An automated online exam system developed at Athabasca University is described in this paper. The underlying design and development is indicative of new digital processes that streamline the management and administration of distance education, allowing overall institutional costs to be contained while at the same time enabling a more comprehensive online learning experience for students.

Athabasca University is located in Alberta, Canada. Its mission is to reduce barriers that traditionally restrict access to university-level education for all adults. To accomplish this, it has adopted open access policies – for instance, offering distance education courses, admitting any adult regardless of prior education, arranging comprehensive transfer credit arrangements with other educational institutions, and pioneering work in prior learning assessment for university credit.

Students can start courses at any time during the year and can complete these at their own pace within a six month contract period. Individualized academic support is provided to homestudy students in the form of telephone and e-mail support from full-time faculty or part-time tutors. The University’s undergraduate business courses account for about 13,000 annual course registrations, or over 1/3 of the University’s total undergraduate registrations. At present, there are about 25 full-time faculty members and a number of part-time markers and academic experts, as well as about 20 full-time professional and student support staff.
The University’s level of government funding is based on how well the University achieves certain key performance indicators like number of graduates and percentage growth. The University has done well under this funding arrangement – undergraduate enrollments have grown more than 25% compounded annually over the last three years, and graduate programs even more – but state funding is not tied proportionately to growth in enrolment levels. As enrolments increase, the University receives a smaller percentage of its total revenue from government and becomes more reliant on tuition fees. Operating grants have shrunk from about 78% of total revenues to under 50% in just six years. As a result, innovation must be demonstrably cost effective in the long run in order to be supported and adopted across the institution.

Most of the undergraduate growth has occurred in independent study courses that still rely heavily on paper-based instructional material and an industrialised delivery model. Predictably, the University’s course development and delivery processes still exhibits many of the industrialized production characteristics described by Peters (1983). The institution continues to mass-produce standardized, carefully-structured instructional media, and differentiate course development, production, and instructional labour processes in order for instructors’ knowledge and skills to be transmitted in a cost-effective manner to a large number of students. Duties that would normally be performed by one classroom instructor are instead distributed among several members or units within the organization, and technology supplants many of the instructional techniques of face-to-face instruction.

This process incurs relatively high fixed costs, but low per-enrollment variable costs in the form of academic support to students. Since additional registrations in existing courses incur relatively small incremental costs, relatively small increases in enrollments can create significant additional net revenues.
However, the transition to new forms of distance education incorporating electronic communication technologies can affect cost behaviour. Although relatively fixed production costs may decrease somewhat, the increased interactivity afforded by new technologies means that variable costs – for example, payments to online instructors – will increase in relatively direct proportion to the number of students enrolled. Therefore, the overall effect of technology-based distributed learning within traditional distance-based universities – those that rely primarily on self-guided, printed instructional material- should be to increase costs.

To overcome this constraint, additional funds need to be accessed or further cost saving measures must be introduced concurrent with the development of a more interactive distance learning model. The School of Business Call Centre is an example of the latter approach. The Call Centre was designed to increase student access to administrative and academic support. Instead of the traditional one-on-one tutor-student relationship limited to a three-hour period each week, students can now call or e-mail front-line “learning facilitators” who are available approximately 60 hours per week. The Call Centre handles all initial academic, administrative or technical inquiries from students in School of Business homestudy and online courses. As well as improving student service, the introduction of the Call Centre has resulted in the reduction of the Centre’s overall delivery costs by about $100,000 per year. Efficiencies were mainly realized through the use of facilitators to route and track a larger number of student queries. Under the traditional tutorial delivery model, relatively high-paid part-time tutors were responsible for all aspects of interactions with a small cohort of students. The related financial savings enabled the School to commence development of an integrated Web-based learning environment using Lotus Notes and Domino software. By September 1, 2000, 15 paced, online business courses in “e-Class” format were offered. These courses can be accessed using standard Netscape Navigator and Internet Explorer web browsers. e-Classes commence every September and January for 15-
week periods. They involve cohorts of between 8 and 32 students, and are instructed by an online academic. The number of e-Class courses will rise to 40 by September, 2003. Group interactivity, audio/video streaming, simulations, electronic assignment submission, and related electronic student support services have gradually been introduced in various courses, although budget limitations increasingly constrain the introduction of new electronic learning enhancements. This is consistent with the findings of Rumble (1999), who suggested that economies of scale might be compromised as curriculum expands (p. 130).

The School of Business wished to continue the development of its e-Classes because of the perceived learning benefits of virtual classrooms. However, faced with these economic constraints, it began to re-examine all of its delivery processes to see if further costs savings could be realized. The scope of this review included all administrative processes, not just those normally associated with teaching activities. The most promising area for improvement, it was concluded, was the examination process.

At the time, all e-Class learning activities could be done electronically, except one. Paper-based exams were still used. Besides inconveniencing some students who were used to working onscreen, the system also incurred significant marking, postage, and clerical costs, and time delays. In January, 2001, the School of Business contracted with Sandbox Systems Inc. to develop a Lotus Notes-based electronic exam handling and administration system. This system was designed where possible to automate the marking process and the handling of the exam from generation to recording of the final mark in a student record database. The primary objectives were to provide a complete online learning experience for students, while increasing efficiencies and reducing costs across various sub-units within the University.

Extensive consultations about system design and functionality were carried out with School of Business and Registry Services staff. The initial phase of the system completed in April, 2001. For ease of handling and security reasons, the exam never leaves the online exam
database it is housed in. All writing and marking activity is completed within one secure database. Four to six complete exams are written for each course. When each exam has been reviewed and given final approval by the responsible academic, its status is changed from draft to active. The exams remain available unless they are placed on inactive status, at which time the exam must be revised or replaced. Registry Services staff are automatically notified when exam status changes to active or inactive.

The student completes a web-based exam request form. From this, information like exam name, course, instructor, student name, date of exam request, and date of writing are entered into the online exam system. Five electronic “forms” enable support staff to administer the online exam system. These allow them to maintain the exams, manage student and invigilation instructions and confirmation letters, track the progress of individual exams from authorization to the recording of exam marks, support the actual online exam process, and notify requisite staff members of changes in the status of an exam during the process (for example, when a student has finished writing an exam). These forms and other “backend” administrative functions are all maintained using Lotus Notes client software, though the exam itself is written via a Web browser (either Internet Explorer or Netscape Navigator).

One of the most challenging aspects of this project is the fact that the computers used by students to write the exams are not under the direct control of Athabasca University. Rather, these computers are located at various locations throughout Canada and abroad. To address this problem, approved invigilators supervise exams. The invigilator approval system is the same for online and paper-based exams administered by the University, although the management of this network will also be integrated with the electronic exam system at a later date. A list of approved invigilators and their locations is maintained on the Athabasca University website, and students choose invigilators and exam centers that are convenient to them. Invigilators are generally full-time faculty members at accredited colleges or
universities. The exams are usually written at the invigilator’s place of work. The invigilation
t network spans a wide variety of locales in Canada and around the world.

Once Registry Services has approved the invigilator, the exam is set up. E-mail
notifications of date and time of the upcoming exam are sent to the student and invigilator, as
well as separate user names and passwords. On the day of the exam, the student goes to the
invigilator’s office and uses a standard web browser to access the exam system. To begin the
exam, the student and then the invigilator log on. The exam is electronically time stamped at
the beginning and end of the exam period. Responses are automatically saved on a regular
basis throughout the exam to minimize the impact of network interruptions. When the student
finishes the exam and logs out, the invigilator also logs out using the specified user name and
password. The double log on procedure at the beginning and the end of the exam is an
important security feature that enhances the academic credibility of the exam.

Exams can contain multiple choice, short answer, and essay questions. All multiple
choice questions are automatically marked. If the exam contains any written responses, e-mail
is automatically sent to the specified marker with a link to the actual exam. For ease of
marking, solutions to the questions are provided for the markers on the same screen as the
students’ answers. The marking field for written questions includes an area for entering the
actual mark awarded and one for marker comments. This is an important feature if a student
wants to review the exam with an academic at a later date. When the marker has marked the
written portion of the exam and entered the marks for this portion of the exam into a field, a
button is clicked. The automated marking process is completed, and the final mark is
calculated by the system. This mark is automatically sent by e-mail to the student and the
academic course assistant. The course assistant records the mark in the University-wide
student tracking system.
In April, 2001 the exam system was piloted in two e-Class (online, grouped) course offerings. Over 30 online exams were written. School of Business technical staff communicated with invigilators to ensure that computer systems used for writing the exams were appropriately configured. The pilot project was conducted over about a two-week period. Information was gathered from participating students, invigilators, course assistants, and Registry Services staff responsible for administering the exams.

Students, invigilators, and University staff were generally satisfied with the system, though several problems were encountered. Some of the more notable ones were:

1. If there were network interruptions or if the browser needed to be shut down during the exam writing period for some reason, the exam security features would not allow students to log back into the exam.

2. There was confusion about whether the student or the invigilator needed to log on to the exam system first.

3. Some students were apprehensive at first because they were unfamiliar with the online exam environment.

4. Questions were entered by course assistants into the exam database using Lotus Notes client software, and then automatically translated into web pages viewable by a standard browser. However, when support staff created the exams there was no way to view how questions appeared on the Web. As a result, the appearance of some questions were different for course assistants and students.

5. Automatically generated e-mail notification of exam marks did not include the student name. This was acceptable if students received exam results directly, but in some instances, exam marks need to be routed to students through the Registry Services of other institutions. In these cases, the applicable student could not be identified.
6. Some unnecessary items needed to be filled out to set up an online exam. Some of the same information also needed to be entered by both students and Registry Services staff because the initial information could not be automatically transferred into the exam system when students filled out online exam requests.

To address these problems, the following features were added:

1. Invigilators and students are now able to continue exams that have been aborted due to network interruptions or other system problems.

2. A link to a demonstration exam has been included on the opening page of the online exam. A checkbox has also been included on the opening page of each exam where, prior to writing the exam, students must indicate that they have reviewed the process.

3. The academic course assistant can now view exam questions in a web browser at the same time that these are being created in Lotus Notes.

4. Data entry has been streamlined. Extraneous fields have been removed or made optional, and the names of some field names and labels have been clarified.

5. Automatically generated e-mails now contain students’ names.

6. E-mails containing invigilator user names and passwords, and other pertinent information are automatically e-mailed to the invigilator. This eliminates the need for telephone contact.

7. Auto generated reminders are e-mailed to students and invigilators 48 hours prior to the exam date.

8. Information in the online exam request form that is filled out by the student now populates the applicable fields in the exam system, eliminating the need for information to be re-entered by staff.
9. Registry Services is now automatically notified when a student has submitted an online exam request. Staff can approve and release the exam in one step.

This version of the system is being tested at present in several individualized homestudy courses with average enrolments of about 200 students per year.

Plans are also underway to extend this system across the University. In conjunction with this, several improvements to the system are planned:

1. Ability for markers to access the system through a standard web browser like Netscape Navigator or Internet Explorer.

2. Ability to automatically enter online exam results into a University-wide student mark system to further reduce the amount of information that needs to be entered manually by Athabasca University staff.

3. Ability to allow students to draw graphs and develop or manipulate formulas on paper, then automatically integrate these answers into the online marking and administrative system through the use of fax gateways.

4. Reduction of the amount of effort by staff to prepare both print and online versions of each exam, through the use of XML technology, for instance.

5. Introduction of item banking, in addition to exam banking, as well as response analysis.

As with any innovation, however, continuing discussions with academics within the School of Business, and with the University community in general is necessary for widespread adoption of this exam system. To date, progress has been steady and encouraging. Most notably, the ability of the online exam system to automate administrative processes and therefore ease demands on staff in both the School of Business and Registry Services has been key to its successful implementation.
Bibliography
