Utilizing Distance Learning Technology to Deliver a Graduate Program in Engineering Management to Working Professionals

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Abstract

Delivering an innovative graduate program in engineering management to a student body consisting almost entirely of working professionals can be challenging, especially when students are geographically remote from each other and from the main campus. Distance learning methods and technologies can be helpful in bridging this gap and making the program more accessible to a larger group of individuals. However, the implementation of courses and programs via distance learning requires much more than mere translation of traditional class materials and methods into new media, and careful planning is required in order to provide the optimum mix of traditional and non-traditional delivery methods. In addition, although working professional students often appreciate the convenience of an unconventional approach, they and their employers are much more focused and assertive regarding their expectations for the outcomes of courses and degree programs. This paper discusses positive and negative experiences associated with simultaneous delivery of Marshall University's graduate program in engineering management to four different locations, utilizing a combination of interactive video link technology, video-tapes, on-line instruction, and live instruction. The discussion includes an overview of the engineering management area of emphasis in Marshall's Master of Science in Engineering program, course and curriculum development issues, and identification of effective teaching methodologies for employed, adult students in a distance learning environment.

Introduction

Increasingly, institutions are responding to geographically widespread educational needs through the use of distance learning technology and techniques. This can be challenging for both faculty and students, but also rewarding, as working professionals and other place-bound students realize their educational goals.

In order to meet the needs of engineering professionals in southern and central West Virginia, Marshall University (Marshall) offers a graduate program in Engineering Management through a combination of interactive video, on-line instruction, video tape, and live instruction. The program was originated by the former West Virginia Graduate College, known for its flexibility and responsiveness to the needs of working students. Following a merger of the WVGC and Marshall in 1997, Marshall's combined engineering faculty worked to maintain the currency and effectiveness of the program and to continue to make it available to engineers in South Charleston, Huntington, Beckley, and Parkersburg, West Virginia.

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Throughout the continuing evolution of the program, students have expressed overall appreciation for the availability of the program. Faculty members, administrators, students and instructional technology staff have also encountered various challenges along the way. The discussion that follows addresses the challenges that arise in the delivery of this type of graduate engineering program, based on Marshall's experience during the previous five years.

Program Description

Marshall's Master of Science in Engineering (MSE) degree program is interdisciplinary in nature and designed to meet the specific needs of engineers employed in industry, government, and consulting. The MSE program offers a broad core curriculum with opportunities for concentrated study in three areas of emphasis: Engineering Management, Environmental Engineering, and Chemical Engineering.

The mission of the MSE degree program at Marshall University is to provide multi-disciplinary, graduate level engineering education appropriate for working professionals and others who do not have the option of full-time programs in a traditional university setting. In fact, more than 90 percent of the students in the program are employed full-time, mostly in the chemical industry, civil engineering consulting firms, the mining industry, the manufacturing industry, and government agencies. Consequently, the program is populated primarily by part-time students, with the typical student enrolled in an average of two three-hour courses per semester.

The primary objective of the MSE program is to provide a curriculum with a strong, focused central core, with opportunities for concentrated study in areas of emphasis important to the region and engineering community. The program must meet the evolving needs of engineers and their employers in the region by enhancing technical engineering competence, management and leadership skills, and sensitivity to legal and ethical issues.

All graduate engineering students are required to complete thirty-six semester hours, consisting of fifteen semester hours of core courses, including completion of a comprehensive project, plus twenty-one additional hours of required courses and electives in the applicable area of emphasis. To accommodate the schedules of employed students, the courses are taught almost entirely in the evening hours, Monday through Thursday. Each course is normally offered in a 2.5 - 3.0 hour block once per week for the entire semester, beginning at either 4:00 or 6:30 pm.

The fifteen-hour core set of courses includes:

- Project Management (3 hrs)
- Applied Statistics (3 hrs)
- Computer Applications (or approved equivalent) (3 hrs)
- Comprehensive Project Formulation (3 hrs)
- Comprehensive Project (3 hrs)

The principal objective of the Engineering Management area of emphasis is to prepare students with undergraduate engineering degrees for positions in middle and upper management.

It is designed for the part-time student who has work experience in his or her specific engineering discipline.

The required courses in this area of emphasis are:

- Management of Technical Human Resources and Organizations (3 hrs)
- Economic and Financial Analysis for Technology Management (3 hrs)
- Operations Management (3 hrs)

The Engineering Management program also requires four approved elective courses (12 hrs). Examples of approved electives are:

- Engineering Law
- Seminar in Engineering Management
- Environmental Law
- Applied Engineering Mathematics
- Quality Assurance and Control
- Operations Research
- Risk Assessment

Other electives are often approved by the student's advisor according to the background and interest of the student in areas such as Environmental Engineering, Environmental Science, Business Management, and Chemical Engineering.

Students in the Engineering Management emphasis also have the option of specializing in transportation management via a collaborative effort with the West Virginia University (WVU) College of Engineering and Mineral Resources. The three courses in this area of specialization, which serve as approved electives and are delivered via interactive video-link from WVU's campus, are:

- Highway Planning
- Highway Safety Engineering
- Traffic Engineering Operations

Student Needs and Demographics

Based on a study completed by independent educational consultants in 2000, the discipline of Engineering Management was identified as the one most in demand with respect to graduate programs and other continuing education opportunities for engineers in southern West Virginia. However, since West Virginia is a relatively rural state, the engineers interested in such programs tend to be dispersed throughout a wide geographic region, with pockets of students located in several cities within a 150-mile radius of Marshall's main campus in Huntington, West Virginia.

A large fraction of the students are located in the Charleston area (the state's capitol city), but others are spread throughout the state. A satellite campus in South Charleston, approximately a one-hour drive east from the main campus in Huntington, is heavily utilized by the majority of the MSE students and is the home campus of several program faculty. Additionally, the program serves students in Beckley, approximately a two-hour drive from the main campus, and in

Parkersburg, approximately a 2.5-hour drive from the main campus. These two areas have high concentrations of engineers due primarily to the location of various manufacturing, mining, and consulting businesses in the region.

Selection of Distance Delivery Methods

As much as possible, Marshall attempts to use live instruction featuring experienced engineers and practitioners for its graduate engineering courses. For example, the full-time coordinator for the Engineering Management Program worked for Union Carbide Corporation for many years and played a significant role in developing and implementing project management for research and development in that corporation. The full-time leader of the Technology Management program, who often teaches courses in the Engineering Management curricula, is a former division president for Mobil Corporation. The instructor for the Engineering Law course is a lawyer in addition to a full-time professor of engineering. The main instructor for the Applied Statistics is an adjunct professor with a Ph.D. in statistics and many years of experience as a statistician with Dow Chemical. All of this greatly strengthens the Engineering Management program at Marshall University and supports the mission of the MSE degree program, and also provides students with a unique opportunity to interact with individuals who have themselves worked successfully in fields of interest.

Due to the special demographic conditions described above, engineering faculty members employee a distance-learning approach quite extensively. Distance learning is a term that means different things to different people, but generally it describes a teacher/student relationship that is remote in time and/or space. Delivery methods that meet this definition include video-tapes, interactive video, web-based courses and correspondence courses.

In Marshall's Engineering Management program, many classes are taught using interactive video-link classrooms, where students and instructors can interact live in two or three different locations at the same time and which provides students with the opportunity to see and hear one another. In order to provide personal interaction, the instructors in these situations also strive to spend time at each receiving site. This method of delivery is discussed in more detail, below.

Because the video-link classrooms are set up for sound and visual recording, the video courses are normally video-tape recorded. These tapes are available to students who are not able to attend the live sessions. Once an instructor has developed a library of tapes for a particular course, and assuming that the course material does not change radically from semester-to-semester, entire courses can be offered on video-tape to students in locations that are not connected to the interactive-video classrooms. Of course, in this situation, the taped course is supplemented with internet communications and live visits, as necessary.

In other words, the best fit for Marshall's graduate program in Engineering Management has been a combination of both conventional and unconventional delivery methods, with a goal of maximizing personal contact with the students wherever possible. According to the students, this has been the key to the program's success, and makes use of distance learning technology much more effective and rewarding for both faculty and students. As the program has progressed and

matured, however, we have witnessed various successes and failures in course and program delivery. The following sections identify several key lessons we have learned from experiences in interactive and web delivery, in particular.

Interactive Video-Link

Marshall University's distance learning interactive video network features live two-way video and two-way audio communication via high-speed telephone lines. Distance learning video classroom facilities consists of six rooms on the Huntington campus, three rooms on the South Charleston campus, one room on the Point Pleasant campus, and rooms in Beckley, , Logan, and Gilbert contracted through third party site owners. Each classroom accommodates 21 to 32 students and includes an automated control system, instructor camera, student cameras, installed computer connection, document camera, white boards, push-to-talk microphones for students, VCR, printer, fax machine, and telephone. Technical staff support is provided during evening hours, although each classroom does not necessarily receive individualized IT support.

Most of the courses in Marshall's Engineering Management program have been offered through interactive video at one time or another during the past five years, and several of the courses are commonly taught over a video-link connection. Through instructor experience and both formal and informal surveys of students, during this period we have been able to identify various factors that appear to be critical to the success or failure of such courses, with success defined as a course that meets educational objectives and that is well-received by students.

By its very nature, interactive video instruction creates several challenges for both faculty members and students no matter what the particular subject matter context. First and foremost among these is the fact that most individuals view television as a passive activity, and are unaccustomed to interacting with a television screen and may even view video class time as "down-time." In addition, many students are intimidated by the technology – they dislike calling attention to themselves with a microphone and/or close-up camera shot just to ask or answer a question or otherwise contribute to class discussion. Finally, we have often witnessed a tension between the students who are on-site with the instructor and those who are off-site during class sessions. This problem can be exacerbated if one group of students includes older, more experienced engineers and another includes younger, more traditional students, as is often the case between our South Charleston and Huntington sections. Add to all of this the potential for technical/system difficulties, and it is understandable that some faculty members may feel this method of instruction is simply not worth the bother.

However, when well done by committed, enthusiastic faculty, interactive video courses can be extremely effective, even in the context of a graduate engineering program. This delivery method allows instructors to reach a wider and more diverse student audience, involve additional guest speakers, link different types of students in mutually rewarding ways, and make creative use of various audio-visual resources. Most of the challenges noted above, related primarily to human factors, can be overcome. In our case, we had to overcome these issues in order to effectively implement the graduate program in Engineering Management, which depends not only on faculty-student interaction but also on interaction among a diverse group of working professional

students who bring their own beneficial insights and experiences to the classroom.

Based on our experience, three major instructional issues define the interactive video course: course structure and design, effective use of technology, and presentation skills and delivery. In designing the course, it is important for the instructor to resist the temptation to try to fit a traditional engineering course, in its entirety, into the video course format. Instead, our experience shown that putting some thought into revising teaching methods is well worth the effort and leads to greater achievement of course objectives in this type of setting. For instance, careful used of planned discussions, multi-media presentations, group projects that cross the "link", debates and panel discussions can greatly improve the rapport among the instructor, on-site students, and remote students.

In addition, it is a good idea to plan for less lecture time. Remote students, especially in two to three hour class sessions, seem to be much more sensitive to punctual beginning and ending times, as well as the need for breaks. They also require more interaction during class time to feel part of the extended group of students.

Prior to beginning an interactive video course, our faculty have also learned to review and revise existing materials with an eye toward developing new materials and methods that engage remote students with variety and interaction. Handouts are pre-planned, as much as possible, and special arrangements are usually made for examinations and quizzes. Our students report much higher levels of satisfaction when they have on-line access to these materials, through e-mail, web pages, or Web CT.

Support staff and logistics are often not entirely under the control of the individual instructor. University policy and budgets may dictate, for instance, the level of instructional technologist support and whether or not the course will have the benefit of an off-site facilitator. (This has been the exception in our program.) The important point is to be informed, well in advance, of the logistics of the course and to plan accordingly. This involves identifying accessible trouble-shooters for technical difficulties, obtaining hands-on training through practice sessions, and developing contingency plans for the class to follow in the case of the hopefully rare but unavoidable technical difficulties or breakdown.

Once the course has been designed, successful implementation of the course requires an understanding and appreciation of the technology by both instructor and students. As noted above, use of a well-equipped distance learning classroom often provides a mechanism for easy incorporation of a wide range of multi-media resources into the course. For example, the instructor can easily utilize video-taped information, has the ability to show overheads, portions of documents/and or books, and other information with the document camera, and may even choose to use the computer screen to show students how to access particular information on the internet in real time. However, with respect to audio-visual aids in particular, some experimentation is necessary to account for such things as the aspect ratio of the screen and the optimal font size and color. In addition, video clips should be used judiciously to avoid creation of a "passive learner" atmosphere at remote sites.

Even though the technology has improved drastically during the last several years, technical difficulties in some form are an unavoidable part of any interactive video course. Although we all hope that any difficulties we may encounter will be minor and short-lived, the students should be prepared in advance to ensure a minimal loss of class time and loss of student confidence. A stated contingency plan has been invaluable for many of our courses, consisting of directions to remote students regarding how long to wait for the connection to resume, a telephone number to call, and related information. Although the difficulty is usually resolved by an instructional technologist or other trouble shooter, it is also important that the instructor have a working knowledge of how to reinstate the connection, adjust the system volume, and other basic mechanics of the system. Finally, a telephone/speaker phone connection, or even a fax, often becomes most helpful in times of technical difficulty.

Often, discussions of interactive video in an educational setting neglect a final, important point: the skill of the instructor in delivering the course and presenting the material in a video format. It has been our experience that even a little extra attention to this component can greatly enrich the learning environment of an interactive video course. Remember, as the instructor of a video-link course, you are also the on-camera "talent" and can make use of several basic rules regarding video performances. Most importantly, use a strong, clear, natural speaking voice.

Most instructors know that maintaining eye contact with students is important. However, when teaching a course to remote students via interactive video, eye contact with students means eye contact with the camera. If you are viewing the students on a television screen mounted in the back corner of the room, and the camera is mounted in the back center of the room, off-site students will perceive that you are not looking at them. Likewise, mannerisms or gestures that are innocuous on-site can appear significantly magnified to remote students (such as looking at your watch, for instance), and it is important to move and gesture more slowly than usual. Likewise, certain clothing can create strange screen patterns and can distract from the material.

As noted above, we have found that the most important factor in distance learning success is personal connection with students. We do this in a variety of ways when teaching courses via interactive video. For instance, instructors make an effort to originate the class from different sites throughout the semester, and make sure to set up a mechanism for consistent, individual teacher/student interaction via e-mail, telephone calls, or other means. As the instructor of an interactive video course, you receive far fewer visual clues due to the technology "filter." As a result, unless you are paying close attention, it is easy to miss signs that your audience is becoming distracted at the remote site. Paying even one visit to the remote site can give you plenty of insight into the group's dynamics and visual clues, so that you know what to look for on camera and consequently know when to give breaks and when to forcefully engage remote students in discussion.

Finally, as resources permit, an off-site facilitator can greatly enhance the quality of the course, although we do not often have that luxury in the delivery of our Engineering Management program. The remote facilitator can serve various roles – maintaining discipline at remote site (not usually a problem for adult students), encouraging interaction from students at remote site, monitoring tests, leading off-line discussions, and managing handouts and exams. The facilitator

also can be a valuable source of feedback for the instructor on some of the "performance" aspects discussed above.

On-Line Courses

As a supplement to live instruction and video-linked courses, we have found the internet to be an important tool in off-site delivery of the Engineering Management program. Depending on the course, on-line interaction can be a small or large part of the course or, as in the following example, can comprise the entire course.

Computer Applications is one of the required courses in the program. It is a numerical analysis course that uses Excel and Matlab to solve engineering problems. Most of our students are employees of local industries so they are familiar with the basics of spreadsheets, the software of choice for business. Many of our students are recent graduates of undergraduate engineering programs, so they are also familiar with Matlab, the software choice of academics. This course illustrates the quick, useful methods of solving engineering problems using these tools.

Two years ago, we made the decision to switch to web-based delivery of the course, a move strongly supported by both students and faculty. Currently, the course is wholly web-based; students only see the instructor when they request a meeting. Communication with the instructor is through the web site, e-mail, fax, and telephone. The course uses a text, supplemented with practical notes provided as hard copy, as well as notes on the WebCT site. The only requirement for the course is the solution of problems that the student chooses from each chapter of the text. Since the students rarely know who else is taking the course with them, we do not have to worry about students copying homework. (Last semester a husband and wife - both engineers- took the course; they chose to work different problems from the chapters.)

Most of our graduate students respond well to this type of course delivery. They do not have to drive to class after working all day. They can study and do homework at locations and times convenient to them, rather than the instructor. Because the instructor is not immediately available to answer questions, students learn to better utilize the text, notes, and other resources. Our students are frequently out of town on business trips. They take their laptops with them and do not get behind in their work. We have had students who spend the better part of a semester out-of-town on business and manage to complete the course without difficulty.

Unfortunately, courses taught this way provide very limited or no interaction among students. This is one of the disadvantages, since we have always found that working students are a great source of information and experience for each other in a traditional class. In addition, students must be self-motivated to take advantage of what this course has to offer; an instructor is not around to provide encouragement. Students may also be required to wait a day or more before receiving answers to questions.

We have also delivered this course in the traditional, live manner. Much more instructor time is a required when the course is web-based. Getting notes onto the web prior to the date that the students need them is a major challenge. Grading homework individually as it arrives

from the students rather than waiting until all student assignments arrive is time consuming. However, for a course with no regular student-instructor contact, we have found that quick turnaround of homework is necessary to the learning process.

Because of the positive feedback from students, we now do quite a few courses this way. The web has become an excellent way to offer courses with highly variable enrollment. It is also convenient for students who need a particular course now, instead of waiting for the regularly scheduled offering of the course, which is often an issue for part-time graduate students who take several years to complete their degrees.

Conclusions

Based on assessment and feedback from students enrolled in the graduate program, students overall are satisfied with the combination of instructional methods utilized for delivery of the Engineering Management program. Of course, in the best of circumstances, students almost always prefer live instruction, but our graduate engineering students recognize that this is not always a possibility and have been willing to work within the constraints of the system.

Most of the students in this program have completed their degrees at the same rates as the on-campus students, and the completion of the final comprehensive project necessarily brings them together with faculty and fellow classmates in a meaningful way at the end of the program. Surprisingly, they also are much more likely to participate in hooding ceremonies and other graduation rituals than the on-campus graduate students. We have perceived this to be proof of the fact that these remote students often appreciate and value the ability to obtain an advanced engineering degree much more than traditional students.

Our experience with the program has shown, however, the most important factor in making unconventional course delivery work is the participation of faculty members who are committed to providing education to distant learners and who understand the importance of making personal connections with students. Otherwise, the students will always feel like an after-thought in the delivery of the course, and will invariably make this point clear in a variety of ways.

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