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# Enhancing Specialized Course Offerings

**Keywords**: Academic Partnerships, Engineering Education, Video Conferencing, Research Collaboration

**Abstract**

Academic institutions throughout the world face budgetary constraints due to the downturn in the economy. In the US, most state funding for higher education was reduced considerably. Although Recovery Act funds were awarded to ameliorate the effect of these budgetary reductions, this funding expires in 2011. To balance higher education budgets, a strategy adopted by many universities is to increase the minimum student enrolment required for a class to be offered. While the new minimum enrolment numbers aid in reducing operating costs and assists with balancing the budget, they may negatively impact a student's education opportunities because senior level specialized courses will be cancelled due to minimum class enrollment requirements or will only be offered sporadically. This paper describes how utilization of existing academic cooperation nationally and internationally, and the use of technology could allow universities to offer such courses while reducing operating expense. Many institutions have built extensive partnerships for student and faculty exchanges or research collaborations which now could be utilized to jointly offer these specialized courses. The joint course offering would allow the expert professor the opportunity to teach the course while ensuring the enrolment quotas are met. This paper details how such joint-courses could be organized when the cooperating institutions are located in different states or countries. Experience shows, that such courses provide for a more diverse course both in content and in student body, and are appreciated by the students. The methods outlined in the paper, such as teleconferencing and 'visiting' courses, not only allow for the continued offering of the specialized courses but also allow the campus to offer preeminent educational opportunities for students regardless of the economic conditions.

## Introduction

Higher education has a responsibility to provide a quality education for the students and the ability to complete the required curriculum in a timely manner. In the 1960's, a degree was commonly completed in four years and that goal still exists today. The recent economic downturn is placing an interesting burden on that goal. Every course offered has associated costs for the university and a balance between students enrolled in a class and the professors available to teach the class must be optimized. For many degree programs, class size is not an issue due to the large numbers of students seeking the degree. However, many degree programs do not have the luxury of large student populations and find it extremely difficult to offer classes with small enrollment.

Dealing[1] with low enrollment is a perplexing issue where various solutions have been attempted. According to 2009 ASEE data, over 75 percent of the United States Engineering Technology programs have a student population of less than 230 students in the Civil, Electrical or Mechanical Engineering Technology degree programs. This low number of students equates to low class sizes and the low enrollment issue. To provide the best education, electives are offered during the Junior and Senior years. However, the low numbers of students combined with the current economic conditions does not make these offerings possible.

The curriculum for the Engineering and Engineering Technology disciplines requires more laboratories and hands on experience which is obtained by interaction between student and professor. This interaction is best facilitated by the traditional classroom setting which is not

feasible when class size is low. The definition of low may vary for different universities, so this paper will utilize the average of 11 students as identified by the MSCD executives. The 11 student size is a critical number when total enrollment in a particular major is less than 230 students.

The challenge of Engineering and Engineering Technology departments is to utilize technology, scheduling or any other means to offer classes in a periodic manner to achieve the following three parameters.

- Students can complete their degrees in a timely manner
- Courses must meet the minimum class size requirements established by university administrators for cost effective utilization of resources and,
- Professors must be properly compensated for all classes taught.

**Educational Delivery Methods**

To attain these three goals, the various methods of education were analyzed and the strengths and weaknesses identified.

Traditional Classroom Environment

This method of instruction has existed for hundreds of years and is predominant in today's environment. When student population in individual classes meets the requirements, instructors and students are comfortable with this method of instruction. However, when class size does not meet the appropriate threshold for conducting a class, various options are available.

Many institutions offer classes once a year during the Fall or Spring semester. This allows a critical mass of students to build, so minimum class size requirements are met. This works as long as students have the available time to take the standardized core of courses in the manner identified by the university. However, students with scheduling conflicts will find the annual offering may delay graduation by four semesters since many engineering courses are pre-requisites for other courses. Additionally, part time students need to plan in advance so they can attend courses when offered. Day and night programs pose additional issues since courses cannot be offered both day and night but must rotate and this causes additional issues.

Although this method is utilized most by universities, it has major issues with the three parameters that need to be met by low enrollment university curriculums.

On-Line

Many universities have migrated to online courses where students can utilize the computer and the Internet to study a topic. With this format, students learn the information by reading books or articles in a self pace mode. This methodology is a correspondence type experience where students learn without immediate feedback. This methodology will allow a professor to be responsible for students in various class offerings. The professor will be responsible to manage enough students to make the offering cost effective. However, the class size issue is not solved by this solution. The hands-on component is difficult to incorporate efficiently in online classes for the engineering areas. Normally, a professor is required to instruct two or more of these on-line courses to meet the appropriate student to professor ratio for economics. Teaching multiple courses for the credit of a single course is an extra burden on the instructor and not well received. The preparation time for each course is the same as it would be for an individual course. Therefore, the financial burden is placed on the professor making this offering an unpopular choice.

Broadcast video

This methodology has been utilized for the last twenty years to broadcast class information to various locations. This is a form of lecture class where students have a video feed from a central location and have an audio return to ask questions. This technology utilizes a special classroom with support people managing cameras so all applicable information is transmitted to the students. This solution uses various locations to increase class size, but the facilities are expensive and the cost is difficult to manage. This solution has many merits, but the cost and specialized rooms diminish the effective impact of this offering. Additionally, testing and homework of students require facilitators at all locations so tests are administered in a timely fashion. Again, additional expense is incurred by the university.

The above options demonstrate no clear individual alternative exists to meet the current challenges. However, by combining new technology, existing technology with existing teaching methods and incorporating partnering between similar institutions, a very feasible solution exists. Each component identified in this solution will be explored to demonstrate how this unique combination has merit for the solution.

**Technology**

The introduction of SmartBoard technology, combined with enhanced web based video conferencing software, offers a cost effective solution that provides students with an interactive education option where courses are taught economically in one location and attended by students from multiple locations. Instructors utilize new technology are able to offer courses that look and feel like the traditional classroom. Students geographically dispersed are combined into a single virtual classroom and courses are offered frequently by experienced professors allowing students to graduate in a timely manner.

**SmartBoard**

Traditional classroom instruction utilized chalk or 'white' board for instructors to write lecture material for the class. With traditional video systems, the information placed on the boards was not readable by students. Chalk board information was replaced by having the instructor sit at a desk and write on a tablet so a video camera could capture the material.

The introduction of the SmartBoard allows the instructor to continue to teach in the traditional classroom environment, but the SmartBoard (a computer monitor) can be transmitted to students as a separate image in a video conferencing image. This technological enhancement allows students to view the instructor and read the information placed on the board similar to being in the classroom.

**Enhanced Video Conferencing**

Video$^2$ conferencing allows for stretching the boundaries of possibilities without being concerned of travel and physical presence in discussions, meetings, conferences, courses (on all levels), research conversations, thesis and dissertation defenses etc. However, traditional video conferencing requires expensive hardware and software (PictureTel, etc.) and administrative and technical support staff at each partner institution and poses scheduling difficulties as well. Web-based video conferencing provides a low cost alternative to the traditional video conferencing as it requires only average computer hardware and affordable software (Cisco WebEx, Adobe Connect Now, etc.).

In the past few years, an interactive web-based video conferencing network solution has been introduced that meets the requirements for a low-cost academic communication solution and

can also be deployed by businesses as a cost savings solution for travel in this period of economic downturn. Stretching the boundaries of possibilities without being concerned about travel arrangements, costs and physical presence in discussions, meetings, conferences, courses (on all levels), research conversations, thesis and dissertation defenses etc., was a very big step in the life of academia. The new lower cost video conferencing technologies show promise of making video conferencing available to any institution without a need for significant institutional resources, while also allowing for easy scheduling. The list is endless in ideas and proposals of activities using these latest systems.

Additionally, the new web based video conference system provides multiple windows for students and professors. The students have a readable image of the SmartBoard information and can watch the instructor as if they were in the class. Additionally, students are able to view other classroom participants and have the ability to electronically signal the professor with a question.

The professor has the ability to view all participants in the class (either the physical room or the virtual classroom) since all remote participants will have video units installed. The professor has the ability to direct questions to any participant as with the classrooms of today. Any question asked by remote students will activate an indicator so remote students will have the ability to ask questions. This is superior to previous video systems which only had an audio uplink.

**Transportation Network**

The Transportation Learning Network (TLN)[3] is a good example of a U.S. based interactive video conferencing network for engineering collaboration. Presently, it is designed to connect states in the western portion of the United States. The network links together the Departments of Transportation (DOT) offices in Colorado, Montana, North Dakota, and Wyoming and the universities of the Mountain-Plains Consortium (MPC), i.e. North Dakota State University, South Dakota State University, Colorado State University, University of Utah, and University of Wyoming. The TLN system was developed to support quality transportation education through a network of people and technology that serves TLN members by enhancing communication, education, professional development, technology transfer, and research. It is considered a national leader in providing access and programming for high quality expertise sharing among transportation professionals.

One of the missions of the TLN Board of Directors is to promote the use of the network in many areas. The MPC is one of 10 competitively selected University Transportation Centers Programs sponsored by the U.S. Department of Transportation. In recent years, the Western Association of State Highway and Transportation Officials conducted a funded feasibility project involving the TLN. Via access to the TLN programming, WASHTO is examining the potential to expand or augment the network to involve Departments of Transportation in virtually all western States.

**Inter-academic cooperation**

Inter-academic institutional cooperation could hold the answer to the economic challenge these institutions face world-wide when offering courses to small student groups or in very specialized topics, and when engaging in collaborative research. Traditional cooperation in-part involves faculty exchange programs which are difficult to organize and harder to fund in economically difficult times as they are expensive due to the travel involved.

Many times low enrollment courses are assigned to professors who may or may not have extensive knowledge of the subject. With the technology and cooperation between multiple institutions, the most qualified professor will teach the class which is a major benefit for the students.

Funding becomes another issue for the collaboration. To facilitate the financial impact, students enrolled in an inter-institutional collaboration class will pay their home institution tuition and fees to attend. The institution teaching the course will receive compensation for teaching from the other institutions based on student numbers and established agreements.

The grouping of institutions is not limited to US universities since appropriate scheduling allows for international cooperation. This is another positive for a global course offering since the advent of a global economy fosters cultural exchange and partnerships with global institutions. These relationships would not only aid the low enrollment issue, but add the cultural exchange component which is missing from today's local education based philosophy.

This paper presents the experience gained by the authors in using both traditional (Internet-based) and web-based video conferencing as the platform for cooperation between the Civil and Environmental Engineering Department of Colorado State University, Engineering Technology Department of Metropolitan State College of Denver, and Bridges and Structures Department of Budapest University of Technology and Economics in teaching and research. These platforms were provided by the United States based Transportation Learning Network funded by the US Department of Transportation. International Inter-Institutional cooperation is also highlighted between Pollack Mihaly Faculty of Engineering in Pecs, Hungary and Engineering Technology Department at Metro State in Denver, Colorado USA. Experiences are analyzed based on feedback of faculty and students involved in these applications. Results show that web-based video conferencing is a viable platform for facilitating academic partnerships. The focus on collaboration between industry and universities is also emphasized, and the need of such cooperation is highlighted.

**Comparison**

The emergence of low-cost web-based video conferencing technologies open new perspectives to the way inter-institutional partnerships could function. These, as well as some weaknesses of the technology are discussed below in parallel with the traditional (Internet-based) video conferencing technique, as they apply to academic teaching/research partnerships[3].

***Benefits*[4]**

- Enhancing the cooperation between faculty/researchers nationally and internationally.
- Curriculum development, improvement, and implementations that satisfy accreditation requirements.
- Collaboration with the industry to bring real-life experience into the curriculum.
- Sharing engineering achievements (through case studies) of experts around the world.
- Pilot course development for small programs, which could not start the course due to small enrollment.
- Faculty work-load reduced by joint-teaching.
- Professional development opportunities for faculty.
- Distance–learning opportunities for students who are able to enroll in any of the participating institutions.

- Global approach to the course topics.
- Student interaction with nationally and internationally recognized experts (professors and practicing engineers), and students from other universities all over the world.
- Students experiencing a very modern environment of learning.

*Additional Benefits of Low-Cost Web-Based Video Conferencing*

- Low investment cost. Requires only purchase of affordable software and works with average-cost and performance computers. Even an inexpensive netbook computer is adequate.
- No need for high-cost facilities and equipment (e.g. PictureTel codec)
- Little need for administrative and technical support staff.
- No scheduling issues because the technology is not linked to a facility.
- No hardware compatibility problems.
- Potentially can avoid commute of faculty as well as of students. This can be extremely significant in case of snow-days, epidemics, or increased threat levels. Ultimately, could also save energy and reduce air pollution.
- Could extend to more remote country locations.
- Effective recruitment tool when used in partnerships with high-schools.
- Could relieve acute space problems present on many campuses.
- Allows for direct control over attendee's computer by the instructor.

***Obstacles***[4]

As everything else, the video conferencing might face some difficulties as well. The additional advantages of web-based video conferencing listed above are also disadvantages of the traditional video conferencing technology. Other common disadvantages are:

- It requires administrators, faculty, students, industrial representatives, and researchersthat are open to new ideas. Without the willingness of these people these technologies could not be widely implemented.
- Technical ability or availability of technical support is essential to the operation.
- The need of a well-organized plan to include all course outlines, objectives, outcomes and evaluation pieces required for a course, but in a different setting.
- Transferable course development needed from one institution to another.
- Coordination of different time-zones, institution schedules and different student-bodies.
- Laboratory and research type courses might need special technology and different class setting.
- Funding transfers between educational entities when traditional video conferencing facilities are used.

**Applications**

There is past[5] and ongoing cooperation between the faculty of the Civil Engineering Technology program at Metropolitan State College of Denver, the Civil and Environmental Engineering Department at Colorado State University in Fort Collins, Colorado, and the Budapest University of Technology and Economics. The cooperation extends from collaborative research to teaching, is using video conferencing technology, and included an internationally conducted Ph.D. public defense in 2004, joint offering and teaching the Timber Design II class (MSCD CET-490A and CSU CIVE-567) in Spring 2007 and Spring 2009, and several international research discussion sessions (New Zealand, Italy, Hungary,

USA). The faculties involved in the cooperation are currently exploring alternatives to expensive traditional video conferencing, such as the emerging low-cost web-based video conferencing technologies. The technology can also be applied to build partnerships with high schools and industry.

Following the success of previous collaboration and in continuance of the educational cooperation between CSU and BUTE, the two institutions, with a formal exchange program agreement at undergraduate level (named Study in Hungary) already in place, initiated a pilot activity, offering a shared course in the graduate Civil Engineering programs. The international course used the technology discussed above, and it was offered in Spring 2005. It was well received in both institutions. The course CE 766 - Shell and Bridge Structures was listed as a graduate course at CSU and it was offered as a technical elective at BUTE. The shared course included guest lecturers from both locations, on topics such as the Elizabeth-Bridge rebuilding project in Budapest, the Millennium Dome in London, the T-Rex transportation/transit project in Denver, Colorado, and the Colorado Convention Center Expansion project in Denver. The real-life experiences shared by the experts in their field was a unique approach of the course, and students benefited from the international projects through the case studies presented, without leaving their classroom. The TLN network gave the opportunity for student interaction allowing them to ask questions about the topics and since the connection is real-time, answers or clarifications were immediately received. Developing more and more "shared courses", can initiate partnerships between many universities nationally and internationally. This is a very modern and user-friendly approach for specific instructor expertise or distance learning, where traveling is a concern both as time and monetary cost. The flexibility of these courses depends on the agreements between the institutions, availability of curriculum development support, required technology and coordination between different time zones.

The traditional video conferencing solution for distance learning was successfully applied in two shared classes between CSU and MSCD (Spring 2007, and 2009). Compatible PictureTel system and IP protocol allowed for smooth connections. Facilities at both institutions possessed the needed expensive equipment. At MSCD the school had to pay a fee for each class to facilities management (the Auraria Media Center) for the media services provided. Shortcomings were experienced only when the MSCD facility was flooded due to a water main break, rendering it unusable for several days. In contrast, if web-based technology would have been used, the class could have been easily diverted to another room since only basic computer hardware and software requirements are to be met.

The success with joint collaboration and traditional video conference units allowed an experimental application of the low-cost web-based video conferencing to be trialed in the Summer 2009 semester. The MSCD Timber Design (CET-4450) was offered via the TLN administrative support and WebEx contract to universities (CSU and NDSU) and DOT offices connected to the Transportation Learning Network via the Cisco WebEx system. This shared-course application involved a hybrid setting, with in-class students and instructor and in parallel with a low-cost web-based course delivery technology for off-campus students and engineering offices. The hardware cost and performance was kept relatively low to simulate average user conditions (average PC and webcam with integrated microphone). The results of a survey conducted with students answering the question if they would recommend taking a WebEx-based class show 50% answered yes, 25% answered yes if no traditional classroom offering is available, and 25% answered no. The teaching faculty found that the hybrid setup presented a significant burden due to the requirement to operate all the technology in a

classroom setting. Based on the survey conducted it was concluded that the low cost video/audio hardware is not well suited for such a hybrid offering due to their low focusing and range capabilities (this would not be a problem when the instructor would only sit at a desk, at constant distance and angle to the camera and microphone). The content delivery, however, which involved an in-class smart-board and extensive use of Power-Point presentations and other shared-applications, was well received by both the off-campus and in-class attendees. There were also varied video and audio experiences depending on the download rate of the medium in place for each off campus student or observer.

Web-based, low-cost video conferencing using the Adobe ConnectNow platform was applied to conduct several international research discussion sessions between scientists in Italy, Hungary, and the U.S. These research video conferences were adequate in video, sound, and computer screen and application sharing quality, and provided unprecedented flexibility to the participants. Successful research meeting were established from hotel rooms while traveling, and from various other locations with acceptable Internet access (e.g. a broadband or a DSL via a 10Mb/s or better Ethernet, or a WiFi 802.11b or better network connection).

**Conclusions**

The low-cost web-based video conferencing offers several advantages over the traditional (Internet-based) video conferencing. The authors experience is that the traditional video conferencing system offers better picture and audio quality transfer capability, due to the higher quality (HD) equipment used. Additionally, web based video conference has ubiquitous access to institutions worldwide and to individual homes.

It is expected that the quality of the lower-cost digital video cameras and the internet data communication rates will improve in the coming years, allowing for advances in the performance of these affordable systems. It was also found that web-based course content delivery could be adequate in its current stage when the instructor is dedicated to this type of delivery (e.g. providing instruction from an office to web-based attendees only). In research collaborations, the web-based technology already offers unsurpassed advantages. The favorable experience is unanimous between the parties involved in the research cooperation.

Further, collaboration is not limited to United States institutions, but can reach to international counterparts. Metropolitan State College of Denver and the University of Pecs in Hungary have this partnership concept and would be able to conduct classes with a global perspective which is an intangible benefit for all students.

The ability to combine technology and institutional partnerships provides a significant opportunity to economically solve the low class size enrollment issue.


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