University of Delaware, Newark, Delaware

Each year the University of Delaware in Newark, Delaware admits about 2000 students to its graduate programs. Nearly 200 staff and faculty members participate in screening about 5000 applications for admission to 46 different programs. A central Office of Graduate Studies has primary responsibility for processing applications and verifying data for accuracy and completeness and co-ordinates the efforts of the various departments involved.

The University of Delaware has moved into a new era of computing and has embraced new and emerging technologies by seamlessly fitting them in with legacy systems. Graduate Admissions on the World Wide Web is just one of the many areas where the university has taken this approach. Processes have been developed to interface with the University of Delaware's Student Information System (SIS) so that admission decisions made using the web application are reflected in real time in SIS. This system has been a very big success story -- one hundred percent of the graduate admissions decisions for the 1996 academic year were made on the web. Paper work and processing time have been drastically reduced. Communications between graduate schools and the Office of Graduate Studies and between faculty members on graduate admissions committees have been automated. Departments are very quickly adapting to this re-engineering of their way of doing business and are requesting additional features and functions.

The system won two awards in 1996: The 1996 Technology Innovation Award from the President of the University of Delaware and The 1996 Exemplary Model of Administrative Leadership Award from the American Association of University Administrators.
I. Introduction and Background

In January 1996, the University of Delaware went live with Graduate Admissions on the World Wide Web. This was a dramatic approach to using the Web as something more than just a delivery tool. The system did much more than that -- it delivered information, captured user responses and did on-line real time updates to the central administrative system.

It was a brand new approach to the use of emerging technologies while leveraging existing technology. Response was excellent and users are enthusiastic about this new system.

Since 1990, the university has had a Student Information System (SIS) running on an IBM mainframe. All student data, from application to graduation, is stored in this system. The programming language is COBOL and the system runs under CICS. The database used is ADABAS. In addition to the on-line CICS portion of the system, there are several batch COBOL programs which perform mass data processing. Enhancements to the system are usually handled by writing programs in a fourth generation language called NATURAL.

In the fall of 1995 the Management Information Services (MIS) department was charged with the task of designing, developing and implementing a system which would use the existing Student Information System (SIS) on the IBM mainframe and build upon it to enable processing of Graduate Admission applications through the world wide web.

MIS worked closely with the Office of Graduate Studies and the user departments to design the system. In a short three months, MIS was able to deliver the system, as promised, on January 2, 1996.

As users got familiar with the features and capabilities of the system, they began seeing the benefits and asking for enhancements. Enhancements to the system are on-going, and are continuing to improve service to the university community.
II. Graduate Admissions -- Processing

*Pre-Web Processing:* Prior to implementing Graduate Admissions on the World Wide Web, applications were handled manually for the most part. The work flow was as follows:

All application forms came in to the Office of Graduate Studies. Staff of this office checked them and added corrections if needed. Batches of forms were sent to be entered into transaction formats by data entry personnel. A batch COBOL program ran to update these transactions into SIS. The forms went back to the Office of Graduate Studies. The Office of Graduate Studies prepared a 'blue form' for each applicant which contained detailed information about the applicant. Application forms were sorted and sent along with these 'blue forms' to the concerned departments. In the departments, paper files were created for each applicant. These files were circulated among members of the department's graduate admissions committee for review and evaluation. It is estimated that each application was handled sixteen times and it took up to five weeks for an application to reach the graduate admissions committee. Once admission decisions were made, the department notified the Office of Graduate Studies. Staff of this office would then manually update SIS with this information and send out letters of admission to applicants. It took several weeks for all this manual processing to be done.

*Post-Web Processing:* After implementing Graduate Admissions on the World Wide Web, there was a dramatic change to the work flow:

As before, applications come in to the Office of Graduate Studies. Staff of this office check them and add corrections if needed. Batches of forms are sent to be entered into transaction formats by data entry personnel. A batch COBOL program runs to update these transactions into SIS. The forms go back to the Office of Graduate Studies. At this point, there is a change in the way information is handled.

Every night, a batch COBOL job runs to examine pending applications and identify new applications which went into the system on the previous day. Each member of every department's graduate admissions committee is sent an e-mail message if there is a new applicant to that department. The Office of Graduate Studies no longer sends application forms and 'blue forms' to the departments. Faculty on the graduate admissions committee of a department use a web browser to get into the Graduate Admissions system on the world wide web. It is estimated that each application is handled five times and application information is available to faculty in two to three days. They can then use the system to review admission applications and applicant details (the former 'blue form'), make comments which can be viewed by other committee members and make admission and financial aid decisions. Once a decision is made, SIS is updated electronically in real time. An e-mail message is sent to the Office of Graduate Studies informing them of the decision. The Office of Graduate Studies sends out letters of admission to applicants. A task that once took weeks is now accomplished in just a few days.
III. Major Features of the new system

*Security:* This is a system with three levels of security.

*Real-time Updates:* The centralized Student Information System is updated in real-time so changes are immediately visible to other users.

*Live Lists:* The five different lists of students the user sees are built in real time from the mainframe database, so they are always up to date.

*Speed:* The system enables users to accomplish in days tasks that took weeks.

*Accuracy:* Greater accuracy is possible due to elimination of manual processes like the preparation of the 'blue form'.

*Minimal Development Costs:* In terms of time and money, costs were minimal. From design to implementation took about 4.5 man months. Web browsers did not have to be purchased, since they are practically free to educational institutions.

*Minimal Training and Deployment Costs:* Most of the users were already used to using the world wide web for other business and only needed to be trained in the functionality of this system. Since they were already using web browsers, many users did not need deployment of a browser on their system.

*Multi-platform:* Web browsers are available for most systems (viz. PCs, Macs, Unix) and this system can be used from any popular web browser.

*Flex-Time:* Users are no longer restricted to working on admissions during regular office hours, since the system is up most of the time.

*Flex-Location:* Users are no longer restricted to working on admissions in the office, or even in the city, state or country, since the system is accessible from practically anywhere in the world.

*Paperless:* The system has virtually eliminated use of paper in the admission process itself. There are still holes that need to be plugged (eg. Transcript imaging), but no additional paper is generated during the process.

*Better Communications:* Faculty members on admissions committees no longer need to find common time to meet and decide on admissions. They can make comments and recommendations on-line and view each other's comments when they wish.
**Fingertip Data Access:** Data is easily available on-line so the user does not have to go to a report or a file for reference.

IV. Functions of the new system

**Getting Started:** Users can access the system from a web browser. All popular browsers are supported (e.g. Netscape, CompuServe, America On-line, Lynx). When a user clicks on the Graduate Admissions link, a password and userid screen is presented. A valid password and userid are needed to enter the system.

**Main Menu Options:** Once the user passes the password screen, a menu of options is presented. This includes five lists of students, a download option, and two options which give additional information related to GRE scores. The five lists are the Pre-Decision List, the Post-Decision List, the Rejected Students List, the Students who are missing Credentials and the Not Paid Applicant List.

**Processing Lists:** When the user clicks on one of the list options, a list of students of the appropriate type, belonging to the user's department, is presented. If the user wants to see further information about or process one of the students on the list, the user clicks on the student's name. A screen is presented with all relevant application information about that student. Additionally, specific menu options appear depending on the list being processed.

**Pre-Decision List:** This list contains applicants about whom an admission decision is still to be made. When the user clicks on a student's name from the list, a screen with application detail is presented. The user is also given options to choose from this screen. There are options to admit the student, reject the application, defer the application to a future term, make comments about the application, or view comments made by other users. Generally, the decision to admit or reject is a committee decision. Members of the committee review applications and type in their comments. They can also view other members' comments. The chairperson of the committee does a final review of all the comments and makes the final decision. Once the chairperson clicks on the admit or reject option, the mainframe SIS system is updated in real time. An e-mail message which is sent to the Office of Graduate Studies. The user is notified that the process is complete and can go on to another application. Financial Aid decisions, which can be made either at the time of admission, or later from the post-decision list, are handled in a similar manner.

**Post-Decision Processing:** This list contains all the students about whom a decision has already been made. This list does not include rejected applicants. Further information about a student can be viewed by clicking on the student's name. From the detail screen presented, the user can either choose an option to make a financial aid offer, or defer the student to a different term or make certain types of changes to the admission status.

**Rejected Applicant List:** This is a list of applicants whose application for admission has been rejected.
Clicking on a student's name gives further details. This option allows departments to review rejection decisions.

**Applicants Who Are Missing Credentials:** This is a list of applicants who have one or more missing credentials. Codes indicate what items are missing. A handy key is presented to the user to let the user know what the codes mean. This is sometimes used by departments to waive certain requirements (e.g. if a student has two out of three recommendation letters and all the other credentials are excellent, the department may waive the third letter).

**Not Paid Applicant List:** This is a list of students who have sent in application forms, but have not yet paid the application fee. Clicking on a student name enables the user to view more information about the applicant. The same options are available as from the pre-decision list.

**Download Options:** This option enables the user to download data from the Pre-decision list, the Post-Decision list or both to their PC. When the user clicks on this option, a screen is presented for the user to enter selection criteria. The user can select the type of software that will be used to view the data (e.g. Excel, Wordperfect), the type of list to extract from (pre-decision, post-decision, or both), the fields to be extracted and the order in which they should be extracted. Additionally, an option is provided for the user to save this template for the next time the user wishes to download data.

**GRE Tape Mailing Dates:** This is one of the options from the main menu. The user can see a list of dates when GRE tapes will be mailed out from ETS. The list of dates is provided by ETS. This is useful for departments which are trying to decide admissions based on unofficial student reported scores.

**GRE Scores:** This is one of the options from the main menu. When a new GRE tape comes in from ETS, the information on the tape is appended to a dataset on the mainframe. Users can view this dataset by specifying selection criteria. Selection can be done to view students by SSN or last name, or to view students with a certain minimum total score on the GRE exam. Some value is added to the basic information that comes in on the tape from ETS, in the form of various exam score totals. This is useful for recruiting new students.

V. Technical Information

**Technology:** Leveraging the existing Student Information System is one of the primary strengths of the Graduate Admissions system. Additionally, the system employs other technology -- Hyper Text Markup Language (HTML), the use of client/server protocols, screen scraping, e-mail.
**Process Flow:**

Security: One of the biggest issues for any new system on the world wide web is security. At Delaware, this is handled by providing three layers of security. Firstly, the application is secured by means of secure socket layer data encryption. This is done through a Unix box which encrypts data before it is passed to the network. Next, when the user clicks on the Graduate Admissions link, a userid and password screen is presented. Only users with a valid userid and password combination can access the system. Thirdly, there is a table of userids and access levels which controls what a particular faculty member can view or update. When the user enters a valid userid and password, the system calls a NATURAL program on the mainframe. This program looks up a table based on userids, on the mainframe. The table also contains information about the department the user can access. The user can only see and process information about applicants to that particular department.

Processing Technique: Whenever the user clicks on a particular link or option, the system goes to the secure socket layer server, which is a CGI program on a Unix box. The request is encrypted before
being forwarded to the IBM mainframe through a TCP/IP client subroutine. On the IBM, there is a
NATURAL server which forwards the request to a NATURAL sub-program. The sub-program
processes information against live SIS ADABAS files and passes back a response. The response
comes back to the CGI program and is decrypted and sent to the user.

There are three types of information processing done by the NATURAL sub-programs on the
mainframe. The first is a request for information (eg., clicking on the Pre-decision List option from the
main menu or clicking on a student name from a list of students to get more information about that
particular student). This is handled by reading the ADABAS files, selecting data to fit the selection
criteria, formatting the data, wrapping HTML around the data and sending back the response. The
second type of request is a request for a blank form to fill in data (eg., clicking on the Make a
Comment option). The NATURAL sub-program formats a standard input form, with HTML, and
sends it back to the user. The third type of request is related to updating information in the database
(eg., clicking on the Admit Applicant option). The NATURAL sub-program calls a screen scraper
server on a Unix box with data. The server program forwards the request to a screen scraper program
which simulates an operator entering data on an on-line CICS screen on the IBM mainframe and does
the update in real time. This technique was employed so that processing logic already in place in the
legacy SIS system could be employed without having to write special update routines. The screen
scraper program returns information about the success or failure of the update to the NATURAL sub-
program, which conveys this to the user.

VI. Planned Enhancements

Several enhancements to the system are either in progress or planned for the future:

Transcript Imaging: One of the most important documents that must accompany an application for
admission is the transcript. Currently, the Office of Graduate Studies receives transcripts and sends
them by campus mail to the department concerned. In future, transcripts will be scanned into a central
server and there will be an option from the web browser to be able to view the image on-line.

Document Imaging: Similar to transcripts, there are other documents which need to be reviewed
prior to making admissions decisions. Examples of these are recommendation letters and essays
(required from the applicant for certain departments). In future, these documents will also be available
on-line.
VII. Summary

Emerging technologies are increasingly changing the way we do business. The challenge is to effectively and efficiently integrate new technology with existing systems to provide cost effective solutions which enhance productivity. It should be the intent of new technology to re-engineer the way we do business, not to re-engineer the business itself. At Delaware, this challenge is being met by merging new processes with legacy systems taking advantage of the strengths inherent in both technologies.

Graduate Admissions on the World Wide Web has been a pioneering step in this direction, paving the way to using the world wide web as more than just a data delivery tool. This system makes use of diverse technologies to achieve this goal -- HTML, client/server protocols, screen scraping and e-mail.

The real success of this system lies in the fact that it has led legacy system users in this and other areas into new ways of thinking and a new appreciation of the benefits new technology has to offer. The coming years promise much excitement and opportunity and we hope to be able to meet the challenge and achieve the promise of information technology.