly push forward equipment capabilities and hopefully reduce equipment costs. There is concern about what it will do to the cost of network access.

These factors and trends combined with the existing universal digital network on the Dartmouth College campus are focusing our development efforts around digital networking for the delivery of multimedia.

Organizational and Infrastructure Issues

Many organizational and infrastructure issues need to be addressed when deploying a campus wide information system. Adding the technical goal of delivering multimedia information over the campus network adds some new issues and additionally impacts some existing ones. The areas listed here seem to be the most important factors influencing what DCIS can reasonably do with multimedia in the near term. Of course, there is also a financial component to all of these problems as well.

- Acquisition and Preparation of Material
- Copyrights
- Access Control and Billing
- Data Storage
- Network Requirements
- Desktop Workstation Features, Performance and Availability

Acquisition and Preparation of Material

A few years ago, few materials were even available in electronic form. Often a work was added to the library's collection because it was the only one of that type available in an electronic form. As computers have become more prevalent in the publishing industry, many new works have become available by virtue of having been manipulated electronically in production. Now there are more sources of materials that are unfortunately in many formats, with occasionally erratic quality. The accuracy and edition identity of an electronic work is crucial for serious scholarship. Some standardization of formats would be a big improvement.

The labor involved in digitizing (by keyboarding or scanning) and organizing a collection is substantial. The DCIS project is identifying and at times developing small tools to automate tedious operations as we proceed. We try to use personal computers where possible to simplify transferring these tasks into the originating department.

Copyrights

The ownership of material is currently a primary concern in selecting projects for development. The pilot projects DCIS has undertaken have been selected in part because their source materials had clearly defined ownership and negotiable permissions.

The requirements of complying with copyrights are at times murky, particularly in deciding what is a "fair use" of certain materials already purchased in a paper format. The simultaneous-usage aspect of electronic media has many publishers struggling with how to control and retain fair value for their property. An electronic copy lacks printing costs and has lower distribution and transportation costs. Should an electronic copy cost more, the same or less than a paper one? Some publishers have been unwilling to discuss the possibilities. Others have been more creative in working out mutually beneficial experimental arrangements. These questions need to be addressed by working with publishers to help them develop new ways to derive fair return on their investment and ultimately by additions to copyright law.

A number of software refinements are being considered to help implement "fair use" policies. The possibilities include limitations on single-search data retrieval and limits on per-session data printing and electronic copying.

Access Control and Billing

At present the licensed data sources Dartmouth has made available have been site licensed for the entire campus. This is quite satisfactory for certain widely appealing resources. DCIS has developed a flexible and effective distributed access-control system. It is possible to limit access to either the entire campus or a subgroup. This has made it possible to adequately and efficiently control site licenses and to develop collaborative licensing arrangements with other organizations. The next iteration of the system will provide limits on the number of simultaneous users of a particular database to provide more flexibility in negotiating licences. The next step beyond that would be to incorporate a billing system into the access-control process to allow per-use types of pricing arrangements.

Data Storage

The demands on digital storage capacity depend largely on the type of data and how it is indexed. The following example should help provide a frame of reference. A typical typewritten page of text consumes 5,000 bytes of storage. A significant work such as the full text of Shakespeare's plays fits in 5 million bytes. The text databases already online at the Dartmouth library range in size from a few million bytes to almost 1 billion bytes. The indexing overhead for text is typically 100 percent; for example, the 500 million byte *Oxford English Dictionary* requires an additional 500 million byte index. Dartmouth's current text collection fills approximately 30 billion bytes.

In contrast to text, the storage requirements for images can grow several orders of magnitude more quickly. For example, an uncompressed 1,000 by 1,000 pixel monochrome image (roughly the size of a 2 page monitor) requires around 100,000 bytes of storage. To represent 256 colors in this same image, the storage requirement increases to 1 million bytes. The same size image with 16 million colors requires 3 million bytes. The raster image of a laser printer page at 300 dots per inch requires about 7 million bytes uncompressed. Fortunately there are a variety of compression techniques or higher-level descriptions of printer pages to reduce these requirements.

Digital video pushes the storage requirements even further. For example, 30 frames (one second) of video digitized at 300 by 300 pixels stored with 256 colors would fill a 20 million byte hard disk (the average personal computer hard disk of a few years ago).

The data storage requirements to provide networked multimedia are substantial. Cost-effective solutions will eventually need to incorporate a hierarchy of storage devices. Early system efforts will likely require some management of storage by the network media servers themselves. Eventually some of the required functionality will move into operating systems as the needs become more widely applicable.

Network Bandwidth

The demands on network bandwidth depend on the type of data, the network protocols used to move it, the rate at which it needs to arrive and the amount of traffic on the network. Measurements indicate that practical bandwidth can at times be reduced to one-tenth of the theoretical maximum when protocol overhead (such as addressing and error correction information) is included. The load variability is a large practical problem for data that must be synchronized (audio or video). The multimedia system software must provide methods for gracefully degrading performance on networks where bandwidth cannot be preallocated in order to cope with this problem.

Text or still-image data do not have real-time delivery constraints like video. When delivering text or still-image data, getting it to the user in an acceptable time frame is the constraint. Simple analysis estimates and practical experience confirms that fast modems (at 14.4 Kbits/sec) or local area networks like LocalTalk (at 230 Kbits/sec) are capable of transferring text and medium-sized images (e.g. 50 KBytes) in tens of seconds. Ethernet speeds (10 Mbits/sec) combined with current compression techniques are needed to transfer larger color images and low frame-rate video. To deliver high-resolution video will require networks capable of at least 100 Mbits/sec.

Networks need to employ compression technology at current bandwidths, and compression requires more workstation processing power. It is likely that the data demands will always stay ahead of the economically available bandwidth so compression will continue to be important. Additional network capacity is a key constraint in the widespread deployment of multimedia applications.

Workstations

The capabilities of a user's workstation historically have constrained what was possible to deliver in an information system. Early terminals and personal computers dealt only with text. A second generation of personal computers opened the richer worlds of graphics and typography. A new generation of machines is now making audio and video manipulation readily available.

The development of DCIS has followed this progression of workstation capability: initially text, and then typography and graphics, with the addition of audio and video now being considered.

There is a balance to strike with regard to workstation capabilities. Some basic requirements can't be gotten around. Each person needs a reasonably sized screen and local memory, adequate processing power and network access. However, all these resources can be stretched by implementation tradeoffs in the client/server division of labor and the amount of labor invested in software performance. The balance point is always changing as equipment capabilities increase, although workstation upgrades must compete with many other budget priorities.

Development Objectives

After studying possible applications Dartmouth has developed the following list of objectives to outline our plan to introduce multimedia into DCIS.

- To develop, or integrate when possible, a suite of applications that enable individuals to make use of these media for research and instruction.
- To implement a server architecture that allows applications to locate, retrieve, and manipulate media resources.
- To develop media resources and to make them available for such a server architecture.
- To develop an environment that will allow users to be both readers and creators of media sets.
- To study aids to retrieving, locating, and describing images and video clips.
- To develop the necessary maintenance tools and procedures.

Recent DCIS System Developments

The requirements of two new library services, an image catalog and electronic document delivery, have been used to focus the development of the basic software components required to support multimedia. The DCIS project's initial goal was to produce a image database that contained searchable textual descriptions of the image. In addition to the existing software, we needed image format readers, decompression modules, bitmap transforms, a suitable database manager, network protocol extensions and a client application to retrieve and display images

None of the database management systems DCIS is using inherently supported binary data fields. Extensions to our servers, which front-end these database systems, added the ability to link to external files of binary data. The server can either open this external file and pass the data through as a binary field, or deliver a reference to it which can be passed to another program. The network protocol was enhanced to allow data transfer to be segmented.

We modified an existing client application used to search text databases to handle image fields as well. This text client can also locate, start-up and communicate with other client applications built specifically to manipulate other media types.

A universal document identifier (UDI) protocol has been implemented based on design proposals being considered for the Internet. A UDI permits references to other media types to be stored in a text database. The text client application is able to retrieve these references from the text database and pass them on to another viewer program that will retrieve and display a particular type of multimedia object.

We have developed an image viewer application that can retrieve and display color and gray-scale images in TIFF, GIF, PICT, and JPEG formats. This application has an interface allowing it to open and display disk files of scanned documents distributed via electronic mail as well.

Multimedia enhancements have been added to several of the existing servers. Several applications have been prototyped including a Dartmouth College Photo Records catalog, an electronically published magazine which includes illustrations, and an electronic document-delivery service. The components produced are generalized enough to be applicable to several other related areas by supplying different data. For example, the same software can display satellite photographs and weather map images stored in a Wide Area Information Server (WAIS). The document collection of the WAIS source is searched using the text client application, which in turn passes on image references for retrieval and display by the image viewer application.

Experiences and Observations

The DCIS development effort has followed a phased implementation approach linking other media to the text database facilities developed earlier. The following discussion summarizes our experiences and some observations.

End-User Equipment

The balancing act between system functions and hardware requirements is a difficult one. Currently at Dartmouth most faculty and staff have a Macintosh. One hundred percent of the students have a personal computer, most of those are Macintoshes. The capabilities of the installed base is, however, relatively modest. The incoming class of students is always the best equipped. The current freshman class has workstations capable of handling the image capabilities we have developed, earlier classes mostly do not. The faculty and staff have difficulties keeping up with the pace. The DCIS team remains concerned about frustrating the end-users by requiring more computer power than they have available. The realization that computing equipment has a relatively short life span is slowly working its way through the community.

Networking is much the same problem; most buildings have LocalTalk networks. Certain locations and new buildings have at least Ethernet networks. A campus-wide network upgrade is planned, although funding has been hard to obtain.

Data Preparation and Maintenance

Multimedia data is mostly captured from other sources, such as scanners and video digitizers. Creating digital multimedia requires special equipment, higher performance workstations and relatively sophisticated computer skills. End users have typically required assistance and funding to get started digitizing and manipulating their source materials.

Construction and maintenance of the databases in the DCIS system are complicated by their delivery from UNIX workstations. The performance of these systems are necessary, although their user interfaces discourage less-sophisticated users. We have converted a number of the maintenance tools to run on the Macintosh, which has greatly simplified setting up the databases and preparing updates. The completed files are then transferred to the server workstations for indexing.

A complex set of tradeoffs surrounds image quality. In principle there is a need to store the originals in relatively high fidelity, perhaps to preserve them but also to facilitate the quality of their reproduction when employed in other work. The time and labor to handle and scan a large collection is a large cost which would be nice to avoid repeating. In contrast, it is desirable to conserve server storage and to produce fast delivery on finite bandwidth. An image scanned beyond screen resolution wastes both these resources for the majority of uses.

One desirable image-format feature in view of this dilemma would be the ability to deliver a base image rapidly, to which subsequent detail can optionally be added. Another possible approach is to generate image derivatives (e.g. a scaled-down size) on the server in response to certain queries.

Database Design

It has proved convenient for maintenance sake to store media objects in individual disk files. These can be manipulated easily with standard tools. Using standard naming conventions helps the maintainer manipulate them in groups. The separate text catalogs can likewise be easily edited.

Some of the image formats provide the capability to include textual descriptions of themselves, although this has not yet been widely exploited. This may allow catalog databases to be produced mechanically from a directory of annotated images.

It is difficult to describe all the different aspects users may be interested in when browsing an image database. Developing methods of viewing samples of many images quickly is an important feature to bridge this gap. Pre-computing certain locational aids, such as miniatures, may be a cost-effective approach. A thesaurus of terms seems to be an important aid in locating images while minimizing the amount of subject indexing. A fairly specific classification combined with a hierarchy of terms can allow an image to be selected for a variety of reasons.

A number of interesting computer programs attempt to analyze and describe the contents of images and to locate scene changes in video. These may develop into both cataloging and retrieval aids.

Building multimedia databases has an enormous up-front digitizing cost. It will be important to make it easy to incrementally add to collections. It may be necessary to set up some collections so an image is scanned and entered when it is retrieved for use the first time. The steps to do this will have to be simple to fit into the work flow.

Image Formats

The variety of image formats is a difficulty. There always seems to be one more you don't have that someone wants to use. At present DCIS has accommodated the most popular formats on the Macintosh. Developing efficient "readers" for these formats is a considerable amount of work because of the variety of coding and compression techniques. For example, different formats provide color maps, provide progressive detail buildup, are revisable in place, are byte order-independent or provide high compression ratios. Some of these features are handy for certain applications and some are incompatible with high compression.

Server Design

As mentioned in the discussion of workstation capabilities, the division of labor between the client and server and the design of the server's features can be used to moderate performance requirements of the workstation. Some additional server capabilities DCIS intends to develop will include result caching, format transformations, scaling transformations and compression transformations.

The network servers could be enhanced with the addition of several logical network services. Since the servers are distributed, static links in the databases and the resulting dependency chain are best avoided. Binding component names at server or session start up through a name-resolution service is much more flexible.

Client Design

Objected-oriented programming techniques have greatly simplified incremental development and code reuse. Access to source code is, however, essential and far too much effort is still expended in reimplementing similar functions and ideas.

It seems that every data provider also wants to be a user interface designer. This is a significant problem, since developing a complete, tested client application is more effort than anything else we do. The extreme of a different user interface to every database would not serve end-users well. The present system does allow the result displays to be customized by delivering a description language from the server to the client. This has proved adequate for a large class of information resources. The exceptions continue to inspire new ideas.

Future Directions

In using the computer to present data, the designer needs to apply all of the bookmaker's and graphic designer's techniques. Screen layouts should please the eye and guide the reader to the most important information, as does a well designed page. The subtleties of fonts and colors need to be used to encourage the reader and draw attention to important information. The object is to deliver the maximum amount of information in the minimum time. It is crucial that multimedia be well crafted since there is an even larger potential to create confusion when compared to paper materials. There is a basic dilemma in having the power to manipulate all these factors and the amount of time and effort one must invest in doing it properly. The ability to add to an already well-crafted framework is a significant need in creating high-quality work more quickly.

Easy access to vast amounts of electronic information causes some problems as well. Users will need help to make sense of and find their way around large collections. Large topical databases may be accompanied by "Guided Tours." A guided tour would be laid out by an expert in the field, highlighting the most important information and providing a main thread for new users to follow or return to while browsing a collection. The underlying information system provides the raw data behind the tour.

Humans are good at visually spotting an anomaly or patterns in data. Reducing large data sets into visualizations can be a powerful research tool. The user should also be able to gain access to the raw data in order to verify conclusions or pursue other questions or analyses. To generate new relationships while studying a data collection with searches, computational reductions and visualization graphics seems to be a desirable additional capability.

Conclusions

DCIS has deployed an information system on the large scale of the entire institution. Over 60 local databases and hundreds of external sources of information are reachable by the system. Five central computers running about a dozen different servers currently provide information services for more than 700 daily users. Portions of the DCIS system have also been installed at a number of other institutions. Well into the third year of production use, we are trying to cope with substantial growth in usage and demand for more information resources. Enhancing the system further with multimedia resources is consistent with many requests received.

DCIS is trying to introduce multimedia to the campus-wide information system in small steps in order to stay in touch with its audience. Up-front considerations of the existing installed base of equipment and stressing efficiency in the software to make best use of the available equipment has kept this fundamental problem in check. Fortunately the evolution in workstations and networks is moving in the right direction to make these new applications attainable. Delivering new applications that aren't too far beyond current practice can concretely demonstrate the benefits of further investment in infrastructure improvements.

Although better networks are certainly very desirable, Dartmouth's existing computing environment provides a unique laboratory for exploring the frontiers of distributed, network-based computing and for applying the benefits of technology to academic and other pursuits. Networked multimedia resources have great potential for having a significant impact on how people learn and work.

Lessons from the Berkeley Museum Informatics Project

Barbara H. Morgan
Director, Advanced Technology Planning
University of California at Berkeley
Berkeley, California

December 8, 1993
barbm@garnet.berkeley.edu

The Museum Informatics Project at the University of California in Berkeley is a collaborative effort to coordinate the application of information technology in the more than 80 museum and other organized, non-book collections on the campus. Faculty, collection managers, curators, librarians and information technology specialists work together to develop data models, system architectures, demonstration systems and network-accessible production databases of text records, images, sound, video and film. This presentation examines some of the early successes and difficult problems of the project and its predecessor activities, to show how the necessary political, administrative, financial and technical support for the project was created within the institution.

INTRODUCTION

Why is the Berkeley Museum Informatics Project of interest?

New alliances are needed so that we can share scarce resources internally on our campuses and leverage external resources. The Berkeley Museum Informatics Project is an example of a new alliance on our campus, and there may be lessons from the successes and problems of this collaborative project and its predecessor activities that apply to other cross-organizational and cross-disciplinary efforts. This examination will show how the necessary political, administrative, financial and technical support for this project was created within the institution, and what kind of leadership was needed to initiate a change effort of this magnitude.

Audiences

Audiences who might be interested in this topic, in addition to individuals embarked on similar efforts at other institutions, include university and college administrators who are responsible for many disparate units and who see promise in information technology for better management of their operations. In particular, people contemplating large-scale ventures to implement imaging systems for paper documents might find useful parallels with this Museum Informatics Project. The project may also be of interest to information technology professionals who are concerned about the problems of moving from fancy multimedia prototypes to large-scale production systems.

University of California at Berkeley

The University of California at Berkeley is part of the nine-campus University of California system, a public institution. We have 31,000 students (22,000 undergraduates and 9,000 graduate students) from 100 countries. Three hundred degree programs are offered in 14 colleges and schools. We have a law school and a business school; we have no medical school. There are probably about 17,000 computers on campus; about 12,500 are connected to the campus network.

MUSEUM INFORMATICS PROJECT

Summary

The Museum Informatics Project (MIP) is a collaborative effort to coordinate the application of information technology in the museum and other organized, non-book collections on the campus. The Berkeley campus has more than 80 collections, with 30 million artifacts, housed in 65 organizational units in all major academic disciplines.

A few examples of the many kinds of materials in these collections include costumes, bugs, forest products, kinetic art, Egyptian mummies, plant specimens, soil samples, fossils, maps, architectural drawings, temple rubbings and musical instruments.

The project was formally created in January 1992. The founding members were:

Jepson and University Herbaria
Museum of Paleontology
Museum of Vertebrate Zoology
Phoebe Apperson Hearst Museum of Anthropology
University Art Museum
Architecture Slide Library
History of Art Visual Resources Collection
Information Systems & Technology

MIP's goal is to broaden access to fundamental academic resources by scholars, students and the public. Participants in the project include faculty, collection managers, curators, librarians and information technology specialists.

MIP has collaborative relationships with other University of California campuses, especially those at Davis and Riverside, and with the University of California Office of the President. Berkeley participants are also collaborating with people working on similar activities at Harvard, Cornell, MIT, USC, the University of Washington and the Australian National Botanical Gardens, among others.

Activities and architecture

The Museum Informatics Project has these major activities:

+ Produce a campus strategic plan for museum informatics;
+ Develop guidelines for information systems in museums and other collections;
+ Maintain an information clearinghouse;
+ Operate a demonstration and development facility;
+ Evaluate, select and implement information tools for scholars and curators;
+ Develop data models, system architectures, demonstration systems;
+ Develop network-accessible production databases of text records, images, sounds, video and film;
+ Assist museums migrating from legacy systems;

+ Obtain extramural funding for campus museum informatics efforts;

+ Provide a forum for serious discussion of intellectual property issues and other matters related to scholarly databases;

+ Produce a comprehensive catalog of campus collections.

The project has a strategic architecture (shown in the diagram at the end of this paper). The network is the key element. The campus high-speed network connects every collection and every user, and the Internet connects the collections to other scholarly institutions, public agencies, private non-profit organizations and the general public.

Collections are grouped intellectually in terms of their relationship to biological diversity, cultural diversity, and physical diversity.

Client-server architecture and distributed systems imply that each function is carried out where it can be done best and is most needed. Each resource is managed by the parties most immediately responsible, but access, including use of shared services and systems, can be granted from any location.

Strategic support is provided by the Academic Senate, the campus administration, the central computing organization, and the Library. "Cooperative autonomy" is enhanced by planning and guidance from advisory committees and functional working groups.

Management and funding

Administratively, the Museum Informatics Project is a department of Information Systems & Technology (IST), the central computing organization. It is directed by a faculty member, Professor Thomas Duncan, who also has an appointment in the Department of Integrative Biology.

The project has a Scholarly Uses Advisory Committee (composed primarily of faculty interested in research and instructional uses of the data in various collections), and a Collections Management Advisory Committee (primarily for curators and collection managers).

Functional Working Groups have also been created in 11 different areas, to work on technical, operational and policy issues. Examples include:

Imaging and electronic multimedia
Geographic information systems
Shared authority and reference files
Intellectual property rights

The Museum Informatics Project core staff (six FTE), and its Development and Demonstration Lab, receive State funding as a unit of Information Systems & Technology. Staff from other units of IST who are participating in the project, as well as staff and faculty from the departments housing the collections, are also paid by various campus funding sources. The National Science Foundation is providing substantial support for one of the MIP projects; the U.S. Department of Education has also provided some funding. Several grant proposals to State and Federal agencies are pending. Many hardware and software companies have supported the project; additional corporate support is being pursued. The Museum Informatics Project has been one of many campus groups involved in planning for a major new fundraising campaign for Berkeley.

HISTORY AND LESSONS

At this point in discussing the Berkeley activities I would normally describe some of our current projects, show some examples of materials from our electronic collections, and comment on our successes and difficulties, with suggestions about pitfalls that other groups might avoid. However, for this CAUSE Conference, I have been thinking about how this ambitious effort came about and what lessons there might be for similar efforts at other universities.

Preliminary work actually began in 1987, almost five years before the Museum Informatics Project was formally announced to the campus. Staff members working with three collections, the Architecture Slide Library (Maryly Snow), the Geography Map Library (Daniel Holmes) and the University Art Museum (Howard Besser), came to the chief campus computing officer (Raymond Neff) for help in creating "image databases" of their materials. Dr. Neff agreed to fund a collaborative pilot project, but only if the images were digital and the collections could be accessible on the campus network. A group I direct, called Advanced Technology Planning, was formed in 1988 and became responsible for image-database software development activities.

I am not going to recount the interesting events that have happened in the last six years. Instead, I want to talk about factors that came together to make it possible for the campus to create this large-scale, cross-disciplinary, cross-organizational, multi-year effort to provide access to the resources in our museum and other organized object collections.

It seems to me that at least eight elements of support had to be present to create the conditions for the Museum Informatics Project. This complexity turned out to be a strength; different entities were active at different times so that, when support weakened in one area, it increased in another. This project and its predecessor activities show the synergy that can come about from administrative commitment, government support, commercial support and individuals who believe in what they are doing and are willing to work very hard.

Sustained high-level administrative interest

The single most important factor supporting the Museum Informatics Project has been the personal interest and consistent support by our Provost for Research, Joseph Cerny. Information Systems & Technology has been reporting to Dr. Cerny since 1990, but his interest pre-dates that arrangement. He has made additional resources available to other campus units besides IST, most notably the Hearst Museum of Anthropology, and he has been a strong advocate of museum informatics since before we knew what to call it.

The central computing organization has made this cluster of activities a priority for more than six years, through four different information technology management arrangements (three different heads of computing, plus a faculty committee). Our current Vice Provost for Information Systems & Technology, John McCredie, is a strong supporter of the Museum Informatics Project, and it reports directly to him.

The right technology

We needed enough network connectivity and bandwidth to make both the earlier image database and the current museum informatics activities possible. We needed software portability (provided primarily by Unix, by the X Window System and by SQL database software). The cost of equipment has been coming down dramatically, of course (especially digitizers, workstations, and storage devices). We are now seeing interesting new developments in cost-effective CD-ROM tools that are likely to make it possible to do both network-accessible databases and subsets on CD-ROM for special purposes or special audiences.

Another aspect of "right technology" has been important: there is now enough technology in place on our campus, as a normal part of everyone's daily work, so that it is easier for people to think of computers as being helpful, to imagine sharing ideas and data, and to believe that disparate groups might have similar "information" problems.

Image databases are attractive applications, and the prototype databases we developed have had broad appeal: many people who don't think much of computers or networking can imagine the possibilities.

Good programmers

We had an excellent programming team working on the original prototypes, with a particularly brilliant and productive team leader (Steve Jacobson, now with Franz Inc.). We have been able to continue a strong programming team (currently led by Randy Ballew) through several personnel changes.

In addition to prototypes, the Advanced Technology Planning group has been designing and implementing production databases for some of the collections. We are in a slow process of turning those databases over to programmers working for the Museum Informatics Project and to programmers paid by grant or departmental funds to work with particular collections.

Faculty leadership

In spite of successful prototypes, the Museum Informatics Project would not have become a major campus activity without the leadership of a dedicated faculty member (Thomas Duncan), who was willing to make enormous personal and professional commitments to the project.

We had difficulties in the early years of the image database work because we did not have faculty "champions" for most of the prototype projects. Our small teams of curatorial staff and computer center programmers were sometimes in awkward positions relative to the priorities in academic departments, with problems obtaining resources from deans and provosts, or from external funding agencies.

Professor Duncan has been much more effective than staff had been in persuading other faculty to participate in strategic planning, grant writing and data modeling activities. Increasing faculty involvement continues to be a high priority for the Museum Informatics Project.

Vendor interest

We have had support from many hardware and software companies since the earliest days of the image database project. Support has meant much more than just encouragement: we have received donations and loans of hardware and software, been sponsored at conferences, and had frequent opportunities to talk with corporate software development people.

Early supporters were Image Understanding Systems, Ingres, Sun Microsystems, Apple Computer and IBM. Modest support was also received for the image database work from Digital Equipment, MIPS, NeXT, Oracle and Pacific Bell. At one point Carlyle Systems licensed the Berkeley image query software, under an agreement involving the Museum of Anthropology collection; although that arrangement did not work out, the experience was instructive for all concerned.

Sun Microsystems has been our most consistent supporter. A large donation to the fledgling Museum Informatics Project in early 1992 helped put equipment into eight different departments on campus. This donation proved to the potential MIP campus participants that collaborating can have tangible results, and the timing was helpful in obtaining National Science Foundation support for one of the MIP projects.

Discussions are currently underway between MIP participants and several companies, mostly notably Apple Computer, Eastman Kodak and Silicon Graphics.

Government support

The National Science Foundation (Biological Research Resources Division) has provided substantial, multi-year funding to the Specimen Management System for California Herbaria (SMASCH). We believe that the campus commitments to the Museum Informatics Project and to collaboration with the national (and international) botanical community were major factors in NSF's decision to make this award.

The U.S. Department of Education (College Library Technology and Cooperation Grants Program) was our first Federal supporter, with funding in 1991 for a 40-gigabyte image server for the Architecture Slide Library collection.

Proposals have been submitted recently by Museum Project participants to the National Endowment for the Humanities, the National Endowment for the Arts, the National Science Foundation and the California State Library. The next two years should see a substantial increase in grant-writing activities.

People who own the data are willing to work together

The original request for computer center help in 1987 came from campus individuals who cared about the data in their collections and who were willing to work together to try to create something mutually beneficial. The belief that campus groups need to come together to try and leverage scarce resources has been especially strong among staff curators and librarians for special collections. Recently we have seen increasing acceptance from both faculty and staff of the idea that collections in different disciplines may have common information management prob'ems and opportunities. In addition, many interesting new relationships have been established among groups and individuals who had never worked together in the past.

In 1989, 25 individuals from 12 campus organizations participated in an evaluation of collection management software. Eight organizations founded the Museum Informatics Project; 18 were represented at the first formal meeting in the winter of 1992. There was an excellent response to MIP's call for expressions of interest in early 1992. Thirty-six campus groups responded within two months, and almost 80 collections are represented in the extensive survey of the campus collections that MIP has been working on for the past year. Many individuals are participating in the Functional Working Groups, which began meeting in the fall of 1993.

Many of the collections participating in the Museum Informatics Project are part of the campus Library organization. Library management has been supportive of the image database and museum software evaluation activities since 1988. In 1992, representatives from the MIP core staff, the Advanced Technology Planning group, and the Library began meeting monthly to talk about supporting "scholarly databases" and to make sure that each group's activities are coordinated and difficult development work is not duplicated.

Visibility

Berkeley people (both information technology professionals and the people with the data) have been willing to make presentations, demonstrate software, help other groups with demos, and write about the work we are doing. Most of us always say yes to opportunities to present in academic settings, and we will present in other settings if there is a potential benefit to the campus.

Descriptions of the Berkeley activities by software and hardware companies which publicized our work have also been helpful.

Visibility helped legitimize the Museum Project on campus, and it also brought us external collaborators: people engaged in similar activities and those who are interested in sharing data as well as design ideas.

OPPORTUNITIES FOR THE FUTURE

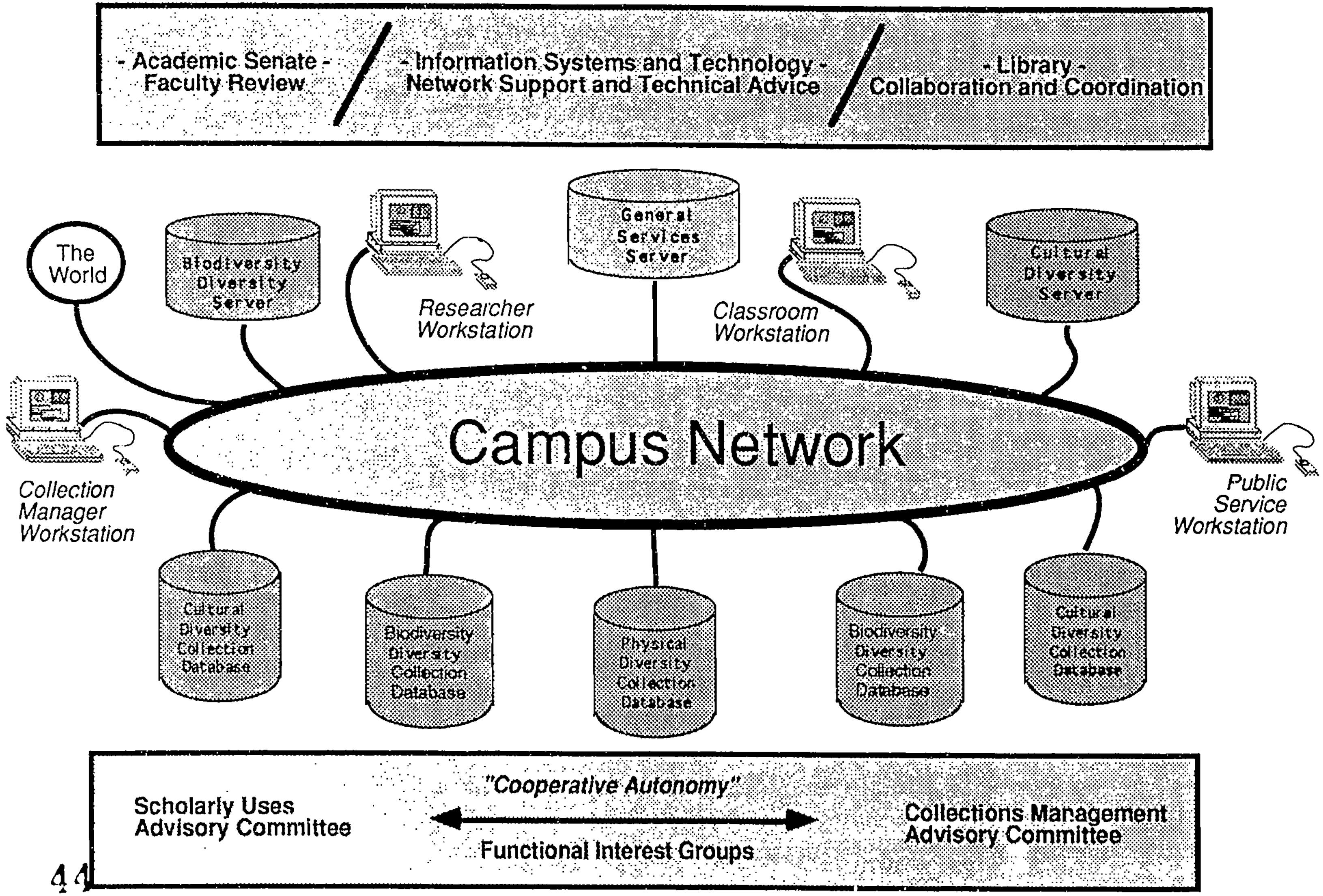
Now that the Museum Informatics Project is underway, where are we going?

We are assuming that fast, high-capacity, easy-to-use computing technology will become available all over the world in the next decade. Technology will become affordable for most institutions and scholars, as well as for others who wish to access data from museums and other collections.

By providing access to the data, images and sounds contained in our collections, we make the collections themselves more valuable, we get to use them more intensively, and we can also do a better job of conserving the artifacts and specimens.

We can "liberate centuries of captive information," in the words of one of our participants: we finally have an opportunity to access information that traditionally has been ignored and inaccessible to many scholars, teachers and students.

We can unlock the wealth of our collections. Most collections are underutilized. Many cannot be used for multiple kinds of study because of the extreme cost of finding pertinent materials. Museum informatics technology provides the way to exploit our campus intellectual resources more thoroughly.



Museum Informatics Project

CAMPUS-WIDE DEGREE AUDIT

By Emil O. Hanson
Weber State University
Ogden, Utah
December 9, 1993

Abstract:

Weber State University's Degree Audit system is accessible across campus and is used to advise students, as well as to evaluate program progress for degree candidacy. Departments have access to screens where they electronically input program requirement waivers, substitutions and/or exceptions. They also use the Degree Audit screens to clear or sign off students.

Advisors can perform "what if" functions for students who are trying to decide among two or more majors. By printing several program of studies or Degree Audits, the student can determine the courses needed to complete any program, compared with courses in the system they have already completed, and which are stored in their electronic transcript file.

The Degree Audit system reduces confusion about program requirements for students, and reduces time and the problem of misadvisement for faculty advisors. Secretarial work/time is reduced significantly because memos are no longer sent between departments and the Graduation Office.

CAMPUS-WIDE DEGREE AUDIT

By Emil O. Hanson
Weber State University
Ogden, Utah
December 9, 1993

Preface

The Weber State University Degree Audit program is unique in many respects. Most degree audit systems across the country are printed to a blank sheet of paper and the requirements and data meeting those requirements usually look alike, making them difficult to read. The STAARS system prints to a partially pre-printed form making the requirements stand out and are more easily read. The system is based on a comprehensive file of program requirements spanning a seven-year period, based on the changing requirements in annual catalogs.

The variable program requirements are input into the file using a unique screen format allowing a great deal of flexibility (Appendix A), and at the same time providing the necessary logic to make the requirements machine readable as it compares those requirements to the transcript record. The transcript is also formatted in such a way as to provide uniformity of data and yet the flexibility to record all types of achievement and different courses, some of which may be equivalent. The system not only reads the Transcript File, but it pulls data from several data files, including the Transfer Course file and the current Registration File, so that it prints current enrollment data on the Degree Audit form, placing asterisks in the grade column to distinguish them from completed courses which have a letter grade in that column.

I. Graduation Office

A. **Application** - Students are encouraged to apply for graduation a year in advance of the time they think they will complete requirements. An application form is completed, and a $25 application is paid. The fee covers all of the expenses related to a student's graduation and Commencement exercises, including the diploma cover, insert, cap and gown, and the after-Commencement luncheon social, etc. The Graduation information is then input to the Graduation Input screen (Appendix B).

B. **Input Procedure** - From the application a Graduation Office clerk calls up the Degree Audit screen (Appendix C) from the Graduation Menu Screen. If there are several applications that need to be processed, they can all be keyed in at once or they can be input one at a time. After the data is input and "return" is keyed, Degree Audits can be printed off on request. The following data is input to initiate the Degree Audit from the application form: SS#, degree, year, major, minor.

C. **The Degree Audit System** - As "return" is keyed the system compares the course ID numbers of the program requirements with the course ID numbers in the student's Transcript File. If any match, the grade is put in the grade column of the Degree Audit form indicating the requirement is done or complete. Those courses without grades are courses that haven't been completed. Double asterisks in the grade column are currently enrolled courses.

D. **Checks** - When the Degree Audit form(s) is printed off, it is reviewed for possible errors, and all graduation deficiencies are highlighted.

E. **Mailing** - The Degree Audit is double-checked for accuracy and then is either handed or mailed to the applicant with a letter of instruction.

F. **Clearance** - Students take the evaluation to their major, and if appropriate, minor department advisors, who review the requirements and transcript data to review major/minor deficiencies with the student. The major/minor course requirements are listed on the form, and if any of the courses have been completed, a grade appears in the grade column. If everything looks correct, the major/minor department chair will clear the candidate based on their completing the remaining requirements as outlined on the form. The Graduation Office then has the responsibility to follow up and verify that everything on the contract is done before the student is allowed to commence and receive a diploma.

G. **Transfer Course Equivalencies** - Approximately 60 percent of transfer students transfer from other institutions in Utah. We are in the process of loading and annually updating those institutions' course masters into the STAARS Course Equivalency tables. When transfer courses are input to the Transfer Maintenance screen (Appendix D) they are compared against that particular institution's equivalency table, and if a course is identified as equivalent to a WSU course, it is given an equivalency number and will slot throughout the system wherever the equivalent WSU course was identified as a requirement.

When we finish coding EDI, then the transfer courses will come in and be matched electronically, and the product will be a degree audit form that will be sent to the student, hopefully before the term they applied for begins.

H. **Major/Minor Substitutions/Waivers** - If the student negotiates to use a substitute course and/or have a course waived, the department must call up the Graduation Log Screen (Appendix E) and log in the substitution course name and number, and the course name and number for which it is substituting; or in the case of a waiver, they would identify the course being waived. The next time the Degree Audit is run those waivers or substitutions show up on the form where the requirement was previously listed that is now waived or substituted. If the exception approved is other than a waiver or substitution, the exception is typed out on the Graduation Comments screen (Appendix F).

I. **Committee Action and Institutional Requirements** - Students sometimes request a waiver or substitution of requirements which are considered institutional requirements. They include general education, specific course requirements, total hours, GPA, upper division hours, etc. Exceptions to these requirements must be approved by the administrative Admissions Credits and Graduation Committee. If the student's request is approved, the secretary of that committee logs the waiver and/or substitution into the Graduation Log File; and when the student's Degree Audit form is printed electronically, the log notation is printed in the appropriate place on the Degree Audit form.

J. **Final Clearance** - Once the department has cleared the candidate, the dean of the school must clear them. The student reviews the Degree Audit with the dean or the dean's designated official, and if everything appears satisfactory, they clear the student electronically by calling up the Deans Signoff screen (Appendix G). The student is never required to return the hard copy form used to verify graduation status and clearance. All exceptions, if any, and the dean's clearance, are done electronically. In the former procedure, students took the Degree Audit form to the departments to obtain the necessary clearances, and every once in awhile discrepancies were found. It was decided that in the STAARS system, hand carried clearances would be avoided.

K. **Diploma Processing** - Each quarter candidates, who have indicated that quarter as their completion date, are checked for completion of requirements. The degree is then systematically posted to the Transcript File (see below). The degree information is downloaded to a PC diploma file which is set up to produce diplomas. Diplomas are printed, checked for accuracy, and mailed.

L. **Graduation Input Screen** - The Graduation Input screen controls all graduation reports. (See Appendix B at the end of this section.) There are two fields on the screen--one is for the student's estimated date of graduation, and the other is the actual quarter the student graduates. When the quarter code is input to the Actual field, degree information is systematically posted directly to the Transcript file and the next time a transcript is requested, it will show the degree information in the designated place (Appendix H).

M. **Graduation Reports** - Each spring a variety of Graduation reports are requested by department chairs, deans, the College Relations Office, etc. The report formats available in STAARS include: graduates by major, minor, school or college, by degree type, alpha order by degree, etc., ranked by college, by major. The Commencement program has a specific format, and one of the reports prints the names according to the Commencement program order. One report calculates Summa Cum Laude, Magna Cum Laude, and Cum Laude. These are then printed in the Commencement program, honoring these students. The above designations are stored in the Gradadd File, and the diploma is printed with the various honors identified.

II. Campus-Wise Advisement

A. The Degree Audit program is accessible to academic and support departments all across campus. They use it exactly the same way that the Graduation Offices uses it, utilizing the same screens and form.

B. When students come in for advisement at whatever level of achievement and regardless of major or minor, students have access to a complete and personalized Program of Study to guide them through their academic career.

C. The primary advantage of maintaining everything electronically, including waivers, substitutions, or any other commented exception is that all offices are looking at the same data. The hard copy programs provided students are guidelines only; the official record is the electronic record which may be modified weekly with a waiver or substitution. No paper is passed between departmental advisors/chairs and the Graduation Office.

D. Departments also have access to a display only Transcript screen (Appendix I), even though every course that is printed on the transcript also comes out on the Degree Audit screen/form. If students question a grade or hours, they have access to the transcript to verify. This access includes options to display just WSU work, transfer work, and/or experiential credit, such as challenge exams, CLEP, AP, etc.

E. Departments have access to each student's current Registration Display screens (Appendix J), as well, in order to verify current enrollment that is displayed on the Degree Audit form with asterisks in place of grades.

F. **What if** - Departments can assist undecided students in selecting majors by printing various programs showing how the student's completed courses compare with required courses for the programs in the system. That is not the most effective way to select a major, but it is nevertheless one of the factors.

G. Personalized training is available on request to each department or when new secretaries are hired, etc.

III. Future Modifications

A. The Graduation software will have a Tracking Screen programmed to track a candidate's status and specific data necessary to print their diplomas. When this program is completed the Graduation Office will no longer use the hard copy application to track students. The 3" x 8" card is currently the only paper in the Graduation Office and we want to get rid of that.

B. Stage II of the Degree Audit program will evaluate deficiencies and print them in summary form at the bottom of the electives column. Rather than print a narrative of the requirements, it will merely print the number of the requirement that is deficient. Therefore in the Stage II format each requirement on the form will be given a unique number. This information will save time for Graduation clerks and further reduce advisement errors across campus.

C. EDI (Electronic Data Interchange) implementation will provide electronic transfer of credit between institutions, which will make it possible to complete evaluations and assign equivalencies electronically before the transfer work is ever touched by a staff member.

WSU CATALOG - SPECIFIC REQUIREMENTS

```
                        +-----------------------------------------+
Optn _                  |Year ____-__      Major ___    Minor ___ |
                        +-----------------------------------------+
+-------------------------------------------+ +------------------------------------+
|Req ___  Core _   Adv Stnd _               | |Req  Abbrev Course  and/or   Grp|
|                                           | |___  ______  __ _    __       _ |
|Select __              numbered ___        | |___  ______  __ _    __       _ |
|Hours/Classes/Grps _   or above/below _    | |___  ______  __ _    __       _ |
|from grp _ through _   in dept _____       | |___  ______  __ _    __       _ |
|with __ Hours/Classes _ excluding grp _    | |___  ______  __ _    __       _ |
|or more/less _         elective grp _      | |___  ______  __ _    __       _ |
|from _ each/# grp(s) _ grp _ must/can _    | |___  ______  __ _    __       _ |
|                       repeat _ times _    | |___  ______  __ _    __       _ |
|                                           | |___  ______  __ _    __       _ |
|Track  ____________________________        | |___  ______  __ _    __       _ |
|       ____________________________        | |___  ______  __ _    __       _ |
|       ____________________________        | |___  ______  __ _    __       _ |
|       ____________________________        | |___  ______  __ _    __       _ |
|                                           | |___  ______  __ _    __       _ |
+-------------------------------------------+ +------------------------------------+
  PREV- Cursor req     INSERT- Open line
  NEXT- Cursor abbrv   SELECT- Toggle screens    REMOVE- Delete    DO- optn
```

APPENDIX B

WSU GRADUATION INPUT

```
SSN _________   Optn _   Name _________________________________

Address ____________________________________________________________
Sex _______                                           Phone(___)-___-____
+--------+  +-------------------------------------+------------------------------------+
|____-__|  |Degree ___    Expected _______       |Degree ___     Expected _______     |
+--------+  |              Actual   _______       |               Actual   _______     |
            |Major         Post     ___           |Major          Post     ___         |
            | ___     _________________________   | ___   ___________________________  |
            | ___     _________________________   | ___   ___________________________  |
            | ___     _________________________   | ___   ___________________________  |
            | ___     _________________________   | ___   ___________________________  |
Comment     | ___     _________________________   | ___   ___________________________  |
Degree ___  |Minor    _________________________   |Minor                               |
Honors ___  | ___     _________________________   | ___   ___________________________  |
GPA ____    | ___     _________________________   | ___   ___________________________  |
            | ___     _________________________   | ___   ___________________________  |
 Catalog    | ___     _________________________   | ___   ___________________________  |
 ____-__    | ___     _________________________   | ___   ___________________________  |
            +-------------------------------------+------------------------------------+
```

APPENDIX C

GRADUATION EVALUATION

```
     SSN ________   Optn _   Name ______________________________

     Catalog Year ______   Degree ______________________________
+-------------- Major ---------------+ +-------------- Minor ---------------+
|___ _______________________________| |___ _______________________________|
+------------------------------------+ +------------------------------------+
                               DECLARED
     Catalog Year ______   Degree ______________________________
+-------------- Major ---------------+ +-------------- Minor ---------------+
|___ _______________________________| |___ _______________________________|
|___ _______________________________| |___ _______________________________|
|___ _______________________________| |___ _______________________________|
+------------------------------------+ +------------------------------------+
                                                        Page __ of __
Del   SSN           Student's Name              Degree Year Major Minor
 _  ________  ______________________________     ___   ___  ___   ___
 _  ________  ______________________________     ___   ___  ___   ___
 _  ________  ______________________________     ___   ___  ___   ___
 _  ________  ______________________________     ___   ___  ___   ___
 _  ________  ______________________________     ___   ___  ___   ___
```

APPENDIX D

```
                   T R A N S F E R   M A I N T E N A N C E
                                                                  VERIFY _
SSN _________  OPT _  NAME ___________________________________
UNIV-CD ____  CD _  COLLEGE ____________________  CITY-ST ________________________

 CD SCH-YR  QTR ABBRV  NUM SUF   COURSE-TITLE     HOURS GRD GE  UP V-ABBR V-NO D
 _  ____ __  _  ______ ___  _  __________________  _____ __  __  _  ______ ___  _
 _  ____ __  _  ______ ___  _  __________________  _____ __  __  _  ______ ___  _
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 _  ____ __  _  ______ ___  _  __________________  _____ __  __  _  ______ ___  _
 _  ____ __  _  ______ ___  _  __________________  _____ __  __  _  ______ ___  _

+-------- STUDENT'S OVERALL ---------+ +-------- CURRENT SELECTION ---------+
|TOT-HRS GRD-HRS GPA-HRS GPA-PTS GPA | |TOT-HRS GRD-HRS GPA-HRS GPA-PTS GPA |
|______  ______  ______  _______ ____| |______  ______  ______  _______ ____|
+------------------------------------+ +------------------------------------+
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APPENDIX E

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                     GRADUATION LOG MAINTENANCE

   SSN ________     Optn _    Name ____________________________________

      +------ LOG TYPES ------+   Type __  _________________
      | _  __________________|   Coll __  ______________________________
      | _  __________________|   Major __  _____________________________
      | _  __________________|   Hours ___   SUBSTITUTE          FOR
      +-----------------------+              Course _____    Course _____
                                             Num    __       Num    __
                      Page __ of __          Suffix _        Suffix _
+-------------------------------------------------------------------------+
| Entered  Del Type Maj  Coll   Substitute       Course Num    GE  Hours|
| _______   _   __  __  ____   _____ ____ ___   _____ ____    __  ____ |
| _______   _   __  __  ____   _____ ____ ___   _____ ____    __  ____ |
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| _______   _   __  __  ____   _____ ____ ___   _____ ____    __  ____ |
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APPENDIX F

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              GRADUATION REQUIREMENT COMMENTS MAINTENANCE

        SSN ________     Optn _     Name ___________________________________
                         Line ___   Lines ___
 +---------------------------------------------------------------------------+
 | Line    DATE                    COMMENT                   INS/DEL   DEPT |
 |  __   _________   ______________________________________     _    _____|
 |  __   _________   ______________________________________     _    _____|
 |  __   _________   ______________________________________     _    _____|
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APPENDIX G

DEAN SIGN-OFF MAINTENANCE

SSN ________ Optn _ Name ______________________________

Degree ___ ________________________
Major ___ __________________________
Minor ___ __________________________

Page __ of __

Del	Deg	Major		Minor		Entered
_	___	___	____________________	___	____________________	________
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APPENDIX H

D E G R E E   M A I N T E N A N C E

SSN ________ OPT _ NAME ____________________________ SCREEN-OPT _

SCH-YEAR QTR DEGREE DATE TEACH

______ _ ___ ________________________ ______________ _

UNIV-CD COLLEGE CITY-STATE APPRV

__-__ ________________ ____________________ _

MAJ	MAJOR	MIN	MINOR
___	__________________________	___	__________________________
___	__________________________	___	__________________________
___	__________________________	___	__________________________
___	__________________________	___	__________________________
___	__________________________	___	__________________________

HONORS

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BEST COPY AVAILABLE

APPENDIX I

TRANSFER WORK

SSN ________ OPT _ NAME ____________________________

CODE _ COLLEGE ________________ CITY/STATE ____________________

CD	SCH-YEAR	QTR	ABBRV	NUM	COURSE-TITLE	HOURS	GRADE	GE	SUF	W-ABBR	W-NO
_	______	_	_____	___	_______________	____	__	__	_	_____	___
_	______	_	_____	___	_______________	____	__	__	_	_____	___
_	______	_	_____	___	_______________	____	__	__	_	_____	___
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STUDENT'S OVERALL					CURRENT SELECTION				
TOT-HRS	GRD-HRS	GPA-HRS	GPA-PTS	GPA	TOT-HRS	GRD-HRS	GPA-HRS	GPA-PTS	GPA
_____	_____	_____	_____	___	_____	_____	_____	_____	___

APPENDIX J

REGISTRATION DISPLAY

SSN ________ Opt _ Yr-qt ____-__ Qtr _
Name ________________________
Address ________________________
Phone ___-___-____ Student Directory _

Administrative Deferment _
Athlete _
Veteran _
Financial Aids _

COURSE INFORMATION										
CR-ID	Dept	Crs	Time	Crs Type	OB	Hours	GRD	Type	Last Atnd	PD
_____	_____	___	____	__	_	____	_	_	______	_
_____	_____	___	____	__	_	____	_	_	______	_
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The Information Arcade:
A Library and Electronic Learning Facility for 2000 and Beyond

Anita Lowry
University of Iowa
Iowa City
Iowa

This paper describes the planning and development of the Information Arcade in the Main Library at the University of Iowa. A collaborative effort of the University Libraries, the Office of Information Technology, and the academic faculty, the Information Arcade is an ambitious facility designed to integrate electronic resources and methods into research, teaching, and independent learning. Organizational relationships, facilities, resources, and staffing will be discussed, along with examples of innovative teaching efforts in the Arcade.

THE INFORMATION ARCADE

UNIVERSITY OF IOWA LIBRARIES

by
Anita Lowry
Head, Information Arcade

Planning for the Future

When the Information Arcade in the Main Library at the University of Iowa opened its doors in August 1992, it marked the culmination of nearly two years of planning for an ambitious new library facility designed to support the use of electronic resources in teaching, learning, and research across the curriculum of a research university. In the words of University Librarian Sheila Creth: "The goal of the Center is to bring new information technologies into the teaching and research process of the University of Iowa campus, using the library as the primary focus in order to link traditional print materials to the electronic information sources."[1] The original name of the center was to be the Interactive Information Learning Center -- not nearly as catchy as "Information Arcade," but indicative of the emphasis on teaching and independent learning in the conception of the Arcade.

Established with a three-year, $752,432 grant from the Roy J. Carver Charitable Trust supplemented by $400,000 from the University and $50,000 from the University Libraries, the Information Arcade is a cooperative effort of the University Libraries, the Office of Information Technology, and the academic faculty. Over 50 people, drawn equally from these three groups, were involved in the planning process, which was designed not only to draw on the diverse expertise of faculty and staff from around the campus but also to ensure that the major stakeholders in the project would be represented and committed to it from the start.

Two major advisory bodies, the Steering Committee and the Advisory Council, were established for the entire three-years of the Carver grant and are likely to continue to in some form even after this initial developmental period. The Information Arcade Steering Committee comprises Sheila Creth, the University Librarian, Lee Shope, the Director of the Weeg Computing Center (formerly Acting Director of the Office of Information Technology), and John Huntley, professor of English; this is the group that provides guidance on long-term goals and major policy issues. The Information Arcade Advisory Council is a much larger group, with members drawn from the Libraries (representing Reference; each of the three subject divisions: Humanities, Sciences, Social Sciences; the Library Systems Analyst), Academic Computing Services (representing Second Look Computing, the multimedia development studio; the Personal Computer Support Center; and the Personal Computer Information Center); the academic faculty (currently we have representatives from English, Library and Information Science, Political Science, Biology, and Nursing); and a representative from the University Video Services. The purpose of this group is to contribute a variety of perspectives and expertise to discussions of issues and policies and to facilitate communication with their colleagues.

In addition, during the planning period prior to the opening of the Information Arcade, task forces on space utilization, databases, instructional software, tool software, and operations, along with a Technical Advisory Committee, worked together to develop the specifications for the Arcade. These task forces did an extraordinary amount of work in a relatively short time and have since been discharged, their duties now being the responsibility of the Arcade management and its advisory bodies. I hasten to add that I cannot take any credit for this initial planning process and its coming to fruition, having been hired after the Information Arcade officially opened and arriving to take over the reins as Head of the Arcade in January 1993.

Needless to say, these groups all served, and in the case of the Steering Committee and Advisory Council continue to serve, important political as well as practical aims in reinforcing a collaborative ethos and in strengthening the institutional position of the Information Arcade.

A Blueprint for Collaboration

What is the blueprint for collaboration that makes the Information Arcade a reality?

> **The Library** is responsible for managing and staffing the Arcade; for selecting and purchasing appropriate electronic resources; for helping faculty and students to use these resources and to integrate traditional and electronic resources into their research and teaching; for assisting faculty in the development of curricula that incorporate electronic materials; and for assisting students in developing class projects.
>
> **The Computing Center** is responsible for managing the Arcade servers, network, and networked laser printer; for providing and supporting the "core collection" of Information Technology Center software on the Arcade server; for assisting in the selection of tool and instructional software; and for providing multimedia and instructional software development support for faculty.
>
> **The Academic Faculty** is responsible for developing courses to be taught using electronic resources; for teaching in the Arcade; for evaluating courses and methodologies; and for assisting in the selection of information sources and software.

The full-time staff of the Information Arcade consists of the Head, who reports to the Libraries' Director for Information Systems and Technology. The Library Systems Analyst, who has a masters degree in Instructional Technology, devotes approximately 25% of his time to the Information Arcade providing technical support and participating in management and planning. "Front-line" information and instructional services are provided by six half-time graduate assistants and a number of undergraduate and graduate student lab monitors. The Arcade has formal collaborative relationships with the managers of the Distributed Systems Group, the Network Services Group, and the Information Technology Centers, as well as informal relationships with the managers of Second Look Computing (the multimedia development group) and the Instructional Software Development Group -- all these units are part of the Weeg Computing Center. And, of course, the staff of the Arcade work closely with the staff of the University Libraries, especially those in Information and Instructional Services, Library Automation, and with library selection officers.

And what happens after the grant-funded period is over? The University administration has made major commitments to ongoing funding for the Information Arcade, including supporting the six graduate assistantships as well as providing substantial funds for upgrading equipment and for acquiring software and databases. The

Libraries have re-allocated a permanent professional line to the position of the Head of the Arcade and will provide funds for lab monitors, facilities, and resources, while the Office of Information Technology will continue the technical support and cost-sharing that it currently provides.

The Environment

Let me briefly sketch for you the environment of the Information Arcade. Located just inside the door of the Main Library and adjacent to the Main Reference Department (with its full complement of printed and electronic bibliographic and reference tools), the Information Arcade is approximately 6,000 square feet in size. The electronic classroom covers approximately 1,400 square feet. It is equipped with 24 Macintosh student stations and seating space for two students per station (Quadra 700s); the instructor's station has two computers, a Macintosh Quadra 700 and an IBM PS/2 Model 57slc, to which are attached Apple and NEC CD-ROM drives, a Pioneer Laserdisc player, a Sony VCR, a SyQuest drive and Spin read-write optical drive. Images from the instructor's computers and/or peripherals may be projected to the front of the classroom using a Sony Multiscan Projector or a Sharp LCD panel (e.g., in cases where simultaneous projection from both computer screens or from a computer screen and a laserdisk are desired); sound is projected via an amplifier and a system of built-in ceiling speakers. One wall of the classroom is floor-to-ceiling "privacy glass;" with the touch of a button the wall can be made opaque (to shut out distractions from the rest of the Arcade) or clear (to enable Arcade staff to monitor the room when classes are not using it) -- this is always a big hit with visitors!

The Information Stations located outside the classroom are used to access the Internet, CD-ROMs, and other local and remote information databases, as well as instructional software; at present, there are ten NeXT Stations, five IBM PS/2 Model 56sx's, and three Macintosh IIci's (there are relatively few Macs because the Macs in the classroom can be used as Information Stations when a class is not in session). There is a cluster of Multimedia Stations designed to enable students and faculty to use existing multimedia databases on CD-ROM and laserdisk and to create their own multimedia presentations and programs; this cluster has 7 Macintosh Quadra 700s (4 of them equipped with 21" color monitors), one Macintosh IIci, and one IBM PS/2 Model 57 slc, along with a color scanner, 2 black and white scanners, VCRs, CD-ROM drives, laserdisk drives, and removable storage media (SyQuest drives and Spin read-write optical drives).

The Course Preparation Lab, with 2 Macintoshes and an IBM and IBM-compatible, CD-ROM drives, and a laserdisk player, is used mostly for consultations with faculty and by librarians and faculty preparing instructional materials -- though it is not meant to be a full-service multimedia or software development lab.

The Information Desk is prominently located -- that's where patrons come for all manner of assistance in using the resources of the Arcade -- and it houses the growing collection of manuals, reference works, newsletters and journals, and other information sources. The offices of the Head of the Arcade and of the Graduate Assistants and a good-sized equipment/work room complete the visible picture.

The network infrastructure is invisible but just as crucial to our operations. All the Macintosh and IBM computers are networked to the Information Arcade file server, an IBM PS/2 Model 95 located in the Weeg Computing Center across the street and managed by the Distributed Systems Group at Weeg; the NeXT Stations are connected to a NeXT Station server, also at Weeg. We use an Ethernet network, the server software is

Novell Netware 3.11, and all the microcomputers in the Arcade have access not only to the local resources, but also to the campus network and to the wide world of the Internet!

Beyond Bibliographies

Information technology has penetrated nearly every aspect of the modern research library, so what is unique about the Information Arcade? In a nutshell, the Information Arcade is without precedent in its emphasis on:

- **non-bibliographic** electronic source materials in the humanities, social sciences, and sciences, including **electronic texts, image and multimedia databases, numeric data, courseware, information access and management tools, software for analysis and simulation, and programs for multimedia authoring and for collaborative work**;

- the **analysis, manipulation, and creation** of information in electronic formats;

- the **integration of computer-based resources and techniques into the undergraduate and graduate curricula** as well as into library instruction;

- the provision of **expert, in-depth information and instructional services** to support computer-aided teaching, learning, and research.

To date, the application of information technologies in libraries has been directed primarily towards the creation, management, and access of bibliographic records, whether in the library's online public access catalog or in the collection of bibliographies and indexes on CD-ROM or in facilitating access to remote library catalogs via the Internet.

But in recent years there has been an explosion in the creation and publication of **primary source materials** in electronic formats. Initially this occurred in the sciences and social sciences with the development of numeric databases, like censuses, or voting records, or economic time series data, and special databases, like chemical structure databases. But the humanities have now gotten into the act as a number of scholarly electronic text projects have made major primary source text databases and sophisticated and user-friendly text analysis software available to scholars in the humanities. To give just a few examples, there are the *Thesaurus Linguae Graecae* database that includes thousands of ancient and classical Greek texts, the *American and French Research on the Treasury of the French Language Database* that includes over 2000 literary, philosophical, religious, political, and scientific works from the 17th through the 20th centuries, the *Past Masters* series of British and European philosophical texts, and the *WordCruncher Disk* that includes the *Complete Works of Shakespeare*, the King James and New Revised versions of *The Bible*, selected texts from the Library of America series of American authors, and a large number of historical documents relating to American constitutional history. And, increasingly, primary source image databases and multimedia databases are enabling scholars and students to have ready access to rare or difficult to locate images, for example, the *AVIADOR* laserdisk database of architectural drawings from the great Avery Architectural and Fine Arts Library at Columbia University or the *Videodisc Encyclopedia of the Twentieth Century* that reproduces over 80 hours of clips of news footage from the turn of the century to the present -- a veritable gold mine of sources for students in history, political science, literature and the arts, journalism and mass communications, education, the history of science, and interdisciplinary cultural studies. And it is worth noting that the materials in the *Video Encyclopedia of the Twentieth Century* are all licensed for re-use so that students and faculty may use it to create their own video compilations on video tape or in digital multimedia programs, so long as it is for non-commercial, educational purposes.

With the increasing importance and availability of electronic primary source materials, today's scholars and students must learn not only how to identify and locate, but also how to analyze, manipulate, evaluate, and even create a wide variety of sources in printed and electronic formats. The true electronic library of the future is one that facilitates not only information retrieval, but also information analysis, enabling its users to bring computer-based tools and methodologies to bear on the data at hand; it also provides means for them to incorporate digital information directly into research documents and teaching tools of their own. Accordingly, the resources of the Information Arcade include:

- electronic source materials, with an emphasis on scholarly electronic texts and image and multimedia databases;

- text analysis software (e.g., *WordCruncher, TACT, TALLY, Micro-OCP*);

- information access and management programs (e.g., Internet navigation tools like *MOSAIC* to help people make better use of the resources available on the Internet, *EndNote Plus, FileMaker Pro*);

- scanning, OCR, and sound and image-capture and manipulation software (e.g., *Ofoto, Photoshop, AccuText, TypeReader, Premier, SoundEdit Pro*);

- hypertext and multimedia authoring and presentation software (e.g., *HyperCard, SuperCard, Storyspace, Persuasion, Passport Producer Pro, and interText,* developed at Second Look Computing at the University of Iowa)

- statistical and mathematical analysis and simulation programs (e.g., *Minitab, Maple, Excel, and MathCad*);

- graphics and desk-top publishing applications (e.g., *PageMaker, SuperPaint, Corel Draw, Morph*).

Teaching and Learning in the Information Arcade

And in a world in which computer-based interactive learning is changing the ways that teachers teach and students learn, the educational applications of electronic resources figure prominently in the mission of the Arcade. Our collections include high-level instructional software and courseware designed for use in the classroom and for individual and independent learning. For example, we recently acquired a CD-ROM called *Think for Yourself,* which contains many large data sets of statistics on the environment, health, economics, and demography from a variety of U.S. and international sources; it is designed as a teaching tool, bringing together many different kinds of data and providing a menu-driven graphing program and over 10 hours of self-paced tutorials to teach students how to select, analyze, and evaluate numeric data. The instructional software in our collections also serve as models for showing faculty what kinds of programs exist and for giving them ideas about materials that they could develop for their own teaching purposes. Hypertext and multimedia instructional programs are particularly interesting, and, with the advent of easy-to-use multimedia authoring software like *Passport Producer Pro,* the development of such programs is not beyond the reach of an enterprising faculty member or graduate student.

The centerpiece of the Arcade's educational facilities is the electronic classroom, though one-on-one consultations and small-group instructional sessions take place throughout the Arcade. Librarians and other library staff, Information Arcade graduate assistants, faculty, and professional staff from other parts of the university all participate in the Arcade's educational enterprise by teaching here. For example, the Data Archivist of the Iowa Social Sciences Institute teaches workshops on data manipulation and analysis, while staff from Second Look Computing, the multimedia development group in the Weeg Computing Center, teach workshops on various software programs for multimedia work.

Information Arcade lab monitors and graduate assistants (GAs) provide "front-line" reference and instructional assistance to patrons in the Arcade during all the hours that it is open. The GAs hold half-time graduate assistantships comparable to a teaching or research assistantship and are chosen for their subject knowledge and service skills as well as for their technical expertise. The competition for these positions is keen, and they represent a creative solution to the staffing challenges presented by a high-tech facility in which students, faculty, and staff with varying levels of computer literacy work with sophisticated equipment, software, and source materials.

In addition, librarians from throughout the Libraries give demonstrations and teach "hands-on" classes on information retrieval, the Internet, and electronic source materials and tools; some of the special sessions scheduled to date for this academic year cover electronic texts in the humanities, electronic primary sources in the social sciences, and electronic resources in history, medieval studies, classics, music history, mass communications, Spanish, and education. Librarians and Arcade graduate assistants provide in-depth, one-on-one consultations for students and faculty who are using or creating electronic resources for research and teaching. Librarians also work in teams with Information Arcade graduate assistants to develop new electronic information sources and teaching tools. For example:

- a librarian in Special Collections is preparing a multimedia presentation, incorporating both digital images and sounds, on Old English manuscripts and modern artists' books from the Libraries' collections;

- a reference librarian is combining text and images from the *1492: An Ongoing Voyage* exhibit at the Library of Congress (retrieved via ftp over the Internet) with additional images, sound, and text that she digitized and wrote in order to create a sophisticated hypermedia program on the diversity of peoples in the Americas;

- the bibliographer for European history developed a multimedia instructional module on the political geography of Renaissance western Europe for an undergraduate history course that she taught this semester;

- another reference librarian, who is teaching a senior seminar next semester on the impact of the civil rights movement on African-American culture, plans to have her students present portions of their primary source research as multimedia programs that can be integrated into a class hypermedia database on the topic;

- and librarians are participating in the design and development of the new University Libraries "gopher."

But the Information Arcade has even more ambitious goals for its new environment for teaching and learning. In order to encourage and facilitate the integration of electronic resources and interactive methods into the curriculum, the

Information Arcade promotes the use of its facilities, including the electronic classroom, for academic courses and special class assignments that take advantage of these new resources and methods. Faculty in many disciplines teach classes in the electronic classroom of the Information Arcade. In the words of Professor Gregg Oden, who teaches a course on problem-solving:

> ...the Information Arcade classroom has turned out to be ideal for this class. Nearly every class day makes use of the classroom's special facilities in one way or another. Some days, the instructor's workstation and the screen projector are used to provide multimedia lecture support. On other days, these same facilities enable me to show techniques for using the computer in helping to solve problems, with the students following along on their own individual workstations. Or, the students may work independently on applying class principles using their workstations while the TA and I are available for tutoring and trouble-shooting as needed....Although the course is still undergoing considerable development and evolution, it already seems clear that it has the potential for being a model of how technology can help in teaching general intellectual skills.[2]

"Literature and Culture in Twentieth Century America," taught by professor of English Brooks Landon, is another particularly innovative course that makes heavy use of resources in the Information Arcade and throughout the Libraries. In this course, the students do not write term papers but instead create their own multimedia projects on some aspect of the Columbian World Exposition of 1893. This was the Chicago world's fair that was a seminal event in the transformation of American mass consciousness about technology. It is noteworthy that in his evaluation of this course, Professor Landon was particularly excited by the fact that students in this class, inspired by his large multimedia database on the Exposition and by their opportunity to contribute to it, did much more bibliographic and historical research in contemporary primary sources (e.g., newspapers, magazines, exposition publications, eyewitness accounts) than is usually the case with undergraduates. In the words of one of his students: "The open-ended nature of the assignments is what excites me. We need to research information from virtually everywhere, employing all the resources available at the university: scanners, advanced software..., electronic mail and Internet, and even real books! We have the opportunity -- the responsibility -- to add to a large, growing base of information in such a way to illuminate the previous data in a non-trivial way."[3]

This Fall semester, ten academic courses met weekly in the electronic classroom; ten more met there occasionally to take advantage of the presentation and interactive capabilities of the room. These classes all have assignments that make use of special software or electronic resources in the Arcade, and in at least five of them the students prepare hypertext or multimedia projects. Letters and evaluation forms from our faculty bear eloquent testimony to the impact of the Information Arcade on teaching and learning. Thanks in large part to the Information Arcade, at the University of Iowa the library is seen as a major player in the campus efforts to enhance the quality of undergraduate education -- a concern shared by institutions of higher education throughout the nation.[4]

Challenges for the Future

Lest you think I'm looking at everything through rose-colored glasses -- a rosy mauve being prominent in the color-scheme of the Arcade decor -- let me assure you that there is much unfinished business in the Information Arcade. And there are real challenges here, some of which will sound familiar to managers of campus computing facilities and some of which arise from the particular situation and goals of the Arcade.

- **Security of equipment and data**: We feel fairly confident that our fiber optic security alarm system will discourage theft of machines, but accidental, mischievous, or malicious damage to files on hard disks is impossible to eliminate in spite of our vigilance. Regular hard disk clean-up and file-replacement is the best we can do, but it is very time consuming, especially in a place where the wide variety of applications and peripherals results in many different system configurations -- and where the configurations are constantly changing as new resources are acquired.

- And that very **diversity and dynamism of our resource collections**, which is one of the great strengths of the Arcade, complicates our information management tasks and our efforts to provide ready access to the materials in other ways. Many of our programs and information sources are produced by small scholarly publishers, even individual scholars, and while they may be wonderful resources, they often pose special installation problems, cause configuration conflicts, won't run on our server and network, etc., etc. -- as one of the computing center consultants who works with us said: "You're trying to run a lot of unusual stuff in here!"

- **Staffing and service:** We have set high standards for ourselves in terms of expertise and "user-friendliness," but because of the breadth of our mandate it is increasingly difficult for staff to keep up with the burgeoning collection of software and resources available in the Arcade and over the Internet and the demands of a growing user population. So we are seeking to set clear priorities and guidelines for support, to develop formal and informal training programs for Arcade staff and librarians, and to involve ever greater numbers of librarians in providing reference and instructional support, especially for electronic source materials and courseware within their particular areas of language and subject expertise.

- **Promotion:** At the same time, we must continue to promote our resources and services to faculty and students, especially to those not already familiar with electronic resources and teaching tools beyond the opac and CD-ROM indexes.

- One measure of our success to date is the **heavy demand for the electronic classroom**, making it impossible to accommodate all requests. Fortunately, this has stimulated some academic departments and the computing center to begin planning and creating additional electronic classroom facilities, but it remains to be seen if the supply can keep up with the demand.

- **Remote access:** At present, Information Arcade resources are accessible only in the Arcade. The technical and licensing issues involved in providing remote access are formidable and will not be easily or cheaply resolved.

- **Evaluation:** And finally, how do we evaluate the Information Arcade? We can keep statistics to measure our usage and can collect surveys and anecdotal data, but it is very difficult to quantitatively and definitively answer questions about the impact of electronic resources and methods on research and teaching.

A Model for the Future

But so far, the anecdotal data looks very good! Although the Information Arcade is only a year old, it has already generated extraordinary interest and enthusiasm locally, regionally, and nationally, as reflected in a steady stream of invitations to participate in conferences and meetings and in requests for information, site visits, and formal and informal consulting. The Information Arcade has a high profile on campus and has hosted special presentations for the Iowa State Board of Regents, the University of Iowa President's Club (group of major donors), and numerous other groups and visitors; it has been featured in all the major campus publications and in recruiting programs, and its Head is a member of the campus-wide Computer-Based Education Committee. In addition, because of its location in a public institution that is prominent in its state and region, the Information Arcade regularly hosts visitors from and serves as inspiration for primary and secondary schools and even commercial concerns, as well as community colleges, four-year colleges, and universities.

As a member of the Research Libraries Group and the Committee on Interinstitutional Cooperation (CIC, the Big Ten universities plus the University of Chicago), the University of Iowa and its Libraries participate in many national and regional cooperative ventures, including the Research Libraries Information Network and CICNet. So as it begins its second year of existence, the Information Arcade looks forward to participating in new cooperative efforts to provide access to and support for electronic source materials in research and teaching.

Notes

[1]"UI Libraries Receives Carver Grant." University of Iowa News Release. May 1991.

[2]Prof. Gregg Oden, a letter to the author, March 12, 1993.

[3]Chris Mortika quoted in an information sheet prepared by Prof. Brooks Landon on his course "Literature and Culture of the Twentieth Century." University of Iowa, February 1993.

[4]C.f., Joanne Fritz, "Playground for the Mind," Iowa Alumni Review 46, Spring 1993, pp. 22-26.

The Digital Textbook:
A Look at the Next Generation of Educational Materials

by Don Hardaway
Faculty, School of Business
St. Louis University

The rapid advancements in digital technology is creating a whole new arena of educational opportunities. Now that multimedia is emerging as the next revolution in personal computers, there are abilities to author creative educational materials and frameworks that would not have been possible several years ago. Some of the common concerns that educators and administrators of computing share are: (1) the form that educational materials will take with the advent of multimedia, (2) the format that education will take to exploit the new technology and (3) the computer technology infrastructure necessary to support new educational environments. This presentation will address these concerns by demonstrating a prototype of future educational materials called "The Digital Textbook" followed by a presentation of how these new materials will allow for different educational formats and the necessary technology to support future settings in education.

Outline

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   A. Technology Needed to Support Education
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      3. Campus
      4. Offices
      5. Computing Centers
   B. Future Technology Trends

Introduction

The acceleration of PC technology has created an environment of both opportunity and confusion. The latest PC technology, with multimedia ability, has provided educational institutions and publishers with a new set of tools that can be used to reengineer the educational process. With the multimedia elements including audio, video, pictures being produced using PCs in a digital form instead of the traditional analog form that used expensive analog equipment, virtually anyone can be a multimedia content producer. Recents trends indicate that the additional hardware that was necessary to bring multimedia to the desktop has been being replaced by software solutions (QuickTime) and/or with hardware in the machine out of the box (i.e. Quadra av). The continuance of this trend would suggest that in the future all machines will have full multimedia resources builtin at a affordable price. With all these changes in technology there is a new playing field for everyone. The following sections will discuss: (1) some of the technology developments that help enhance the technology tool box, (2) the impacts that new technology is having on educational materials, (3) how educational formats might change and (4) technology infrastructures that can embrace new technology and accessibility.

Multimedia on the PC

New technological developments have been the driving force in the creation of new PC technolgy. These developments are evidenced by the new PCs using RISC processors, increases in disk space and speed and the floppies that have much larger storage space that is necessary to store multimedia work. The recent developments in RISC processors such as the DEC alpha chip and the IBM 601 will allow for an entirely new generation of computers to be built at lower prices. These processors provide the needed processing power to support multimedia. The processors that follow (IBM 603, 604, and 620) will continue to push the envelope with staggering performance at relatively low prices. Parallel to the move in processors is the enhancements in disk technology. Disks are becoming smaller, faster and with more capacity. This can be seen in magnetic disks by the move from 5.25 to 3.5 inch disks. In fact, many of the new generation magnetic disks will have performance that rivals that of some disk arrays. Other developments have centered around the development of the 3.5 inch magneto optical disk. This would be the logical replacement for the current 3.5 inch floppies (capacity 1.44 MB) since the magneto optical floppy can hold approximately 128MB. This and even larger spaces would be needed to hold multimedia work and make it easily transportable. Another version of removeable disk is the optical disk. This type is not as popular as the magneto optical but could become popular if certain technological advancements are achieved. What is quickly become the most popular media for distributing multimedia and other content is CD-ROM. Today's CD-ROMs can hold about 650MB of information and costs about $1 per disc to reproduce in quantity. Many of the newer computers come with a CD-ROM drive built in. This trend will continue until all computers come equipped with CD-ROM. Additionally, recent developments have produced a CD-ROM with five time the capacity of today's CD-ROM. We should also expect that CD-ROMs will become smaller. One of the limitations of CD-ROMs have been their speed (access time and bandwidth). CD-ROM drives have changed from having a thru put of 150KB/sec to 300KB/sec and this fall NEC has announced a 450KB/sec and 600KB/sec drive to be available by the beginning of the year. Within a few years all machines will have much faster CD-ROM drives with much larger capacities. Again, this is necessary to hold the new multimedia creations that are forthcoming. We can expect to see the impact of all of these technological developments in the form that future educational materials will take.

Educational Materials and Educational Formats

Educations materials that take advantage of the new technology will all use multimedia components to produce a package for self study or as a audio/video support in the class room. Most developments today include basic textbook content, exercises and testing augmented by some video and/or audio. These materials are presently available on CD-ROMs but with advancements in networking will soon be accessible over networks. The content of the educational material may be reorganized so that the student explores topics in a random fashion or may be organized like today's textbooks where there is a sequence to covering the material. Both of these formats can be housed on a CD-ROM or be played back over a network. The main difference between using a network or a CD-ROM is in logistics. With future PC notebooks and personal digital assistants (PDAs) likely to have RISC processors and CD-ROM drives having materials packaged on a CD-ROM will allow much more mobility due to it's portability. Networks can only be accessed from designated locations whereas PC notebooks and PDAs can be carried anywhere and played anytime. Examining the different arrangements for experiencing learning yields the following possibilities.

1. Same time same place (today's classroom)
2. Same time different place (teleconference)
3. Different time same place (lab use at the discretion of the student)
4. Different time different place (portable materials or ISDN networks from home computers)
5. Anytime any place (portable computer with portable materials or wireless communications)

The trend will probably produce future scenarios that include more different time different place and anytime any place activities than the traditional same time same place style of learning currently used. As industry is currently undergoing much reorganization to stay competitive, education is addressing similar conditions. It will become imperative to use innovation with new technology to stay competitive as the educational market continues to tighten. As with industry, computer technology can be a strategic weapon for educational institutions.

Networking will continue to advance both on campus and nationally. Just recently several vendors were advertising FastEther boards which boost the data transfer rate to 100Mb/sec. This speed can make video over the wire much more feasible. Currently the IEEE standards committee is reviewing some proposed standards for FastEther. In another eff)rt Internet is being investigated as a possible medium for high speed transfer over long distances. This network coupled with ISDN that is surfacing in some parts of the country would provide a viable method for linking society up over a global network structure. All of these efforts will move rapidly to achieve a high capacity networked society by the turn of the century.

Campuses are now moving toward a more networked environment to support the innovative use of computers in education. Dorms, offices, classrooms, libraries and more are all becoming networked. With the feasibility of multimedia only well planned infrastructures will be able to take advantage of the latest technology. The technology base at every campus is vital to the institution being able to be innovative and to achieve more efficient and effective educational environments. A campus with leading edge technology is needed even before the faculty and staff think of ways of fully utilizing it. It is the technology rich campus which serves to motivate members of the campus to try new methods. Only through providing the right atmosphere will people think to try new ideas.

TRACK PRESENTATION:

Providing Students and Visitors with Kiosk-Based Campus Information System

Prepared For:

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Prepared By:

Kathryn Neff, Ph.D.
Artificial Intelligence Specialist
Sinclair Community College

Judith W. Leslie, Ph.D.
Senior Vice President
The Robinson Group, Ltd.

Background

"I don't keep regular hours: I work and I go to a community college and a university. I don't necessarily need to see a person every time I need information. I expect that there will be some sort of system in place so that I can access information at my convenience. That doesn't mean that it's available just during the day. I can be at home, at work, and I take night classes as well. I need to have the information when it is convenient. Some may say that this is difficult, but this is the way that I need to have it to continue my education. I'm in a different generation than my parents: the slacker generation, Generation X, the MTV generation, whatever you call it. We want things differently; it has to be slick, captivating, visually appealing, pleasing. Society is pumping all these images at me that really catch my attention so its kind of difficult to focus in on a static type of media. I really like getting good service when I need it; most of the time I need to know something to continue on and if I have to go through a bureaucracy to get to it, I may never even both to do it or be frustrated as I try to get that service."

Does Fred sound like a student on your campus? He represents a new generation of students to enter higher education:

- they are computer literate, if not fluent;
- they have an urgency about them in obtaining information, services, and instruction, based upon their personal obligations, work commitments, and academic goals; and
- they expect the same or better level of service from their campus environment that they are able to obtain in their commercial world.

How do the faculty and staff feel who work with this type of student as well as the more traditional students? Many of those who were attracted to their professions are frustrated by the amount of time that they must spend in "search and retrieval" non-professional activities. For example, advisors must take time in searching through various text files and making several phone calls for current information regarding which support services may be available to their students: at what time, in which location and whom to contact. As advisors provide guidance to students regarding their course of study, they typically must take time to search through the many hard copy versions of catalogs to find the appropriate one for a particular student and then make a "judgment call" regarding an exception to the prescribed curriculum to accommodate the students "unusual" circumstances. The time taken for search and retrieval is time that could have been devoted to advising students with specialized circumstances and to designing expert systems that could serve more students.

You may have reduced the number of staff in your office, perhaps through an early retirement program. While your enrollments may be steady, there are more part-time students who place increased demands for information upon your staff. The work week is in excess of forty hours not nearly long enough to offer students the level of service that you would like to provide. Have you recently determined how much time a staff person spends in providing a duplicate class schedule to students during the first week of class; how many students request an official transcript during the semester; and do staff in the Financial Aid office spend most of their time answering inquiries regarding the status of students' awards?

With issues of this nature confronting higher education, many institutions are looking for effective strategies to respond. One source of expertise is the business and industry community. Stan Davis and Bill Davidson, in their book, 2020 Vision, suggests that organizations can renew themselves by creatively using a plentiful, but unrecognized, resource within higher education. He states,

"In every economy, the core technology becomes the basis for revitalization and growth. Information technologies are the core for today's economy, and to survive all businesses must "informationalize." From small mom-and-pop stores to giant global corporations, the point to grasp is not merely that all economic activities will depend upon information to create and control their destiny. We've heard that

already. And while it's true, this truth manifests itself so slowly - over decades - that people have tired of it. For many, it is the unpoured honey. Instead of focusing on its not-so-newness, we must focus on the growing power and consequences of this truth. The point is that the economic value from generating, using, and selling information is growing significantly faster than the value added by producing traditional goods and services. ...The value of any product can be increased by incorporating intelligence, information content, and services." [1]

The authors maintain that the assumptions in 2020 Vision are applicable in the higher education context. To make the advice relevant, however, one must assume that the "products" of higher education are service, instruction, and research. The consumers of these products are students. To respond to the current and emerging needs of these consumers, the authors suggest that institutions improve the information content of services provided to students, allow students to conduct their own business transactions using information technology, and provide students with an information-enriched and accessible, learning environment.

The purpose of this paper will be to illustrate how institutions can create new, service-related products based upon the effective use of information resources. The authors first, will identify the factors that accelerate or decelerate the process of creating new products by optimizing information resources; second, will present a model to "informationalize" colleges and universities; and third, will describe how one institution, Sinclair Community College, has begun to informationalize its campus environment and creatively design a new product: an expert system for advising. The paper is organized into the following sections: (1) Problem Statement, (2) Conceptual Model, (3) Application, and (4) Summary and Conclusion.

Section One: Problem Statement

There is growing evidence that higher education is in a paradigm shift, although there is great variability among institutions as they accelerate/decelerate the process of change. The factors that contribute to the process of change are organized in this paper into the following categories: social, political, economic, and technological. Some factors pertain to the vestiges of tradition and others are the harbingers of the future "enterprise." These latter factors are the catalysts creating a paradigm shift within institutions who are transforming from an "industrialized" single entity organization to an informationalized, "enterprise-wide" educational network.

Social

There are at least three social factors that stimulate the informationalizing process. The first is the heterogeneous student body. For a number of years, higher education has acknowledged the changing demography of its student body. To reiterate these characteristics, the students of today are older, more ethnically diverse, more part-time, and more diverse in their learning styles than were their predecessors. The implication of this heterogeneous student body is that institutions must offer information more conveniently, easily, and use more than one medium of communication and instruction.

The second factor is that the high school graduates now entering higher education are a "product" of the "media generation." They learn from "infotainment." When these students sit in a large lecture class with only the professor at the front of the classroom, the student's attention wanes, despite the expertise and experience of the professor. Many of these students have become accustomed to communicating electronically, performing simulations using Nintendo games, and are heavy users of desktop software tools. However, one must also recognize that there are many other students who are not a part of the media generation and are not comfortable with technology. They seem to prefer large, anonymous lecture classes; but, like their younger counterparts, they too have other personal and work demands that require more accessibility to information. The implication of this second social factor is that institutions must be prepared to provide multi-media in both its services and instruction as well as

[1] 2020 Vison, Stan Davis and Bill Davidson, Simon and Schuster, 1991., p. 17

 facilitate the transition from text to image processing of information to those whose "first language" was text-based information.

Political

The social factors identified above accelerate the process to informationalize a campus. The political factors to be identified in this section, however, tend to "decelerate" the informationalizing process. The first political factor is referred to as "the security shield." The turf battle between and among offices regarding who owns the data is well known in higher education. To explain the basis of this battle, one must view information as a resource of power. The person who controls the information, therefore, has power. While data security is a legitimate requirement, data security should not be used inappropriately as a shield to fend off the "information aggressors," since these aggressors are the students and faculty and staff who work with these students. For example, why must someone in the Registrar's office have sole responsibility to update a student's address when the student, who actually "owns" this information should be able to directly input this information into the computer, via voice and/or a kiosk?

The second political factor is the "reluctant giver." The recipients of higher education are the students and the communities in which they reside. These communities, as formalized in governing bodies and governmental agencies, want to know more about the colleges and universities that they support. The Student Right to Know legislation is just one example of their need for information. Although not publicly acknowledged, there is an undercurrent of reluctance among the information-rich. They respond with legitimate excuses such as "they won't understand the context of the information; they will be comparing apples and oranges, and it will take one FTE six months just to provide the information." While there is merit in each of these statements, one cannot discount the reluctance of colleges and universities to "charitably" donate information to their "publics."

Economic

There are four economic-related factors that can accelerate or decelerate the informationalizing process. The first factor that could accelerate the change is the ability of institutions to optimize their current information resources. The investment that has been made in building a robust database could be optimized; perhaps using the business model of "creating new products and markets." For example, an institution could provide new ways to access the data such as through voice technology and multi-media kiosks, thereby extending the use of the data to "new users," students and the community. An institution also could use these data in new ways, transforming the data into information that is interactive and rule-based. Using this strategy, institutions could extend the lifespan of their existing information resources while creating new products to informationalize the campus.

The second factor that could accelerate the process of change is the willingness of institutions to leverage their current and future investments by forming partnerships with other institutions and organizations. To do so, an institution must be willing to migrate out of its homogeneous environment into a heterogeneous one that includes other higher education institutions, K-12, governmental agencies, and business and industry. The network, or highway of communication, now offers institutions the capability to share information resources that traditionally might reside in a single facility at a single institution. Institutions may collaborate with hardware and software vendors to jointly develop new applications.

The third economic factor is the ability of institutions to creatively diversify their revenue portfolio. These institutions are expanding their portfolios from the traditional sources of revenue: public appropriations, tuition, and endowments. The information resources in an institution may constitute a new source of revenue if creatively and appropriately "packaged." For example, businesses, such as fast food providers and copy services, may wish to advertise on campus kiosks and will pay, or at least purchase, the kiosk to do so. Promoting campus events and services to the community through kiosks located in shopping malls, as one possible high visibility location, may generate increased attendance at these events and utilization of these services on a fee basis. Another example pertains to the expertise available in higher education. Traditionally, professors have written and published books and received royalties for these works. Cannot this same model be used to share other sources of expertise and information in the institution? Some may regard such a notion as antithetical to the values and tradition of higher education; for some it may stimulate them to creatively and appropriately use all of the expertise and information resources of higher education to generate new sources of revenue to support innovation.

The fourth economic factor, interrelated with social, political, and technological factors, is the ability to rethink and restructure business processes. The status symbol of today is not how many new staff you've hired this year, but rather, how much have you reduced your staff . The administrator who is able to do more with less is the one to be envied, not the administrator who has the largest staff. An example of one of the areas in which an institution may restructure is in the admissions and records offices. As a starting point, simple questions can be asked: how much time is spent, by how many staff, accessing, copying, stuffing envelopes, and mailing information such as transcripts, class schedules, and grades? How much time do advisors and counselors spend in accessing information, such as the course catalog, referral services for students (including their location, office hours, and type of service) compared to time dedicated to focused, one-on-one counseling and advising of students with specialized interests and needs?

The capability for students to personally and directly access relevant information through voice and kiosks can immediately relieve staff and faculty of these time consuming, routine tasks. As the business world says, "time is money." Thus, not only can the use of information be optimized but also the amount of time can be reduced. A formula can be derived to analyze the cost effectiveness of these tools, based upon the amount of time and number of people required to provide a given piece of information.

Technological

There are three technology-based factors that can accelerate the process of informationalizing the education enterprise. The first factor is the availability of a campus-wide, externally linked, network. This important institutional lifeline must connect all physical locations of the campus and extend the lifeline to the entire academic, governmental, and business communities throughout the world. For many institutions, however, there still are "small, remote communities" within the campus and organizational structure that do not have access to the "interstate highway system" (e.g. faculty offices, classrooms, and local area networks). Until all of these communities are connected to the campus and broader educational enterprise, institutions cannot fully informationalize their organizations.

The second technical factor pertains to an institution's information technology migration plans. Those institutions who, in the eighties, were regarded as "technologically advanced" because they had comprehensive mission critical systems operating on large mainframes accessible by staff from their terminals, now find themselves faced with becoming "technological dinosaurs." To survive in this emerging environment, institutions are confronted with the following challenges: migrating their mission critical applications to a client/server architecture; equipping all faculty, staff, and student labs with a minimum of 486 class personal computers, all with network cards; building their campus backbone; wiring all offices and classrooms, many with voice, data, and video; connecting all their local area networks to the backbone; offering access to and training all users in the use of Internet; acquiring desktop software and training all employees in these productivity tools; and reorienting and retraining technical staff from "data processing" personnel to designers, network navigators and managers, and user consultants. A number of institutions are taking an incremental approach to creating a client/server architecture. For example, they have developed/acquired value-added applications that reside on servers but are linked to administrative systems that operate on the mainframe. To provide benefits to users as the institution is migrating, some institutions are using new and existing technologies in creative ways to optimize the use of information available in their current mainframe-based administrative systems.

The third technology-based factor is the creative use of existing and new technology. One example of the tools they are using is voice response technology, a capability that institutions have been using since the early eighties, but typically the application was limited to the registration process. The trailblazer institutions are reconsidering and now offering students access to information using voice technology in a multitude of ways, among them the following: grades, admissions status, financial aid status, graduation check. They also are facilitating the conduct of business through credit card voice response registration and providing daily updates as to campus activities.

A second example of the creative use of existing and new technology, and the focus of this paper, is a campus information system accessible on kiosks. The concept and use of kiosks has been in existence for many years and in many countries. In its original form a kiosk, or "kioski" was a closet sized, stand-alone structure that carried convenience items. The technology-based kiosk enclosures became popular with the advent of Automatic Teller Machines (ATM). Today we see kiosks that can present information in multi-media form using CDs or laser disks, can print screens for which the requester would like a copy, can include a telephone, debit card/ ID card, and offer other features such as a membrane keyboard and voice activation. The convenience that students experience in their commercial life with ATMs increasingly is being offered to students and visitors on college and university campuses. Institutions are beginning to "unearth" their embedded information resources by completing their networks, developing a client/server architecture, and by creatively using existing and new technology.

Section Two:
Conceptual Framework

The conceptual framework has two components. The first pertains to the evolving potential of the information resource and the second pertains to the integration of tools to optimize the potential. The first component is based upon a model that assumes an interrelated continuum that commences with simple, quantitative data and concludes with complex, qualitative wisdom. Table 2-1 depicts the model graphically.

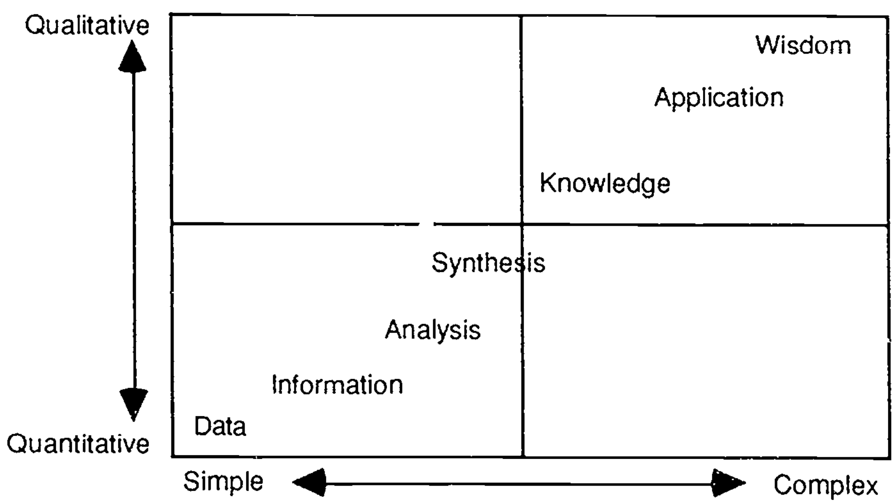

Table 2-1
Information Resources Continuum Model

The definitions used for this model are as follows:

Data:	numerical information suitable for computer processing
Information:	the act of informing or the state of being informed
Analyze:	to separate into elemental parts or basic principles so as to determine the nature of the whole
Synthesize:	to combine as to form a new, complex product
Knowledge:	comprehension acquired by experience or study

Application: the act of putting to a special use or purpose

Wisdom: good judgment, common sense

When this model is adapted to the higher education context, the more common application relates to instruction and research. For purposes of this paper, however, the authors have applied the model to other information-related aspects of higher education. For example, in the area of advising, there are data that are appropriate for computer processing. such as calculating a GPA. The data can be used as information when they are made available to students in a meaningful context such as their applicability toward students' educational objectives. An advisor can analyze information regarding students and the choices that they make by determining some basic principles that apply to students generally. Advisors also may synthesize the information by combining it with their own experience in working with students so that a new, enhanced understanding of student behavior can be derived. The understanding acquired by an advisor working with students is referred to in the model as knowledge. When students translate the advise into action, or application, the advisor is able to measure the effectiveness of his/her advise. and further develop wisdom, or good judgment, regarding the most effective way in which to advise students. Those institutions who are recognizing the potential of the information resource are those who are translating information into its more advanced forms of knowledge and ultimately wisdom.

The second component of the conceptual framework pertains to processes and technologies to store, manipulate, access, and disseminate the information resources. The first model illustrates the traditional way in which students access information. As noted in the graphic, students typically have relied on family and friends for information. When they request information from their institution it is either through hard copy written response or with a secretary or other staff member. The secretary typically must obtain the information from her personal computer or terminal linked to the mainframe or from hardcopy stored in files. Her supervisor, generally not available for direct student contact, "supervises" the process. To obtain instructional information, the student has access through books and classroom instruction. This model, or paradigm, reflects many of the principles of the industrialized society such as a bureaucratic organizational structure. --see Appendix A: Traditional Model

The new information model graphically depicts the student at the heart of the enterprise, accessing information through various tools such as his pc, phone, kiosk, or personal contact. In this new model, the students have direct access to information and do not have intermediaries--or barriers-- to obtain the information he needs or to conduct business transactions. The mainframe applications can be accessed through a server networked to personal computers. Voice response technology can reside on a server and provide students with simple access to all the information-related resources of the model. Networked kiosks, linked to the mainframe through a server, provide additional integrating technologies such as multi-media presentation of information resources, particularly the sharing of knowledge and wisdom. The kiosks also can integrate related businesses processes with a single student ID/Debit card. With these tools and the expertise available in higher education, institutions can optimize all of their information resources to create an informationalized, educational enterprise.

When this model is combined with the Information Continuum Model described above. the information can be shared with students in the form of knowledge and wisdom using such tools as multi-media kiosks where the experts are visible in full-motion video. Students also could use the kiosk to access an expert system for advising that would be either a substitute for or complement to an advisor, depending upon the student's particular needs. Family and friends still play a key role, but they are integral to a students way of life and they can be accessed using technology as well. Technology becomes the integrator and facilitator of optimizing the information resources in colleges and universities. The institutions who use it well are consumer drivers, not consumer driven, providing a student-centered, educational enterprise. --see Appendix A: New Information Model

To test the premises stated in this conceptual framework, the authors present an example of one institution, Sinclair Community College, which is aggressively moving along the continuum from data to wisdom, using applications, tools, and technology to integrate all of its information-related resources.

Section Three: Illustration

Overview

Sinclair Community College, located in Dayton, Ohio, is an example of an institution that is working aggressively to restructure its information systems and supporting administrative processes. Sinclair has recently replaced outdated administrative software with the Colleague system, a comprehensive student information software package marketed by Datatel, Inc. Colleague is accessible campus-wide at Sinclair through an ethernet network with a fiber backbone, using TCP/IP protocol. The campus network provides the Sinclair community with access to Internet, the library system, and to many software packages for office productivity, in addition to Colleague databases.

With these computing facilities and a strong dose of imagination, Sinclair has moved rapidly toward a student-centered, informationalized campus environment. A centerpiece of this transition is the InTouch kiosk system, which offers Sinclair's students convenient access to data, information, knowledge, and even wisdom (or at least very specialized expertise).

Developed in partnership with The Robinson Group, Sinclair's InTouch kiosk software merges several disparate technologies into a smoothly integrated system for information delivery. Multimedia adds appeal and ease of use; relational databases provide rapid access to small collections of data that are relatively stable, while the campus network provides real-time access to highly volatile information in the extensive Colleague databases.

Artificial intelligence adds an entirely new dimension to kiosk functionality; through an interactive dialog with the student, the kiosk's Intouch Counselor gives personalized recommendations and suggestions. While traditional databases deal with the questions, "Who? What? When? Where?", the counseling expert system helps Sinclair students explore "What if?", "So what?" and "What does that mean to me?"

The concept of a "smart kiosk" grew out of a Sinclair project called CWEST ("Counseling With Expert Systems Technology" -- pronounced "quest"), which was initiated in the summer of 1990. CWEST was funded primarily by a grant from the State of Ohio to promote the use of artificial intelligence and expert systems; the underlying objective was the transfer of technology from military to civilian applications. To this end, a team of Sinclair faculty and staff worked with the Center for Artificial Intelligence Applications (CAIA), an organization funded by the Air Force, to develop an expert system prototype.

Application for an Expert System

The Sinclair team selected academic advising for its expert system domain for several reasons:

1. Academic advising is inherently rule-governed and logical; the team felt that "if-then" rules could be defined for much of the knowledge domain.
2. Academic advising is an area that is familiar to almost everyone on campus; rather than selecting an esoteric topic, the Sinclair team preferred a project in which many faculty, students, and staff could participate.
3. Like most community colleges, Sinclair has an insatiable need for counseling services (both academic and personal) due to the increasing numbers of under-prepared and non-traditional students, the diversity of its student body, and the complexity of its program offerings, which include a full gamut of vocational and university-parallel options.
4. Recent budget cutbacks make it unlikely that Sinclair will add more counselors to meet the increasing demand. An automated academic advisor could expand access to counseling resources without adding more staff.

Phase One: Design

During the first year, the CWEST team created a prototype of an expert system that could assist students with the selection of courses for the next term. Although the prototype operated with only small and simplified data files, the team was convinced that a full-scale system could be implemented. At that point, the CWEST team turned its attention to the question of an appropriate delivery platform.

The team decided to pursue the idea of a touch-screen kiosk, possibly with multimedia, so that the expert system could be made available in convenient locations, and the system would be appealing and easy to use, even by students who are not computer literate. However, the decision to field the system on a touch-screen kiosk platform had an unexpected impact on the project. Almost immediately, the team realized that a CWEST kiosk could be used for many other applications, such as maps and general campus information, access to mainframe information, and (perhaps) on-line registration.

As the team sorted through kiosk application possibilities, the definition and scope of the CWEST project went through alternating cycles of expansion and contraction, accompanied by rising and sinking levels of enthusiasm, anxiety, and confusion on the part of the team members. One fact was emerging clearly, however: the team's vision of CWEST had become too large an undertaking for the Sinclair team to complete on its own.

Phase Two: Development

The difficulty of scope and resources was resolved in December of 1992, when Sinclair formed a partnership with The Robinson Group (TRG) to combine the CWEST advising expert systems with TRG's Intouch kiosk software. The TRG/Sinclair partnership was formed after a single meeting at which demonstration software was exchanged. It was immediately apparent to both parties that the products were complementary and compatible in concept and function.

In the knowledge engineering phase, the CWEST team used a sophisticated expert system shell for rapid prototyping. However, to field test the system it was necessary to rewrite all the rules and algorithms in other languages (ToolBook script and C, specifically) so that the modules would be compatible with the Intouch kiosk software and the touch-screen interactivity. The AI modules were also redesigned internally to be primarily table-driven, so that they can be modified with relative ease to fit another institution's programs and course load factors.

Phase Three: Implementation:

The software merge was accomplished during the winter and spring of 1993. In May of 1993, Sinclair installed six kiosks (in six different buildings on campus) running the combined TRG/SCC Intouch software, initially in stand-alone mode. In August the kiosks were connected to the campus network for access to Colleague databases. Since then, new features and enhancements are continually being added in response to suggestions of administrators, staff, and students, and additional kiosks will soon be installed on campus and at off-campus locations. Sinclair is also in the process of implementing a telephone registration system, and is working on an interface between the kiosks and the telephone system.

Implications

The CWEST project, which began as an AI initiative, has evolved in directions unanticipated by its authors. This is not at all unusual for an AI project. In recent years, many software developers working with AI and expert systems are recognizing that AI cannot be a stand-alone technology; to be successful, AI must be integrated smoothly into comprehensive information systems that include many other components, such as relational databases, graphical user interfaces, multimedia, and traditional non-AI programming. In the Intouch system, the AI modules make up only a small portion of the total program code, yet they contribute dis-proportionally to the value of the kiosk.

Based upon Sinclair's experience, the authors conclude that integrating expert systems and traditional software is fairly difficult to accomplish. There are two fundamental reasons why this is the case: 1) the development process for an expert system is usually quite different from traditional software development process; and 2) the software tool kits are not usually compatible. The expert system tool kits (or "shells") have been designed to support the non-traditional style of development preferred by the artificial intelligentsia.

A traditional software application is designed to satisfy a very specific purpose which is clearly and precisely defined, usually in formal specifications. Typically, every aspect of the application is discussed carefully with the client, and all decisions meticulously documented before the programmer writes a line of code. A typical expert system, in contrast, is not exactly designed. The process of design starts out as a fuzzy, ill-defined idea and then grows exponentially into a larger fuzzy composite of ideas. At some point during its non-linear development cycle, the expert system begins to acquire a shape and purpose, and the authors and domain experts suddenly understand what it was that they meant to be doing all along.

This is a process called "knowledge engineering," and the development style is "iterative," which is another way of saying "trial and error." It is an exploratory style in which the authors begin with a few "if-then" rules to solve a problem, and then add more and more refinements until the system behaves, more or less, as desired. For example, one could start with the rule: "If you have a full time job and five children at home, you should not take any more than one class at a time." Then one could add more rules to advise the student about his/her credit hour load: level of job stress, ages of children, grade point average, the level of support received from home for school work, etc. While this might seem to be a straight-forward process, the designers found out what it is not.

The first challenge (and sometimes the primary challenge) is to articulate clearly what the question is that the designers are trying to solve. For example, the CWEST team began with the question, "What courses should I take next term?". It soon became apparent that the scope of that question was so large and complex that it needed to be broken down into a series of smaller chunks, such as:

"What courses do I have left to take?"

"How many credit hours should I take?"

"What courses are required for my major?"

"What courses have I already taken?"

"Which of these are offered next term?"

"Which of these have I had the pre-reqs for?"

It might be obvious that steps two through four above are identical to the steps required to do a degree audit -- that is, matching degree requirements and completed courses to determine remaining requirements. While a degree audit is a very challenging data processing problem, it is not necessarily an AI problem. However, the first chunk, "How many credit hours should I take?" is exactly the kind of "squishy" and elusive problem best suited to an AI solution. This question became the first chunk that the CWEST team set out to solve.

As many advisors are aware, credit hour load is a very critical question for the majority of students at community colleges -- the older students trying to balance their commitments to jobs and families along with college classes. Although it is posed as the simple scheduling question, "How many credit hours should I take?", the credit hour load question serves as a spring board into an exploration of complex personal and academic issues that will have a bearing on the student's success. Knowledge engineering, in this case, involved codifying the judgment and expertise of several academic counselors who have worked personally with hundreds (or probably thousands) of students.

Another AI module addresses the question "What major should I choose?" To develop this module, the authors researched materials used by career counselors, such as the Strong-Campbell Interest Inventory, the Myers-Briggs test, and job classifications used in the Dictionary of Occupational Titles, published by the Department of Commerce. After studying these and several other instruments, the CWEST team decided that none of the existing question sets was appropriate for the CWEST application. Most were much too long; kiosk users would not have the patience to answer more than about 20 questions. Further, the kiosk application should be specific to Sinclair programs, rather than a comprehensive career advisor such as the DISCOVER system marketed by American College Testing Program, or SIGI PLUS from the Educational Testing Service. Finally, the questions should address academic interests as well as career interests, since the module is to suggest possible Sinclair majors, rather than job titles.

After many weeks of work, a list of relevant questions was narrowed down from a few hundred to about twenty. Careful consideration was given to the wording of each question, so that the student would give as honest a reply as possible. Then Sinclair's academic advisors were asked to rate each degree program on each of the factors, such as the program's emphasis on writing or math or scientific problem solving. All of the ratings were entered into a database, and a matching algorithm was developed to match the student's responses with the ratings for each of the various degree programs. When the student runs the module, the kiosk asks the student to rate himself on each factor, usually on a scale of one to ten. The output to the student is a list of the five best matches.

Validation and Verification

Expert systems are notoriously difficult to test, since they deal with "squishy" factors, and the accuracy of the recommendation is a usually a matter of subjective opinion. Further, making adjustments to the rules to fix one "wrong" case will frequently cause problems for other cases that were working correctly.

Another challenge is finding appropriate human subjects. The CWEST team felt that it was very important to test the advising modules with many different groups of students who represent the diversity of our student population. Initially our volunteer beta-testers came from the Accounting Club and Student Government. However, we found that these students tended to represent the higher levels of academic achievement and ability. To find more representative samples, we used students who were waiting for appointments with counselors, and also students from first-term English classes.

The credit hour load module has been tested exhaustively, using written surveys and live beta tests. The "major choices" module has also been tested extensively in beta mode, and its actual use is being tracked in log files where responses and recommendations are recorded. These log files will be used for continuing evaluation of the module's recommendations.

Results

Sinclair's six kiosks have been running continuously since late May, 1993. The volume of use varies from 10 to 100 users per day per kiosk, with the peak activity (to date) during the registration period for Fall Quarter. While all of the main menu options are getting steady use, the most popular function is the access to personal records in the Colleague system, which currently includes unofficial transcripts and class schedules.

Each of Sinclair's Intouch kiosks with automated advising is currently providing the following services to students, based on activity recorded during September 1993:

41 hrs/month - academic advising

42 hrs/month - access to personal records

15 hrs/month - financial information & assistance

2 hrs/month - employment information

11 hrs/month - general campus information

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111 hrs/month - total time in use

If performed by humans, these services would cost the institution about $1,542 per month. This figure is based on salaries (plus fringe benefits) of people who would typically provide equivalent service:

534 academic counselors (41 hours), clerical staff (59 hours), and student employees (11 hours). The total cost of a kiosk, including installation costs (spread over four years) plus annual maintenance, is estimated as about $600 per month, or less than 40% of the "equivalent" human cost.

Future Applications

At Sinclair, the Intouch kiosk system marks the beginning of a revolutionary shift in the use of institutional database systems, from exclusive use by administrators and staff to direct, hands-on access by students. In fact, it is not difficult to imagine that students eventually will become the primary users of administrative systems. This drastic shift in the user base will have important implications for the structure and contents of administrative computer systems. As direct access by students becomes more prevalent, the institutional information systems can be expected to evolve along several dimensions:

1. Database content

Institutions typically maintain items of information about courses, sections, students, and personnel which are critical to the administration of the institution, and much of this is useful to students. However, a student's need for information goes far beyond the data about class schedules and program requirements. Students are hungry for more qualitative information. Which courses in biology are really tough and time-consuming? What is Professor Jones' teaching style? Does she emphasize lectures, class discussion, research papers, weekly exams? What is the syllabus for ENG 219? What percentage of students dropped out of CHEM 312? Should I take calculus along with physics? This is "consumer-oriented" information that students, as customers, want to know when they are making choices about the educational products of the institution. Currently students are obtaining this qualitative information almost entirely from other students.

2. Presentation of Information

Screen displays, as well as the navigation through a computer application, are typically designed with a particular type of user in mind. As students become direct users of institutional databases, the designers of screens will need to consider aesthetic appeal, ease of use, and especially the comprehension of information, from the students' point of view. Much of our current database information is stored in the form of codes which are meaningful to administrators and staff (and very efficient to store), but meaningless to students.

3. Security and Integrity

While read-only access by students is becoming fairly wide-spread, few institutions are yet allowing direct updates of their databases by students, except through scripted telephone registration systems. In the future, most student information in administrative databases will be input directly by students. Security issues will need to be developed for adequate protection of privacy and data integrity. Processes developed for personal identification and PIN handling in telephone registration systems are a start.

4. Inter-Institutional Information Exchange

The electronic exchange of information between institutions could significantly improve services to students. In the future, Electronic Data Interchange (EDI) will facilitate the transfer of student records, and also many other types of information. The need for EDI is especially evident in community colleges, in which significant numbers of students are either transferring credits into the institution or planning to transfer to a four-year school after graduation. It is often difficult and frustrating for students to obtain information about the transferability of specific courses between specific institutions. Electronic exchanges of articulation agreements and course-by-course equivalencies could certainly reduce the level of students' frustration and confusion.

5. Multimedia Databases

Student access to institutional information could also provide the impetus for developing multimedia databases, which would be accessible through kiosks and the electronic highway of the future. These might include images and voice recordings of faculty and staff, campus maps, multimedia campus tours, and pictures of labs, classrooms, and residence halls.

6. Crossing the Course Section Boundary

Traditionally, administrative systems have treated the course section as an atomic unit -- an indivisible chunk recorded in the student's transcript with a grade, credit hours, and course title. In course scheduling and faculty load assignments, the section is also treated as an atomic unit. The management of entities larger than sections (that is, courses and degree programs) have traditionally fallen under the jurisdiction of the administration, while record-keeping below the section level -- the syllabus, sequence of topics, assignments, test scores -- have traditionally been regarded as the domain of the professor teaching the class. Students obviously have an on-going need for information both above and below the course-section boundary. Access by students to administrative information could generate pressure for institutions to look at ways of integrating instructors' class records into the central information systems, although the political implications could be formidable.

7. Feedback from our Customers

In the future, devices such as kiosks, telephones, and desktop computers will facilitate two-way communication between the institution and the student body by means of surveys and polls, as well as direct communication. As students become a primary user base of administrative systems, it will also be critical for software designers to obtain input from students regarding their information needs and the usability of information systems. Institutions will need to develop processes for organizing student focus groups and volunteers for beta testing, as Sinclair has done throughout the development of the expert systems and other components of the Intouch kiosk software.

In summary, Sinclair's Intouch kiosk system provides a glimpse (if not a comprehensive vision), of things to come in the evolution of computing in higher education. As an institution, Sinclair feels strongly that the driving force of the revolutionary changes ahead will be the student as the primary user of our institutional information systems.

Section Four: Summary and Conclusion

The purpose of this paper was to illustrate how institutions can create new, service-related products based upon the effective use of information resources. The authors identified the social, political, economic, and technological factors that accelerate or decelerate the process of creating new products. The authors presented a conceptual framework to illustrate the potential of the information resource, ranging from data to wisdom. They also illustrated the capability of technology to optimize the information resources through the integration of technology and revised business processes. Finally, the authors shared their experience in informationalizing an institution, Sinclair Community College. They described how Sinclair is informationalizing by advancing the information contintunuum_to wisdom, using technology such as an expert system for advising, accessible through campus kiosks.

The authors conclusion draws from the "wisdom" of the student who was cited in the introduction:

"The most helpful tools are those that let me get the information when I need it without having to stand in long lines. I don't necessarily feel that I have to ask people questions to get simple information. If I have a genuine problem, then I will go through the process of seeing someone like an advisor. But if I just want to get simple information, like where is something on campus, I can to go to the touch screen system on campus and just punch it in and find it out. I can go back as many times as I have to, and I am not embarrassed talking about it. First week of class, I can walk up to a kiosk and find out where my class is instead of walking around campus like a goof ball carrying it around. "