Journal of Universal Computer Science, vol. 13, no. 7 (2007), 1002-1011
submitted: 7/3/07, accepted: 25/7/07, appeared: 28/7/07 © *J.UCS*

Creating Online Graduate Engineering Degrees at the University of New Mexico

Gregory L. Heileman
(Department of Electrical & Computer Engineering
University of New Mexico, Albuquerque, USA
heileman@ece.unm.edu)

Chaouki T. Abdallah
(Department of Electrical & Computer Engineering
University of New Mexico, Albuquerque, USA
chaouki@ece.unm.edu)

Wei Shu
(Department of Electrical & Computer Engineering
University of New Mexico, Albuquerque, USA
shu@ece.unm.edu)

Christos G. Christodoulou
(Department of Electrical & Computer Engineering
University of New Mexico, Albuquerque, USA
cgc@ece.unm.edu)

Debby Knotts
(New Media & Extended Learning
University of New Mexico, Albuquerque, USA
debby@unm.edu)

Abstract: This paper describes the motivation, strategies, and implementation details that lead to the creation of online graduate-level degree programs in the Department of Electrical & Computer Engineering at the University of New Mexico. It also presents some of the benefits as well as the challenges encountered when designing and implementing these programs. The paper concludes with a discussion of lessons learned and the future directions of the program.

Key Words: Online degree, WebCT, graduate education
Category: K.3.1, H.4.3

1 Background

Although the state of New Mexico, in terms of land mass, is among the largest states in the United States of America, its population is very small relative to other states. Furthermore, the major population centers in New Mexico are widely dispersed. Thus, the University of New Mexico (UNM) has a long history of attempting to service remote students in the state, as described in [Figure 1]. For example, the birth of distance education at UNM can be traced back to correspondence courses offered as early as 1928. In the mid-1980's UNM began to make use of modern technologies to deliver courses via television, and by the late 1980's the University had established its first degree-granting distance education program. In 1997, the first online-only course was offered at UNM, and the very next year the University created a pilot project to test the use of WebCT technology for content delivery over the Internet. This was followed in 1999 by the establishment of an Extended University Department at UNM that became responsible for coordinating all of the University's distance education programs. One of the first actions of this department was the adoption of WebCT as the UNM learning management system for academic courses in 2000. This resulted in a steady growth of online courses offering at UNM that continues to the present time. Specifically, during the 2001-2002 academic year, 17 online courses were offered at UNM, with 220 students enrolling in these class, and by the 2004-2005 academic year, 124 online courses were provided, with an enrollment of 2,178 students. During the most recent academic year UNM offered 187 courses that were taken by 2,835 students. The growth in courses offered and enrollment since 2003 is depicted in [Figure 2].

Throughout the aforementioned history, the Department of Electrical & Computer Engineering (ECE) at UNM has played an active role in the use of technology for distance education. For instance, the first online-only course at UNM, Computer Logic Design, was offered by the department. Initially, these offerings were ad hoc in nature, primarily determined by the expertise of those faculty interested in experimenting with the technology. Even at this early stage, however, there was a clear rationale for creating these courses. Specifically, the interest of the department was in serving the remote population of the state. As experience was gained and feedback obtained from teaching these courses, new rationales for teaching these courses emerged. This lead, most recently, to the goal of creating a completely online M.S. degree that can be obtained through the ECE Department. This paper details the forces that drove the development of the online programs at ECE, but more importantly, it describes the challenges faced and the lessons we have learned from building these programs.

2 Implementation Details

Once the decision was made by the ECE Department to enter the online space, the department designed a plan to roll out a number of online graduate courses each year. The plan was designed in concert with the Distance Education Office of the Extended University, and was carefully planned around the work

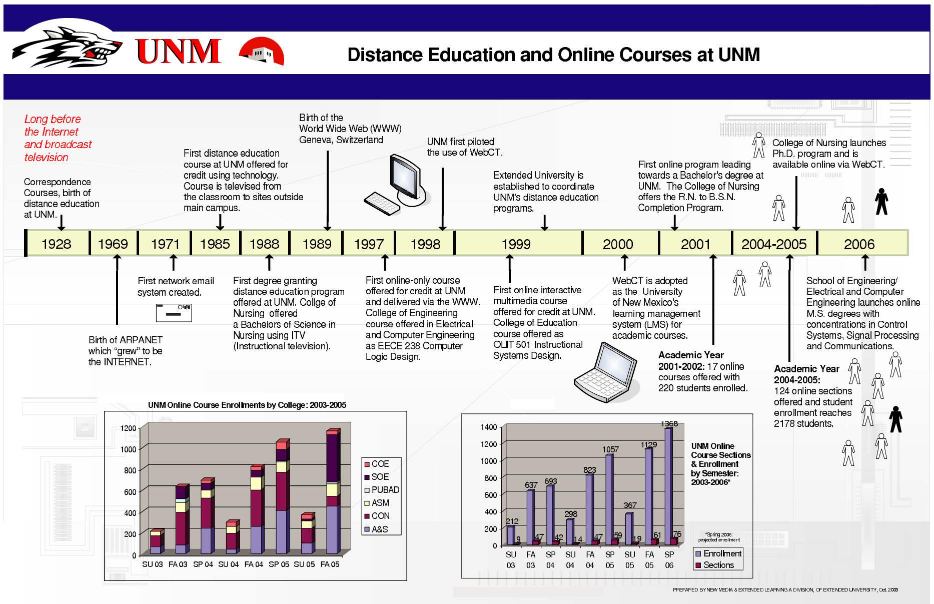

Figure 1: History of online education at the University of New Mexico.

load of the supporting staff (technicians, WebCT programmers and instructional course designers) as well as the faculty members interests and time [Oliver and Dempster 2002]. As part of the discussions during the creation of the ECE/Extended University plan, a number of benefits associated with the implementation of the plan were envisioned [Oliver et al. 2001]. There were the typical benefits one would expect. Subsequently, however, a number of additional important benefits, as well as new challenges, came to light as we sought to leverage out online capabilities.

The ability to discover the additional benefits and challenges associated with our online program was greatly facilitated by "taking the plunge" into online course offerings, and in essence through "learning by doing". Below we describe the initial benefits we envisioned, as well as the realities we observed. Next we describe the additional benefits and new challenges that have emerged, in the that hopes that others may use these to help design online degree programs, with a better idea for the benefits that can be expected, and the pitfalls that should be avoided.

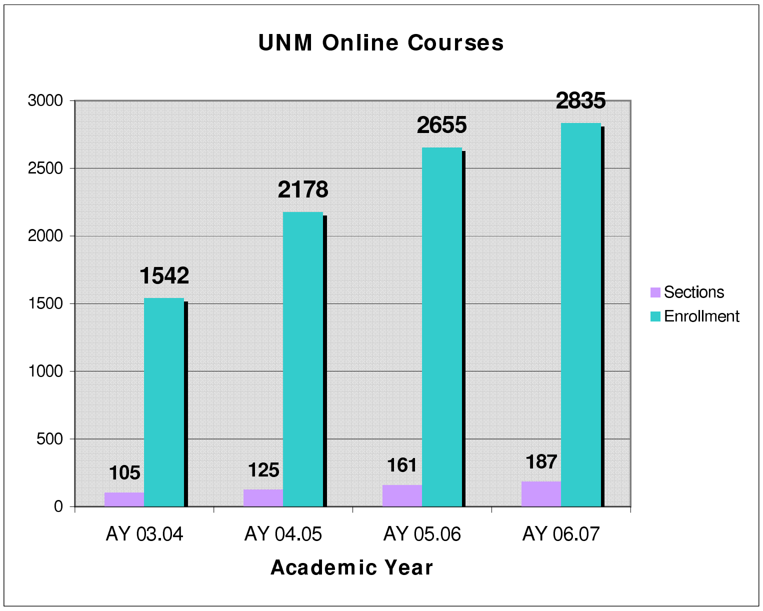

Figure 2: Online enrollment at UNM from academic year 2003–04 to the present.

2.1 Benefits

The benefits that we expected to receive from our online course offerings were largely an extension of those that we received through other distance education delivery mechanisms already in place at UNM. Specifically, many of the graduate students in our department hold full-time jobs at Los Alamos National Laboratory (about 150 miles away from UNM), and other remote locations within the state. Like many other universities around the country, in the 1980's UNM established an instructional television (ITV) program to serve such students. With the advent of the Internet, both faculty and students at remote locations felt more empowered to use the new medium as opposed to the more traditional ITV that required a more rigid approach and a large investment in equipment (satellite link, transmitters and receivers, etc.) and maintenance. Thus, committing to the use of the WebCT system seemed like a natural and cost-effective extension of the efforts we already had in place. Specifically, we anticipated that these remote students would find it more convenient to use the web-based model, and that this might lead to increases in enrollment as well as better retention.

In order to gauge the reasons behind students' decisions to enroll in online classes, a pre-course survey created by New Media & Extended Learning at UNM is administered at the beginning of each online course. A sample survey is shown in [Table 1], along with the responses received in the Fall 2006 and Spring 2007 semesters. It is interesting to note that the surveyed students were

I needed the class to graduate	58%
Schedule conflict with work	42%
Personal preference to take classes online	42%
Schedule conflict with other courses	30%
Schedule conflict with personal or family responsibilities	28%
Inconvenient to travel to campus	23%
I am a student living outside of Bernalillo County	13%
This was the only section offered	12%
The face-to-face sections were closed	8%

Table 1: Pre-course survey used to determine why students take online courses. Reported data are from the Fall 2006 and Spring 2007 semesters, and involved 1372 students surveyed with 1097 responding. Students were asked to choose up to three reasons that best categorize why they are taking an online course. For this reason, the percentages do not add to 100%.

largely making use of the online offering in order to facilitate their graduation in a way that is convenient with both work responsibilities, other classes, and their personal commitments. In addition, we found that a large number of students simply like the online format.

A number of additional unintended benefits were subsequently observed, and are described below. First, a number of faculty have reported a phenomenon whereby students sign up for the online section of a class, even though there is an extra tuition expense involved, yet they primarily attend the in-class lectures. The primary motivator for this behavior turned out to be the flexibility it provides. Specifically, many of the ECE graduate students have full-time jobs that occasionally cause them to miss certain classes. These students were able to use the online services provided by the department in order to “make up” these missed classes. Interestingly, these capabilities were available with the ITV system as well, but the convenience of accessing the materials via the Internet seems to have made a difference in terms of the emergence of this student behavior.

The use of the WebCT system has allowed two of the authors to develop and teach an online course from remote locations, specifically, while on sabbatical in Europe. This has provided the faculty in question with further appreciation for the asynchronous nature of the online courses, as well as forcing them to adapt their teaching styles and courses to the online medium. More importantly, this has led us to the notion that the online courses offered by the department are synergistic with international programs. Naturally, online courses expand student learning and instructor teaching beyond the boundaries of the classroom, which provides an opportunity to build a global experience for students as well as faculty. There are many issues to be addressed, such as resource sharing, multilingual problems, time-zone differences, etc. For example, they allow international and exchange students to take some course work at their home institutions. In fact, these types of courses are now a major leg in our international programs with JiaoTong University in China, and the university of Campinas (UNICAMP), Brazil. Under various scenarios, a faculty member at a partner university may teach a UNM online course that may be taken for credit by UNM students, as well as by students at the partner university. A similar approach will be implemented in the fall 2007 semester, when an ECE-UNM faculty member will conduct an online class that will be taken by students at JiaoTong university in China.

Another unexpected phenomenon we have noticed is the use of the department's online courses to "window shop" before actually committing to a university. We see this as one of the main attractions of the online graduate program. As more universities begin offering such programs, we have noticed that many students with varying backgrounds are checking our online offerings prior to committing to pursuing a graduate degree at UNM. This include students who had started a degree at UNM or elsewhere, before dropping out due to personal or professional reasons, as well as students whose undergraduate degrees are in non-ECE majors. Indeed, although the "competition factor" was not evident at the outset of the program, we have noticed that many other universities are encroaching on our traditional local markets. By offering online courses targeted towards our local market, coupled with the convenience of being able to visit with our faculty, we are able to provide a better product than that which can be offered by our competitors.

An important factor regarding the use of online learning environments for our students is that it fosters teamwork and networking in a way that is the wave of the future. According to a study by the national academy of engineering, the engineers of the future will need to be more globally aware and learn to operate within a virtual global team environment [Oliver 2002]. We believe that online collaboration, such as that offered through WebCT, will become more prevalent in the future. Some of our online instructors have actually exploited the opportunities provided by WebCT to encourage the students to form virtual teams and to work on large class projects that required frequent synchronous and asynchronous interactions.

Another attractive feature of WebCT is the ability to use it in providing feedback mechanisms to the instructors. The pre-course survey allows the careful instructor to calibrate the course to the level of his/her students. The mid-course surveys allow the instructor to adjust the style and content of the course, while the final surveys provide for comparison between courses and allows the instructors to adjust later course offerings.

2.2 Challenges

We can group the challenges we faced into three main categories, those that involve students, the course itself (including those related to the instructor), and the technology. One of the most difficult student-related challenges is the high drop-out rate for online courses. We have found that in many cases, students underestimate the time commitment required to complete an online class. Given that implied structure associated with set class meeting times is no longer present, many students have difficulty establishing the discipline needed to systematically progress through course modules. For this reason, we recommend providing a standard "warning" to the introductory module of every online course that we teach which clearly describes the time commitment necessary to have success in the course. In addition, since in most cases face-to-face meetings between student and instructor do not occur with online courses, students and faculty are not provided with the same opportunities for developing personal relationships. Such relationships are important in the case of students that will pursue research projects under the direction of a faculty. This problem extends to the issue of exams. Creating an environment of trust between the instructor and student in this area is much more difficult than for a traditional course, not to mention the time-consuming nature of arranging for proctors at multiple remote locations.

Regarding the course, a major challenge in any online offering involves obtaining quantitative measures of quality. While we continue to struggle with ways to measure and contrast online versus traditional programs, we believe that the recent study showing no significant difference between online and regular class offerings is accurate [Oliver 2003]. This however obscures second order effects such as variability of instructors and their teaching styles.

Another challenge we have faced concerns the question of how the faculty workload associated with an online course is counted. One of the major issues facing department heads is how to encourage the faculty to teach online courses while still being able to cover the standard course offerings. While it is generally agreed that the effort expanded in creating and offering an online course for the first time is much greater than offering a traditional in-class version, opinions diverge on assigning work load credit after the first offering. The basic issue from the department point of view boils down to the following: In order to complete its academic mission, the ECE department must offer a certain number of classes. These may be in-class or online courses, but since at this stage, in-class offerings must remain available (due to their desirability and cost effectiveness), adding an online course must be done in addition, and not instead of a regular in-class course. Thus, and absent the addition of new faculty members, the work load of our faculty members will increase. This leaves financial incentives and departmental citizenship as the prime motivators for faculty members to offer online courses.

In the current generation of web courses at UNM, the interactions between students and instructors are primarily asynchronous in nature. This can impede the learning experience as answers to students' questions are not immediate, and necessary corrections to the pace and amount of materials provided by the instructor are sometimes easier to discern in face-to-face meetings. As bandwidth, storage and delivery technologies improve, the ability to capture more of the course content as video is supported, and the possibility of offering live lectures, or at least question-and-answer sessions, becomes viable. Indeed, current web courseware technologies now include tools that support synchronous student interactions, and we expect these to be used extensively in the future.

3 Lesson Learned and Future Directions

In our experiences we have found that offering a new online course demands a large amount of effort in preparing the materials and authoring multimedia coursewares. The necessary time commitment is often underestimated by faculty. In order to smooth this one-time commitment and encourage more faculty members to offer online courses, we have found that encouraging faculty to offer a web-enhanced or hybrid course can be an alternative towards a pure online course. A web-enhanced course is a traditional face-to-face course that utilizes WebCT in order to expand student learning beyond the boundaries of the classroom, while a hybrid course is a blend of face-to-face instruction with online leaning via WebCT, reducing the amount of classroom meeting time. By going through such a transition, both instructor and students can benefit from a gradual readiness and acceptance of the online learning environment. In short, it is important to understand and to formalize the different stages of integrating new technology into a course [Plewes and Issroff 2002].

As stated above, our goal is to expand the ECE online offerings so that it is possible for a student to obtain a graduate degree entirely from these offerings. One particularly interesting case arose with our graduate seminar course. Specifically, it is a requirement in our MS and PhD degree programs for students to attend weekly research-oriented seminars. The goal is to broaden the student's education by exposing them to other areas in addition their own specialties. In the upcoming year, we will experiment with offering such a seminar course online; previously we have offered this seminar through ITV. The challenge we see is that a seminar course usually demands a more synchronous style, such as interactive questions and answers. Thus, for this course it is essential that we pair the online offering with the in-class version. The in-class students are in fact necessary in making the online version viable, as the in-class students provide the questions that must be captured in the video that will be placed online. Obviously, the presence and quality of questions will be an important factor in determining the ultimate quality of the online offering.

An issue that we will consider in the future is the possibility of expanding our online offering at the undergraduate level. There are two immediate issues that have come to the forefront in considering this issue. First, we have already mentioned problems we have faced with students underestimating the time commitment associated with online courses. Due to the fact the undergraduate students are generally less mature than graduate students, this problem is expected to be more acute at the undergraduate level. Thus, stricter monitoring of course progress will be warranted. Second, the problem of including lab experience with remote learning is an issue. We are investigating the use of LabView to simulate some of the experiments and to control laboratory equipment via remote control [NCEHE 1997, Noble 1998]

In the future we envision new and exciting ways in which to leverage both our online coursewares, along with the experiences we have gained in this area. For example, in the upcoming year, we are planning on offering an online course that primarily serves the purpose of outreach to students that may be interested in pursuing a degree in our department. The idea is that by capturing a series of interesting lectures and demonstrations related to careers in electrical and computer engineering, we can provide course materials that can be used statewide at remote locations, high schools, or community colleges in order to recruit these students into the profession. In addition, we are considering the idea of combining parts of various online courses in order to create new courses from these existing ones. This approach, we believe, would prove useful in creating professional training or short courses that could be offered to industry.

4 Conclusions

This paper presented our motivation, our strategies, and implementation of online graduate-level degree programs in the Department of Electrical & Computer Engineering at the University of New Mexico. We have discussed the challenges encountered as well as the lessons learned in designing such programs. Some unexpected benefits as well as challenges have been highlighted, and future improvements and plans were detailed.

Acknowledgments

This paper is dedicated to the memory of Ronald C. DeVries, who taught the first online-only course at the University of New Mexico.

References

[NCEHE 1997] National Committee of Enquiry into Higher Education. Appendix Two – New approaches to teaching: Comparing cost structures of teaching methods. Bristol: HMSO, (1997). www.ncl.ac.uk/ncihe/a2_001.htm

[Noble 1998] Noble, D.: Digital diploma mills: The automation of higher education. *First Monday*, 3(1), (1998). http://www.firstmonday.dk/issues/issue3_1/noble/

[Oliver 2002] Oliver, M.: What do learning technologists do? *Innovations in Education and Training International*, 39(4), 1–8, (2002).

[Oliver 2003] Oliver, M.: Rethinking the reuse of electronic resources: Contexts, power and information literacy. *Journal of Interactive Media in Education*, (1), (2003). www-jime.open.ac.uk/2003/1/reuse-21.html

[Oliver et al. 2001] Oliver, M., Bradley, C. and Boyle, T.: The distributed development of quality courses for a virtual university. *ALT-J*, 9(2):16–27, (2001).

[Oliver and Dempster 2002] Oliver, M. and Dempster, J.: Strategic staff development for embedding e-learning practices in HE. *Interactions* 6(3), (2002).

[Plewes and Issroff 2002] Plewes, L. and Issroff, K.: Understanding the development of teaching and learning resources: A review. *ALT-J*, 10(2):4–16, (2002).