120th ASEE Annual Conference & Exposition
FRANKLY, WE DO GIVE A D*MN
June 23-26, 2013

Paper ID #8008

The Move to Online: More of the Same or Re-Creating Engineering Education?

Prof. Wayne P. Pferdehirt, University of Wisconsin-Madison

Wayne P. Pferdehirt is the Director of graduate engineering distance degree programs for the University of Wisconsin-Madison's College of Engineering. Wayne has also directed the University of Wisconsin-Madison's technical leadership degree, the Master of Engineering in Professional Practice (MEPP) program, since the program's launch in 1998. MEPP was UW-Madison's first completely online degree program and has won several national and international awards for proven quality of instruction and student support.

Prior to joining UW-Madison, Wayne directed the Midwest solid waste consulting services of Camp Dresser McKee and led energy conservation research projects for Argonne National Laboratory. He has a BS in engineering from Carnegie-Mellon University, an MS in civil engineering with an emphasis in regional planning from Northwestern University, and is a licensed professional engineer.

For more information about UW-Madison's online graduate engineering degree programs see http://distancedegrees.engr.wisc.edu

The Move to Online:
More of the Same or Re-Creating Engineering Education?

Abstract

The rush to take more courses and more degree programs online continues to rise exponentially. Too often this decision is made in a "Ready, fire, aim!" mode. Institutions decide to "go online" to increase enrollments and revenues but do so too often without seriously considering how course and degree offerings, and their design, align with the institutional mission and strategic goals. When online learning is simply construed as digitally capturing what already happens in a traditional on-campus classroom and streaming that to remote students, institutions fail to capture the exceptional opportunities that online learning provides for creating fundamentally better ways to teach and learn. Those opportunities can reach new, strategically targeted students, increase teaching skills of all involved faculty, and synergistically improve teaching on campus.

This paper will explore key strategic opportunities that online learning presents for improving the quality, reach and impact of engineering education, when focus, effort and resources are explicitly committed to doing so, rather than simply getting off-campus students to enroll in existing traditional on-campus offerings.

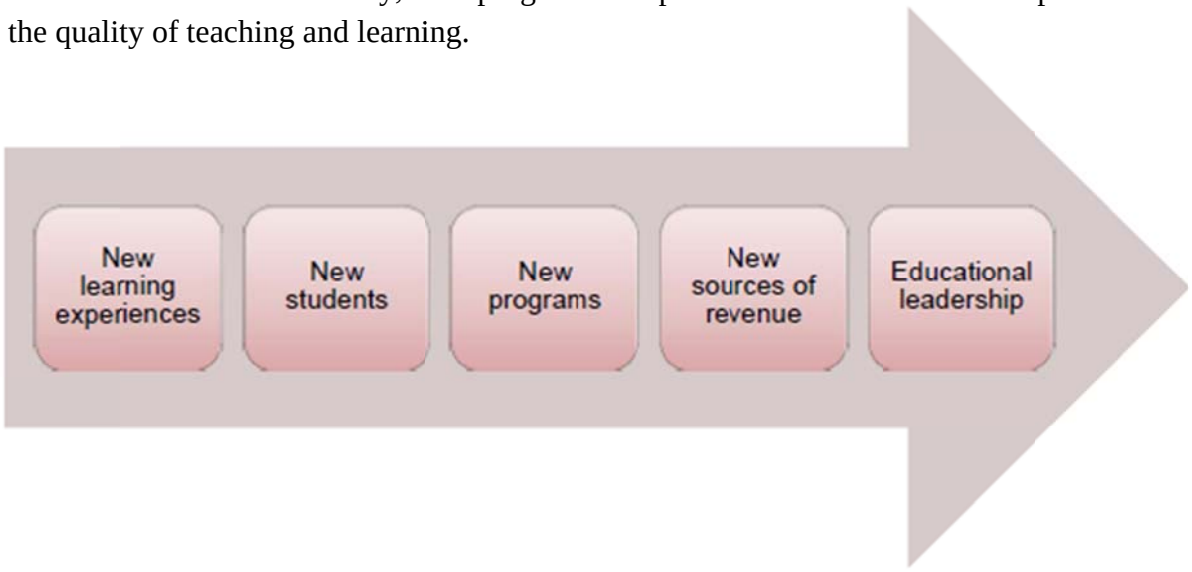
The paper draws largely upon the experiences of the University of Wisconsin-Madison's College of Engineering in developing new distance graduate engineering degree programs. The College has committed to building best-in-class degree programs that grow from centers of strength within the College and which strategically deliver value to the College. This strategic value is derived by creating new, stimulating opportunities for faculty to teach highly experienced engineers, learn with them through challenging authentic project-based learning, and create spillover benefits for faculty on-campus teaching and research. Rightly viewed and applied, online learning creates genuinely new, creative opportunities for teaching and learning, rather than a burden of teaching more of the same.

The focus on quality with which UW-Madison College of Engineering has pursued the creation, delivery and support of online learning has been recognized by major national awards for quality from the Sloan Consortium[1], The University Continuing Education Association[2], and the American Distance Learning Association[3]. In January 2012, U.S. News & World Report's first-ever ranking of online degree programs rated UW-Madison's online engineering degree programs first in two key categories of proven quality: teaching practices and student engagement; and student services and technology[4].

Introduction

As the director of several online degree programs and an instructor of an online course, the author is a strong advocate for advancing the quality and reach of distance education, especially within graduate engineering education. That said, the author also confesses his frustration and disappointment with much of what presently constitutes typical design of distance courses and degree programs in engineering education. We can do better. We can do *much* better. This paper offers an exploration of the opportunities that can be realized by faculty, departments and institutions interested in using distance education to fundamentally improve the quality and impact of engineering education.

Figure 1 illustrates the many opportunities that online education can enable when strategically envisioned, designed and implemented. Entirely new degree or certificate programs can be created, reaching new students with new targeted, authentic learning experiences. Programs that are well designed to meet market needs and are effectively marketed can provide new sources of revenue. More fundamentally, such programs can provide educational leadership in advancing the quality of teaching and learning.



Typically any industry or enterprise that adopts a new form of information technology does so by simply by digitizing existing practices. Examples include scanning forms and papers for downloading and printing and electronically recording and streaming lectures. Revolution occurs when users realize and creatively capture new opportunities for quality and impact. Thus the difference between the interactivity that Facebook enables, versus a system that simply provides access to scanned biographies.

We can provide a much more meaningful educational experience for engineering students by tapping the full potential of online learning, rather than settling for digitizing classroom lectures and providing a "digital peephole" to distance students. This is a frontier moment for those willing to leave the secure fortress and discover new lands of opportunity for students, faculty,

and their institutions. This paper explores some opportunities and invites the reader as a partner in re-creating engineering education for increased impact as well as greater faculty fulfillment.

The Challenge

Here's the typical scenario playing out across U.S. engineering colleges. A dean, department chair, or perhaps a small collection of faculty are concerned the college is not doing enough in distance education and fears the institution might be left behind its peers in exposure, number of graduates, and tuition revenues. A decision is made to rapidly grow online offerings. The basic goal is to increase enrollment in current courses by enabling participation from students anywhere. Implicitly or explicitly the assumption is made that current classroom teaching practices should be disrupted as little as possible. Because it is assumed that current classroom teaching practices are fine, the goal is simply to record and electronically transmit classroom lectures, with supporting materials, and enable distance students to perform "as well as on-campus students."

The above approach typically fall shorts from several perspectives:

- It sets the bar too low for distance learning. We can do much better than traditional lecture-based classroom instruction.[5]
- It fails to see how properly deployed and supported technology can greatly increase the quality of teaching and learning for both on-campus and off-campus students.
- It fails to see the vital importance of building an active learning community that supports deeper learning and personal support among students.
- It fails to show how truly collaborative, active learning helps students master effective distance collaboration skills sorely needed in the global workplace.
- It fails to distinguish between the learning goals and needs of distance students as opposed to those in the on-campus classroom. Distance students are typically older, have more professional experience[6,7], and rely on technology as a lifeline rather than as a supplemental format.

The above limitations occur despite the high level of education and teaching experience of engineering faculty. The core problem is seeing technology as a way to do more of the same rather than as an opportunity to do something much better. This paper attempts to paint a vision of what can be for engineering colleges that dare to use technology to reinvent teaching in ways that research tells us work best for students and instructors.

The Opportunity

Fundamentally the opportunity is using technology to help us recreate engineering rather than simply doing more of the same to more people. This is not to say that technology itself is the

answer. In fact, infatuation with the bells and whistles of technology too often gets in the way of important, valuable innovation. The real key is using technology to enable richer, deeper, and more valuable learning.

To make this point let me us consider two contrasting scenarios depicting different models of online graduate engineering education. In the first scenario, distance students, who are mostly adult, practicing engineers enroll in a Master of Science program in mechanical engineering. Students watch lectures recorded from live classroom sessions for on-campus students. Students complete written assignments which they submit electronically. Questions are answered via e-mail by the instructor or a teaching assistant. Online students complete exams that are locally proctored. The program allows distance students to obtain a graduate degree from anywhere, and learn from some highly renowned professors at the subject university. The program enables the university to generate some new revenue from the students enrolled in the distance. The program requires little change from instructors except to remember to turn on recording equipment, stay in the camera's range when lecturing, and remember to repeat questions posed by in-classroom students so they are included in the lecture recording.

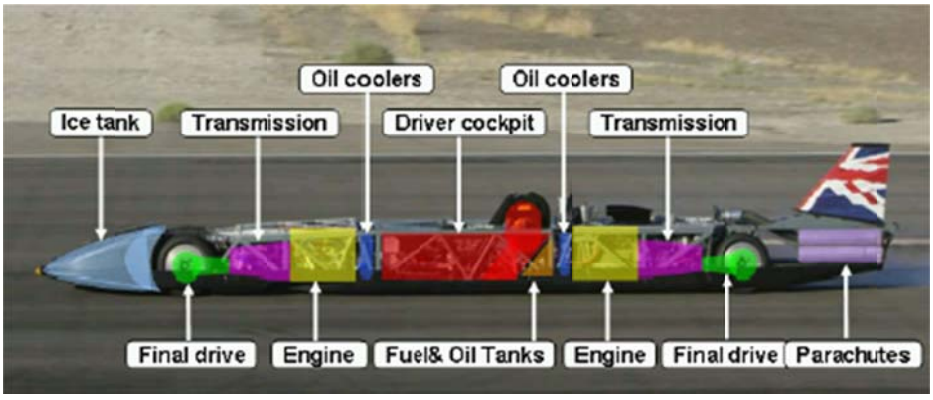
Contrast that with a Master degree program intentionally designed in content and format for practicing engineers who design internal combustion engines. The design of all courses uses problem- and project-based learning that engages real problems and projects from the workplace. All students have significant experience designing engine systems and subsystems; this expertise is intentionally engaged by instructors to deepen the learning of all students. Students engage meaningfully with each other each week through a mixture of asynchronous discussion forums, class web conferences, and student-scheduled study web conferences. Teams of geographically dispersed students work together over two years to design actual engines. They learn with and from each other as they design the many systems and subsystems that comprise their engines. Just as importantly, they learn how to effectively manage and contribute to collaborative design accomplished by geographically dispersed teams. Guest speakers from across the world interact live with students during weekly web conferences. Development of the program has challenged instructors to rethink what and how they teach. Supported by an instructional design staff, instructors have re-created their courses to address the needs of experienced, practicing engineers, and have creatively structured opportunities for these experienced engineers to contribute to group learning in the course. The result is a graduate program honed to the specific content and logistical needs of the target students. Instructional technology is the great enabler that makes this program possible. Web-based technology enables this group of peers from across the world to study and learn together in a way they never would if relocation to a campus was a prerequisite. Well-structured and supported technology also enables these students to meaningfully interact and collaborate. Students graduate with highly advanced technical competencies, and the ability to effectively lead engine design projects and teams. In short, they achieve the authentic learning they and their employers seek and value.

The second scenario may sound unrealistic. However, this is exactly the approach and experience of the University of Wisconsin-Madison's Master of Engineering in Engine Systems (MEES) program. All students in the MEES program are full-time working engineers, contributing to the engineering design, manufacture, test, or support of engines across the globe. Engine designers from companies such as Cummins, Harley-Davidson, Navistar, Toyota, Honda, GM, and Fairbanks-Morse, study together, complete team-based design projects, and learn from each other as well as senior faculty from UW's Engine Research Center. The online design of this program enables engineers who "live and breathe engines" to study and work with similar-minded peers from throughout the world and to learn from world-class research faculty with UW's Engine Research Center. Students complete team-based projects using a set of collaborative tools that teach them how to contribute and lead similar projects with global teams in their everyday work.

The online design of the MEES program both makes the program possible and provides the supporting structure for students and faculty. By removing the obstacle of distance, the program enables a sufficient number of practice-oriented engine engineers to enroll in the program without moving or suspending their careers. The intentionally collaborative, project-based learning in the program enables students to learn with and from highly experienced industry peers. The program also creates broader and deeper connections between campus faculty and industry, enabling faculty to gain greater understanding of, and linkage with, the interests and needs of mid-career engineers and their employers.

For the author, the unique learning opportunities that online learning can create was illustrated particularly well in a web conference held for a MEES course a few years ago. The course, Engine Project Management, teaches engineers how to effectively manage engine design projects, providing a highly focused, context specific, applied approach for engineers leading engine design groups and projects. The course is taught by Brian Price, former lead powertrain engineer for Harley-Davidson. Brian is a lecturer in the School of Engineering & Applied Science at Aston University, UK, and an adjunct instructor for UW-Madison. Brian had invited Doctor Tim Leverton to be a guest speaker for the subject web conference session. Leverton spoke from his office in Rocester, UK, Price participated from Russia (due to business travel), students participated from across the U.S and as far away as India, and the author moderated the session from Madison, WI. During the session Leverton addressed the technical, schedule, logistical, and leadership challenges of designing a vehicle to break the land speed record for diesel-powered, wheeled vehicles. During this live, interactive web conference Leverton provided MEES students with a look "beneath the cover" of Dieselmax, which successfully broke the targeted record at the Bonneville Salt Flats in 2006, a record (350 mph) that still stands. The online design of MEES enabled this live, highly interactive dialogue between Leverton, engine design engineers from throughout the world enrolled as MEES students, and the instructor. This session illustrates the potential for online degree programs bringing new groups of students together, an instructor living in and teaching from another country, and

facilitating learning that is richer by expanding the boundaries of where and how learning takes place.



The MEES program is one example of using online learning to create new high-impact curricula to meet a previously unmet education need. The focus on designing a curriculum that directly responded to the career development needs of target students, rather than simply recording and bundling existing on-campus courses was the key to success of this program.

More of the same or re-creation of engineering education? Distance technology can be used by engineering colleges and departments to do either. Choose either, but know what truly is possible.

How Do We Get There?

- *Decide to use your initiatives in distance education as opportunities to create programs and courses that make major advances in the nature and quality of education offered by your institution.* Aim high. Create a vision of what can be and engage faculty in shaping,

refining and realizing that vision.

- *Decide to make meeting the needs of students as the #1 priority. Distance students are more likely to be practicing engineers, with learning goals tied to advancing their practical knowledge and career advancement.* Course content must be highly relevant and authentic. Employ project-based learning that challenges and enables students to apply what they are learning to their workplace projects. Provide flexibility in assignments that allow students to hone their learning to their specific goals. Engage the experience and expertise of students for the benefit of all learners in the class.

- *Engage experienced, capable instructional designers in the design of the program and each course.* Investing in knowledgeable, capable instructional designers is one of the best investments a distance program can make. Instructional designers are experts in effectively employing technology and pedagogy to achieve learning and instructional goals. Instructional designers enable faculty to focus on being content experts, as they rely on the instructional designer to identify how to best use various formats, technologies and practices for maximum learning by students and the best possible teaching experience for instructors.

- *Effectively support faculty throughout course development, delivery, and evaluation.* Create a true team culture in which faculty work with instructional designers, the program director, and support staff to develop, deliver and improve courses. Free instructors from the hassle and low-value of learning the intricacies of course management systems. Develop team ownership of course results so that instructors feel genuinely supported in assessing results and working together to make the course the best possible offering to students

- *Build community.* Create a culture that values and supports meaningful interaction between students. Set and model expectations for frequent, meaningful engagement in course discussions, as well as in broader professional discussions (e.g., best practices, career management, etc.), and in helping each other with logistical issues within a course or the overall program. Done well, this will help students learn more, feel supported, and work more efficiently.

- *Integrate learning and professional practice.* Adult learners especially value the ability to practically apply what they are learning. This leads to better, longer-retained learning. Also, this enables employers to see the impacts of their employees' learning, especially important when employers are financially supporting students' tuition. Also, this helps students demonstrate to peers and supervisors their growing talents and their readiness for career advancement.

Practical Advice

Let's take it down to the practical level. What are some specific ideas and practices that could be used to enrich engineering education as an engineering college grows its online offerings? The following suggestions are offered as starters based on the author's experience. These ideas just scratch the surface in terms of possible creative strategies for online learning.

- *Group Projects*. The ability to effectively lead and contribute to project teams that are globally distributed is a critical need in today's workplace. Distance learning programs are an excellent venue for teaching these skills through well-designed and supported team projects. Best practices can be taught, modeled, and supported. Students can learn from the experiences of their team and other teams by structuring exercises in which teams evaluate their performance, identify opportunities for improving their performance, and share those insights with other teams, either in a course web conference or via a discussion forum.
- *Interactive Web Conferences.* Few things are more boring than a web conference that is little more than a narrated PowerPoint show. A well designed web conference, however, can be highly engaging, with students as well as instructors contributing to the content and discussion. Frequent (at least weekly), live web conferences, intentionally designed for high interaction with students are an excellent way to meaningfully complement asynchronous learning, and builds meaningful, active engagement between students and instructors. To prevent web conference becoming one-way slide show, invest in training for instructors that teaches the value and logistics of interactive sessions. Model the use of interactive web conferences through their use in online meetings with faculty and staff.
- *Student-Led Presentations.* Have students contribute to learning by preparing and delivering presentations that contribute to course learning goals. These presentations can be delivered either live as part of course web conferences, or recorded by students for asynchronous viewing by other students. In the project management course the author co-teaches, two students each week deliver a 10-minute presentation on a project management topic, case study, or practice that goes beyond the core, instructor-prepared curriculum. These presentations are always a highlight for students as well co-instructors, as students share case studies of challenging real-life engineering projects, and best practices employed in their workplaces.
- *Student-Led Discussions.* Have students actively contribute to course learning by leading weekly asynchronous discussions related to the week's lesson. A designated student leader can pose open-ended questions related to the week's learning, sustain and deepen discussion through follow-up comments, than draw together lessons learned through the week's discussion as part of a summary posting. The author's experience is that this is an excellent way to have students enhance their learning and learn effective leadership of online discussions.

- *Anytime Study Groups*. Web conference tools can be effectively used to support student-initiated study sessions. Rather than gather face-to-face at the library, small groups of students can agree to get together at times that work for them to work together to support each other's learning. Teaching assistants can similarly call sessions to help students work through challenging lessons and assignments.
- *Robust Collaborative Tools.* Provide and support tools that enable effective, efficient collaboration among student teams. Help students learn best practices in effective distance collaboration. Use and support tools that are worthy of industry use rather than "e-toys." Tools that should be available for all students to use for collaboration should include, at a minimum, a document management system, anytime web conferencing, student-configured (e.g., membership-restricted) discussion forums.
- *Engagement of Alumni.* Alumni can be meaningfully engaged through distance technology to mentor current students, to serve as guest speakers in course web conferences. Select alumni can also be engaged to assist with courses; for example, they can be engaged as reviewers for assignments or to help lead focused online discussions that relate to their areas of expertise. In addition, alumni can be effectively engaged for their benefit and that of the university through program-specific discussion forums and web conference seminars.

What to Avoid

As a complement to the preceding recommendations, the following are offered as some directions to avoid in planning new online degree offerings:

- *Avoid anything that makes online students feel like distant, second-class participants in courses and the sponsoring departments and colleges.* Within courses, create meaningful, well supported venues for student-instructor and student-student interaction. Beyond individual course, degree programs should create opportunities to build meaningful student-student and student-faculty and student-alumni interaction and networking.
- *Avoid faculty frustration and burnout caused by inadequate support.* Provide proactive, reliable, responsive support to faculty in course design and implementation. Enable faculty to be the content experts, working with a team to select and deploy various complementary strategies, methods, and tools within their course that best help student achieve the course learning objectives. Without this support instructors are likely to become frustrated and may make poorly-informed course design choices that are likely to be difficult to correct given effort and political considerations.
- *Avoid the failure to plan well for meeting students' needs at the program level.* Think and plan beyond individual courses. How can everything from admission processes, to orientation, curriculum, cross-course integration, the projects that students complete, and alumni relations be structured to provide students with an integrated, innovative

educational experience? Such experiences can and do occur in best-practice online degree programs, but only when such integrated experiences are valued by institutions and intentionally supported in program design and operation.

Conclusion

The creative use of online distance education can provide engineering colleges with exciting new possibilities to engage new types of students in innovative degree programs that deliver strategic advantages to the institution and its faculty. All of this is possible if the vision for "going online" is set high enough to inspire faculty, administrators, and staff, and the commitments are made to make it happen. Unfortunately online education is too often seen as just a way to add more students to on-campus courses without rethinking what is taught and how it is taught. Making online education "as good as on-campus education" is setting the bar too low. By thoughtfully, creatively employing distance technologies and formats we can re-create engineering education for distance students, and create the impetus and means for improving on-campus education as well.

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