Managing Large Volumes of Assignments

A system designed to cope with a growing volume of assignments has lowered costs, reduced errors, and increased satisfaction of students and faculty

By **James Park** and **John Hagen, Jr.**

In spring 2003, the Distance Education Network (DEN), Viterbi School of Engineering at the University of Southern California (USC), had 860 students and more than 1,000 enrollments in 70 courses toward 10 different degrees. (See the sidebar "About DEN.") Typically, for assignments in engineering courses, professors require students to show how their answers are derived so that they can review student analyses and progress and make notes accordingly. This results in complex formulas and drawings that cannot be written easily with desktop software. In a distance education setting, the obvious tool for this situation is the fax machine. Fax machines are widely accessible and provide a simple way for students to submit handwritten work.

In some distance education programs, students and professors exchange documents directly. The benefit to this approach is minimal administration. The downside is that a student's work is not archived, logged, or receipted, which makes student vigilance a necessary part of quality control. DEN, on the other hand, has committed to providing a means through which student work is channeled and recorded.

As a service to DEN students and professors, a document center was created to keep a record of assignments submitted, graded, and returned to students. In spring 2003, the center manually assembled, logged, and distributed more than 25,000 pages of incoming faxed homework, with assignments averaging 10 pages in length. After TAs and professors graded and returned these 25,000 pages to the center, the staff—which consisted of one full-time employee and 11 part-time student workers—manually logged and scanned them and e-mailed them to the students. We at DEN realized we had simply "hit the wall" with fax machines. The inherent limitations of stand-alone fax machines became a problem we had to address.

The Early System

In the early days of the fax system, DEN students downloaded blank cover sheets from the Web, which they completed by hand, and faxed homework to one of three fax machines on campus. Students indicated on the cover sheet the number of pages being faxed, but due to both transmission and simple counting errors, this number frequently varied from the number of pages received. Staff dealt with collation, error handling, and problem resolution while trying to meet timely delivery goals. Furthermore, each fax machine had a single dedicated analog telephone line, resulting in occasional waits for students who were forced during busy times to keep dialing until they reached an available machine.

Many of the problems with stand-alone fax machines manifest themselves during unstaffed times, such as weekends:

■ Consumables, including toner and paper, run out.
■ Fax machine memory becomes full.

About DEN

Established in 1972, DEN provides working engineering professionals the opportunity to pursue advanced degrees from anywhere in the world. When C. L. Max Nikias was appointed Dean of the Viterbi School of Engineering in 2001, he made distance education a top priority and provided the resources to make the program state-of-the-art, and the Viterbi School today consistently ranks as one of the top e-learning graduate programs for engineering. DEN offers distance enrollment for courses currently offered on campus. Class lectures are posted online in streaming audio and video. Students have the option of joining class lectures in real time and participating in live chat, or dialing an 800 number to interact with the professor and other students. DEN currently offers 14 degrees, as well as enrollment options for non-degree and audit students.

- Fax receipts are automatically generated, even for work that is not received in whole or in part due to consumable or memory problems.
- Homework assignments can end up in disarray on the floor, requiring hand sorting by document center staff.

The center coped with these problems by increasing staffing for high-load periods, such as weekends and during deadlines, and by creating a plan to achieve a more automatic and scalable method for processing homework. Nonetheless, the risk of failure in managing the flow of paperwork between professors and students became unacceptable. What DEN needed was to create a new structure that was accountable, scalable, and compatible with its systems and values.

The Search for a Solution

Automated delivery was at the top of DEN's list of desired features. Eliminating manual renaming and routing of documents would minimize the possibility of human error in document handling and ease the staff workload. Additionally, an automated system would allow us to focus on other issues related to faculty and student service. The primary evaluation criterion was performance, but not at any price. We needed a solution that would quickly pay for itself while meeting our delivery-excellence goals. The search began early in the budget cycle, enabling us to submit the costs for approval as part of our 2003–2004 capital expenditure allocation.

The first step toward an acceptable solution was to set up a fax server—a network computer that would interface to the telephone network either directly or through a private branch exchange (PBX). Fax servers include one or more intelligent fax boards for sending and receiving faxes. With a fax server, homework is automatically logged and converted from 10–30 individual pages to one TIFF file—no more collation and assemblage!

DEN began discussing options with Biscom, a well-established fax server company founded by engineers. We learned that fax servers offer routing options based on the sender's telephone number, if available (it comes through printed on the top of the fax), or on the number that is directly dialed. For DEN, neither option was viable. Students' corporate environments have too many fax numbers for dialer identification to be practical, and 14 percent of our students are enrolled in more than one course, further complicating the problem. Dial-in numbers would not have worked either because DEN had three telephone lines and 70 courses.

Representatives at Biscom referred us to a software partner, Reportée, that offers SmartForms, custom-designed forms programmed for automatic processing with its SmartCapture software. Officials from Reportée worked with DEN to assess our goals and proposed a custom solution that would scale with our anticipated growth. In fall 2003, DEN implemented a homework processing system that included Reportée SmartForms and Biscom FAXCOM fax server software.

Setting Up the Fax Server

We originally assumed that a two-port fax server, with each port capable of receiving one page per minute, would suffice. An operational analysis concluded, however, that a four-port server was required to handle peak periods and planned growth. We took advantage of an idle server the department already owned and built a Windows 2000 fax server. Biscom provided the four-port analog fax board, the fax server software, and support for the installation, which we did on our own.

Reportée then remotely installed its software on the server. Reportée's fax capture software automatically creates "ungraded" course directories based on course ID whenever it receives an incoming fax for a new course. DEN added a "Graded" directory to receive documents from our high-speed scanner. Existing "Individual Student" directories receive the graded assignments, which can be accessed by a Web portal available to our students.

The fax server allowed homework to be received, logged, and archived and eliminated the problems associated with consumables. It was a huge relief not to have to worry about losing documents from our conventional fax machine, and with storage space costing less than one dollar per gigabyte, we can hold an entire year's faxes in one central location for just dollars per year.

Data Integration: Web Services

An issue of significant concern was the secure exchange of student data with Reportée on our Windows fax server. We wanted Reportée to have access to DEN cover sheet information without opening up our complete student database. Additionally, we were planning to move our student database from Windows to UNIX.
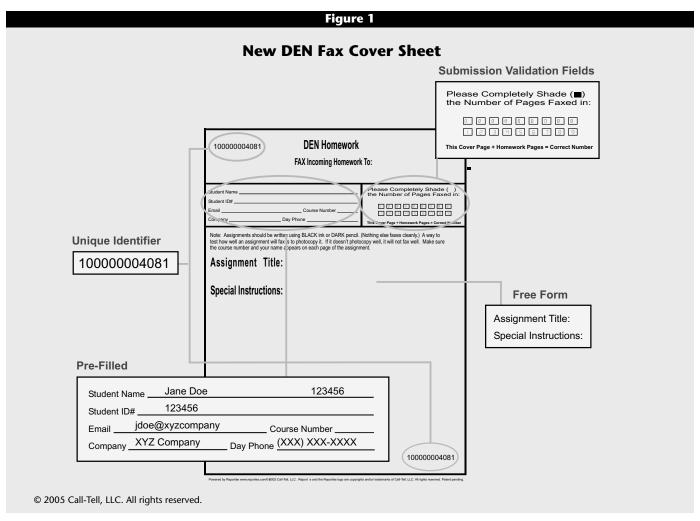
Reportée suggested using Web Services for integration, an idea endorsed by Chris Soto, DEN's technical support engineer. Web Services, which are XML-based, provide connectivity and interoperability between applications. Using Web Services, disparate systems can exchange data securely, reliably, and without complex and expensive custom coding. Soto believed in Web Services as a strategy and knew that they addressed the concern for student security because the fax server would reside behind DEN's firewall. Because Web Services are platform- and language-independent, DEN's Oracle database could "talk to" the Windows 2000 Reportée/Biscom server. Reportée's John Hagen designed three Web Services interfaces that transfer information between the two servers: RequestCoversheet, RequestCoursework, and RequestGradedWork.

The New Design

With the new system, students download a cover sheet for each course in which they are enrolled. The cover sheets are pre-filled with each student's information and a unique identifier (see Figure 1).

Obtaining Cover Sheets

Students log in to the Web portal and identify the course for which they need a cover sheet. This action invokes the first Web Service, RequestCoversheet, which receives the information from the Web portal and checks it against the local

Figure 1

New DEN Fax Cover Sheet

Submission Validation Fields

Please Completely Shade (■)
the Number of Pages Faxed in:

▢ ▢ ▢ ▢ ▢ ▢ ▢ ▢ ▢ ▢
▢ ▢ ▢ ▢ ▢ ▢ ▢ ▢ ▢ ▢

This Cover Page + Homework Pages = Correct Number

100000004081

DEN Homework

FAX Incoming Homework To:

Student Name _____
Student ID# _____
Email _____ Course Number _____
Company _____ Day Phone _____

Please Completely Shade ( )
the Number of Pages Faxed in:

▢ ▢ ▢ ▢ ▢ ▢ ▢ ▢ ▢ ▢
▢ ▢ ▢ ▢ ▢ ▢ ▢ ▢ ▢ ▢

This Cover Page + Homework Pages = Correct Number

Note: Assignments should be written using BLACK ink or DARK pencil. (Nothing else faxes cleanly.) A way to test how well an assignment will fax is to photocopy it. If it doesn't photocopy well, it will not fax well. Make sure the course number and your name appears on each page of the assignment.

Assignment Title:

Special Instructions:

Unique Identifier

100000004081

Free Form

Assignment Title:

Special Instructions:

Pre-Filled

Student Name __Jane Doe_____ 123456_____
Student ID# __123456_____
Email __jdoe@xyzcompany___ Course Number _____
Company __XYZ Company___ Day Phone __(XXX) XXX-XXXX__

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database. If any data have changed or if the student is new, Reportée updates the local database, generates a new cover sheet, and, if required, assigns a new unique identifier.

Reportée returns to the Web portal the appropriate cover sheet as a PDF file, which the student can then print and fax with the assignment. Along with the cover sheet, the software also transmits student ID number and course number, which ensures that during times of high traffic, the requesting application can uniquely match the response with the original request. The software also includes the unique identifier, allowing DEN operators to get involved as needed.

Submitting and Processing Assignments

On the cover sheet, students indicate the number of pages being faxed and can also use a "Free Form" area to enter information such as assignment title or special instructions. Students then fax assignments with the appropriate cover sheet to one of the three fax lines connected to the Biscom fax server.

The Reportée software retrieves the TIFF file from the "ungraded" folder on the fax server and extracts the unique identifier and the number of pages in the file. If the number of pages is correct, the Reportée software uses the second Web Service, RequestCoursework, to determine the appropriate course directory, based on student ID and course number; routes the assignment to that directory; and logs the transaction. Once the homework has been routed to the correct course directory, the application notifies the student by e-mail that the assignment has been received and attaches a copy of the TIFF file. Besides confirming receipt, this message allows the student to verify that the assignment was received in the form the student intended.

If the number of pages indicated doesn't match the number of pages received, an error notification is e-mailed to the student with the TIFF file. Homework is not considered successfully processed until the page count is correct. If the unique identifier cannot be read by the software, the homework and cover sheet are forwarded to a DEN e-mail address; DEN operators review the prefilled area of the cover sheet and manually route and log the homework, as well as send a receipt to the student.

Notifying Students of Graded Work

Instructors or their staff receive homework as hard copy in the document center. Graded work is returned to the DEN office, where it is scanned as TIFF files and placed in a "graded" folder on the fax server. When this occurs, the Reportée software retrieves the file and

extracts the unique identifier, invoking the third Web Service, RequestGradedWork. Using student ID and course number, the Web Service determines the individual student directory where the graded work should go. The TIFF file is converted to a PDF and placed in the appropriate directory. Once the homework has been routed to the correct student directory, the Reportée application notifies the student by e-mail that a new graded homework file is accessible online.

Adding E-Mail to the Process

As DEN expanded its curriculum, the need for automatic e-mail processing grew proportionately. In spring 2003, 25–30 percent of assignments were sent as e-mail; that number had climbed to 50 percent by fall 2004. Despite being electronic, e-mail involved a manual, labor-intensive workflow process. DEN staff had to open the e-mail, determine the student and course combination, make a copy of the e-mail, and put the assignment into the correct directory. Staff then had to rename the e-mail, log the entry, and type out a receipt. The growing e-mail volume was taking at least as much time as the faxes.

More problems were created because we were unable to reply immediately to e-mail. Students' expectations of real-time processing led to impatience and anxiety about the status of their e-mail assignments. Phones were busy with status inquiries, and e-mail processing mushroomed with follow-up e-mails, duplicate assignments, and even assignments sent separately as faxes. In effect, one transaction turned into two or more, each requiring labor.

In fall 2004, DEN added e-mail to our automatic fax-processing system. We were able to leverage many of the principles and features originally designed for fax processing. Students e-mail assignments with a USC cover sheet to the university. Reportée technology then parses information from the e-mail to identify the student and course, send a receipt to the student, and log information into the local database. The e-mail processing application uses the Request-Coursework Web Service for routing and receipting.

The Road Ahead

DEN's continued growth may mean adding fax ports. We might also look at leaving the analog lines behind and upgrading to digital telephony. With an eight-port digital system, we could move to fax over Internet protocol (FoIP) and add up to 250 direct inbound dialing (DID) numbers that would map automatically to users' e-mail accounts.

Although DEN's initial goal was to convert to a completely electronic system and to require homework to be graded in its electronic format, professors made it clear that until there is an electronic solution as easy and cost-effective as a pen, we needed to allow them to receive homework in a manner they could grade quickly—paper. The goal now is to increase access for faculty without forcing them to change and to provide options to help faculty migrate to electronic processing.

We plan to implement two of Reportée's upcoming features: an electronically "fillable" PDF cover sheet that can be processed automatically, and the ability to scan our graded homework as one batch per course. The software will use the cover sheets to separate, rename, and correctly route each student's assignment. Once these features are implemented (in 2005), our labor focus should see an 80 percent annual reduction relative to 2003, prior to our initial implementation.

Conclusion

Prior to implementing the Reportée/Biscom solution, about 30 percent of labor was focused on managing incoming faxes, 10 percent on managing e-mail, and 60 percent on scanning and returning homework. DEN's document center required staffing 60 hours per week and averaged 116 man-hours per week during the fall and spring semesters, unevenly distributed to meet student demand. Summer semesters were managed exclusively by one full-time employee.

The Reportée/Biscom project had little impact on DEN resources. Reportée's technical team installed the software and integrated it with the fax server, DEN's e-mail (SMTP) server, and the student Web portal. The team also developed the Web Services required to integrate the various systems. Very little training was required for DEN staff, IT personnel, or faculty to use the new system effectively. No training was necessary for students to use the new cover sheets. In fact, the pre-filled cover sheets mean less work for students, and their cover sheets are more legible, which is a benefit for staff.

Without any reduction in work/study staff, DEN projected a 71 percent cost savings over a two-year period, which we evaluated with enrollment numbers from spring 2003 through fall 2004. We are able to accommodate a growth rate of 10–20 percent per semester without adding personnel. Our reduced effort in processing homework has enabled us to better manage the rise in e-mail without increased staff and to address other activities that support departmental strategy. Furthermore, with the error rate substantially reduced, student satisfaction has climbed to new levels.

With our new system, the document center workload is significantly lower per enrollment, human error is minimal, and problems inherent with manual processing have been eliminated. Most importantly, we have achieved our goal of excellence in delivery and student service. A 2003 faculty survey indicated increased faculty satisfaction with our services. In fact, no dissatisfaction at all was expressed, which is a great improvement from previous years.

We believe we are truly taking the "distance" out of distance education. Technology enables real-time interaction between professors and students, and our new processing system delivers a level of efficiency equal to that of our digital classroom. *e*

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