AC 2010-1775: A CASE STUDY ON TRANSFORMING UNDERGRADUATE ENGINEERING EDUCATION AT THE UNIVERSITY OF WISCONSIN-MADISON

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Abstract

Several reports such as the National Academy of Engineering's (NAE) *The Engineer of 2020* and *Educating the Engineer of 2020* document the changing nature of engineering as well as the changing world in which engineers practice. As *The Engineer of 2020* and others argue, this changing landscape that our graduates face strongly suggests a need to change the preparation our students receive.

The University of Wisconsin-Madison has been facilitating change in the undergraduate program to promote a different kind of engineering education. To provide leadership and strategy for change, the College of Engineering (CoE) formed the *Engineering Beyond Boundaries* EB^2 Task Force (TF) consisting of a core group of faculty.. Through a series of focus groups, faculty meetings and the formation of a larger working group, faculty and staff articulated and pursued the following goal:

The College of Engineering will provide a contemporary engineering education that is strong in the fundamentals of the discipline and also fosters an understanding of the societal context of engineering and a passion for life-long learning. This will be achieved by guiding students through new educational opportunities to:

- *build disciplinary excellence with multidisciplinary perspective,*
- *nurture critical thinking,*
- *develop multicultural competence,*
- *cultivate collaboration and leadership skills, and*
- *promote an ethic of service to the profession and the community*

To provide the necessary incentives and mechanisms for change, to-date the College has held three internal solicitations for proposals to transform undergraduate education providing faculty and staff with modest grants for release time and other resources. A total of 26 projects have been funded. The purpose of this paper is to describe our process, document accomplishments to date including successes, challenges, lessons learned, and to detail our next steps to continue this transformation.

Background

Rapid change is a common thread that runs through our world today. While rapid change presents uncertainty, it can also present opportunity. The later was the philosophy adopted by the University of Wisconsin-Madison as it builds a culture of academic innovation in response to a rapidly changing modern world. Engineering Beyond Boundaries is the brand and identity given to the college's long-term educational reform effort that encourages faculty and staff to "go beyond." Specifically, EB^2 encourages members of the CoE community to rethink the academic culture to address important changes by going *beyond boundaries* of:

- conventional engineering education and recasting our content and approaches for a rapidly changing world.
- the classroom, with new technology and multi-media strategies that allow faculty to expand their educational approaches.
- the college, with programs supporting greater connections across disciplines such as biology, medicine, business and the humanities.
- the state and nation to prepare students to work and succeed in many different countries, cultures and languages.

The call for change in engineering education has been studied and reported in a variety of venues and the types of changes needed have been articulated in more than one study by the National Academy of Engineering[1,2]. Similar themes are expressed in the Creating a Culture for Scholarly and Systematic Innovation in Engineering Education (CCSSI) Phase I report[3]. Implementing the identified changes needed in academia has proven to be a more complex and slower process that continues to lag behind the pace of change in technology and the world economy. It is clear from the literature and our experience that engineering educational reform is a journey, not a destination and often a slow journey at that. As early as 1996 the University of Wisconsin-Madison was participating in and presenting methodologies related to educational reform[4]. These efforts were tied to introducing a freshman introduction-to-engineering course that at the time was novel and building a teaching improvement program with a particular emphasis on assisting teaching assistants and new faculty. Our efforts have developed in parallel with and have been built upon the work of others. For example, Froyd, Penberthy and Watson have drawn the distinction on the differences between academic change processes and good educational experiments[5]. Fornier-Bonilla et al. articulated the organizational impacts and resistances to change in their on-going efforts in engineering at Texas A&M University[6]. The CCSSI Phase I report provides a comprehensive list of more recent relevant literature[3].

While our college has always been intent on offering its students an education deep in contemporary preparation, our efforts were focused and re-chartered in 2005 with the creation of a seven-person Engineering Beyond Boundaries Task Force and a series of engagements with faculty. The Task Force was formed following our attendance at the first Engineering Education Leadership Institute (sponsored by NAE and the Center for the Advancement of Scholarship in Engineering Education). The Task Force has since been engaged in activities that have been influenced by methodology presented by Massy and the general steps of education reform identified here and elsewhere in the literature are similar[7]. Massy's seven implementation steps for academic reform are enumerated as:

1) Build awareness and commitment
2) Commission pilot projects
3) Create venues for ongoing discussion and development
4) Organize skill development and consultation services
5) Broaden the rewards, recognition, and incentives environment
6) Adopt performance-based resource allocation
7) Develop an internal oversight and review capacity

In June 2009, Task Force members again participated in an NAE-sponsored workshop on "Developing Engineering Faculty as Leaders of Academic Change." This workshop set out with four key goals: "catalyze knowledgeable faculty to engage in change leadership activities on their individual campuses, convene knowledgeable engineering faculty and administrators in a structured two-day workshop to distill and synthesize their tacit and explicit knowledge about how to identify and implement needed campus change processes, translate the distilled change leadership knowledge and skills into a post-graduate leadership development program focused on academic change; and, through identification and implementation of appropriate mechanisms, encourage engineering faculty to participate in a post-graduate program to develop in academic change leadership."[1] Approximately thirty institutions were present, representing a spectrum of engineering units at large publics, privates and smaller undergraduate public institutions.

At the 2009 NAE Workshop, we observed both common elements and major differences in building a change culture at different types of institution. A consistent and reoccurring theme is the need for faculty incentives to embark in major pedagogical changes in a course or curriculum. The time demands on faculty and the lack of risk-taking rewards seem to pervade through most institution types. Current faculty promotion criteria have also been repeatedly identified as inhibiting faculty to make bold changes in teaching and yet existing criteria appear to remain firmly entrenched at most institutions. Changing the promotion processes to provide incentives and recognition to faculty reformers is not easily accomplished at large public research universities. The expectations for faculty to build strong, recognized research programs provides a constraint on how much time faculty are able to devote to redesigning classes and/or undergraduate education.

From knowledge gained at NAE 2005 Engineering Education Leadership Institute workshop and the implementation steps of Massy, the task force engaged the faculty and staff in a series of venues including listening sessions, all-college faculty meetings, and the formation of a larger group of change agents that we call the EB^2 Roundtable.

Implementation Steps 1 and 3: Building Awareness and Commitment through Venues for Ongoing Discussion

In October and November of 2005, the task force hosted five listening sessions in which CoE faculty, staff, and students were invited to attend and share their views on how the landscape is changing. Approximately 60 members of the CoE community attending the meetings and others provided comments via email or telephone. Changes described by attendees fell into three broad categories of 1) environment, 2) interaction, and 3) people. Following is a summary of how attendees defined change given this method of organization:

Environment

- Leadership, incentives, and flexibility must exist for students, faculty, and staff to participate in experimentation, change, and choice.
- Faculty and staff must provide an education that prepares our students to enter the world as it will be, not as it was.
- Faculty, staff and students need to be able to work effectively in an environment where diversity is the norm rather than the exception.

Interaction

- Cross-disciplinary research and education will be the norm, but only if the support infrastructure exists.
- Interaction across groups (faculty, staff, students, departments, etc.) will help build community and encourage further cross-disciplinary collaborations.

People

- Professional development for faculty and staff will enable them to keep pace with changes in the college, the profession, and the world, and thus serve students well.

Following the listening sessions, the CoE hosted "Designing the College of Engineering for the Future," an all-college meeting in mid-January of 2006. This meeting summarized results from the recently concluded listening sessions and presented a foundation for future change. The goal in transforming the CoE is to "educate engineers who will be leaders in tomorrow's world by exploiting the breadth of learning opportunities at UW-Madison."

The Task Force convened a group of internal college faculty and staff change agents to gather feedback on goals and to serve as a cross-cutting advisory group. The Roundtable was formed in 2006 to expand the involvement and reach of the smaller Task Force. Twenty-five faculty and staff were selected, including the seven-person Task Force. The membership has evolved over the past three years but the Roundtable is representative of the different departments and constituencies in the college and includes faculty involved in departmental curriculum committees. The charge to the Roundtable has been to "Understand the changing environment for higher education and its implications for the College of Engineering and develop an action plan that includes changes in course curriculum and delivery to meet the new challenges in undergraduate education." This followed directly from the step 1 implementation from Massy to build awareness and commitment and is articulated with similar words in the CCSSI Phase I report and other institutional change literature.

The Roundtable determined that three elements in addition to disciplinary excellence characterize the best undergraduate engineering education: 1) curriculum and course content relevancy, 2) emphasis that engineering occurs in a broader societal context, and 3) creating a foundation for life-long skill and knowledge development. These elements were reflected in the following goal:

The College of Engineering will provide a contemporary engineering education that fosters an

understanding of the societal context of engineering and a passion for life-long learning. Achieving this goal requires that faculty and staff guide students in shaping their undergraduate experiences to:

- *build disciplinary excellence with multidisciplinary perspective,*
- *nurture critical thinking*
- *develop multicultural competence,*
- *cultivate collaboration and leadership, and*
- *promote an ethic of service to the profession and the community.*

Implementation Step 2: Commission Pilot Projects

As indicated in several sources, building a culture of innovation and change requires providing incentives for faculty to take on new developments and risks. Because this was the first round of pilot projects the objective was to begin by being intentionally broad and inclusive. The pilot projects provided salary support and teaching assistant support to allow faculty to be relieved from other obligations for the proposed development. The Roundtable members identified six priority themes for pilot projects in 2007-08:

- societal and multicultural understanding;
- multidisciplinary perspective;
- flexible and relevant curricula;
- service to the profession and community;
- contemporary educational delivery; and
- development of students' professional skills.

Eleven projects (40% of the proposals submitted) were selected for funding. A wealth of creative ideas flowed from the initial solicitation and pilot project completion. However, as described in the next section refinement was needed. In all, 26 projects (as shown in Appendix A) have been funded over three years with funds set aside for this purpose and it has been important in building the culture of reform that the pilot project effort be sustained.

Challenges and Successes Related to the Pilot Projects

Broadly speaking, the challenges to implementing the goals of Engineering Beyond Boundaries relative to transforming undergraduate engineering education have been in the areas of:

- Leading a change management process
- Getting broad faculty involvement
- Applying research on engineering education innovation from peer institutions and educational research.

The work of the Engineering Beyond Boundaries (EB^2) Task Force and Roundtable has been fully supported from the college administrative leadership and increasingly has formed the basis of the college's strategic plan. Department Chairs and Faculty have been invited to engage in the planning process as members of the Task Force and/or Roundtable to provide ideas and create strategies to gather broader input from across the CoE. All faculty and instructional staff have

been encouraged to submit education innovation pilot projects in response to the EB^2 call for proposals.

As a result of this engagement, the proposal criteria incorporated broad performance goals to promote projects that would contribute to the vision of the EB^2 to innovate engineering education. The response generated a range of projects with a few focused on creating multidisciplinary content and development of certificates building upon existing courses. The challenges identified by faculty in year one included:

- Collaboration across departments
- Technology support and delivery of blended or online courses
- Sustainability due to lack of funding or budget support

The shift in organizational culture is slow to adapt a more collaborative approach to interdisciplinary course design and delivery with a focus on modular content that can be pursued across programs and departments. This appears to be due to a variety of perceived procedural and cultural constraints.

After the first year of Roundtable meetings and funded project implementation in academic year 2007-08, a refinement to the proposal criteria was made to encourage greater flexibility in the curriculum by emphasizing interdisciplinary teaching through modularized core content, and integration of technology to move toward blended and online course and modular delivery of content. During Academic year 2008-09, the Task force and Roundtable focused the funding of projects by asking the following questions:

- How do we bring the EB^2 Vision and corresponding changes to core courses?
- How do we engage our faculty colleagues to design more flexible curricula and yet retain the appropriate level of disciplinary depth and excellence?
- How do we encourage teams of faculty to develop modular core courses and move toward online content using standardized tools and principles of good instructional pedagogy?

Now entering the fourth year of this initiative the Task Force continues to examine ways to promote faculty leadership and involvement in engineering education redesign that leads to flexibility, quality, and effectiveness in the CoE engineering curriculum. The funded proposals for the 2009-10 projects articulated criteria which encourages flexibility in designing curriculum, and support of sustainable and scalable projects that meet the EB^2 goals and vision. With a renewed focus on the engineering education innovation literature from ASEE, NAE, NSF and our peer institutions, the EB^2 effort seeks to encourage faculty engagement in interdisciplinary teaching. Meanwhile we continue to adopt effective strategies to transform engineering education in the CoE to address the multidisciplinary learning outcomes necessary for future engineers.

Lessons Learned from Pilot Projects

Over the course of this work, several evaluation and assessment strategies have been employed. In all calls for proposals, a requirement for "a description of assessment, dissemination and sustainability of the project" was included. Proposals address the assessment requirement in a range of ways, but it was clear to the Task Force at an early stage that not all

engineering faculty and staff are adequately equipped with the skills necessary to conduct a meaningful assessment of their project. Our initial approach was to mandate attendance by at least one of the project investigators of each funded project to a workshop providing basic information on assessment and evaluation tools that they might employ in their project/course. The second half of the workshop focused on developing an assessment plan to fit their project. Subsequently assessment and evaluation resources were provided on college's Engineering Learning Center website at (*http://www.engr.wisc.edu/services/elc/*) to reinforce the assessment strategies reviewed with the workshop participants.

At the conclusion of the first year of projects, Task Force members evaluated the final reports of all projects to determine how well each project had achieved its stated goals, which of the five goals of the Round Table were addressed, and the sustainability of the project. Assessment outcomes were not consistently reported by the project PIs and the overall impacts of the projects on the Round Table goals were difficult to determine although it was clear that all projects nurtured critical thinking skills and most built disciplinary excellence with multidisciplinary perspective.

Overall, 80% of the projects funded addressed the stated objective of building disciplinary excellence with multidisciplinary perspective. Thirty percent of the projects addressed the goal of nurturing critical thinking; 20% addressed the development of multicultural competence; another 20% addressed the goal of promoting an ethic of service to the profession of service; and 10% of the projects addressed the goal of cultivating collaboration and leadership skills.

Two electronic surveys were administered to engineering faculty members and students in Spring 2008 to assess overarching learning outcomes from both the student and faculty perspectives from the 2007-08 course projects. These surveys were designed to establish a baseline for the project and used selected questions from the UW-Madison campus' National Survey of Student Engagement, Academic Pathways of People Learning Engineering Survey (APPLES), and Educational Benchmarking, Inc (EBI). While these assessment data have not been significant in determining impact on the desired outcomes, it has identified those courses, in and outside of the initiative that are contributing to the goals of the EB^2. For example, survey results indicate that students found a number of courses outside of specific EB^2 funded projects also contributed to their development of the EB^2 specific project course goals.

At regular intervals reports on the progress of projects were made to the members of the Roundtable. These were either in the form of a summary report provided by a Task Force member or invited talks presented by project PIs. The focus of these reports was on how projects were meeting Roundtable goals, lessons learned through the project, and long term sustainability of the project.

Next Implementation Steps for EB^2

While the pilot projects have been an important component of our change process, as indicated by Massy there are other implementation steps: 4) organize skill development and consultation services, 5) broaden the rewards, recognition, and incentives environment, 6) adopt performance-based resource allocation, 7) develop an internal oversight and review capacity. Each of these

remaining implementation steps are in various stages of development. For example, we are working to realign instructional support services to provide faculty with the skill development and consultation services they have identified as important for instructional design (Step 4). These services will be part of a new learning facility integrated in a new model for engineering libraries. Efforts to engage EB^2 project teams in effective assessment of student achievement and performance will require a greater focus on faculty development and recognition for effective teaching[9]. Increasingly our assessment and ABET activities are being aligned with the goals of EB^2. We are planning new awards and recognition for faculty who show the most accomplishment in the pursuit of EB^2 efforts (Step 5). To ultimately be successful, all of the implementation steps and the corresponding culture of change will increasingly be integrated into nearly all college activities.

As part of the outcomes of the 2009 NAE workshop, the Task Force members were asked to identify and mentor change leaders. Because we had already undertaken this task, having identified these leaders through the membership of the Task Force and Roundtable, the Task Force members brought back new strategies to foster the development of a culture academic change. The next steps are:

- Expand the knowledge base of our change agents, particularly in the areas of pedagogy and consensus building. We are increasingly bringing educational experts into the college for special seminars and presentations. We seek to better leverage the educational innovation activities that occur broadly across our campus.
- Engage colleagues in manner that is pre-emptive in managing conflict and change reluctance.
- Re-communicate the vision of the EB^2 initiative.
- Recommit to working toward better measurement, documentation and communication of progress.
- With the long-term in mind, continue to move forward with consistent goals and messages.

Summary

Despite an increasing number of studies calling for major changes to engineering education, implementation of change has proven more difficult. This in part is because few road maps exist on how to actually implement the changes within the existing general framework of higher education and the lack of specific guidance on how to customize roadmaps for the unique characteristics of individual institutions. This paper provides a summary of an approach taken at the University of Wisconsin-Madison over a period of years. Key elements of the approach include adopting a strategic framework of implementation (in our case based on the work of Massy[7]), clear brand identity (EB^2), incentives to innovate, and consistency in goals, messages and implementation throughout the processes of the college.

Acknowledgements

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Bibliography

[1] National Academy of Engineering, *The Engineer of 2020*, The National Academies Press, Washington, DC, 2004, 101 pgs.

[2] National Academy of Engineering, *Educating The Engineer of 2020*, The National Academies Press, Washington, DC, 2005, 192 pgs.

[3] ASEE, *Creating a Culture for Scholarly and Systematic Innovation in Engineering Education - Phase I Report*, American Society for Engineering Education, 2009, 33 pgs.

[4] Millar, S. and Courter, S. From Promise to Reality: How to guide an educational reform from pilot stage to full-scale implementation, *ASEE Prism* v6 p30-4 N 1996.

[5] Froyd, J., Penberthy, D., Watson, K. Good Educational are not Necessarily Good Change Processes, *Proceedings of the 30th ASEE/IEEE Frontiers in Education Conference*, IEEE, 2000.

[6] Fournier-Bonilla, S., Watson, K., Malave, C. and Froyd, J. Managing Curricula Change in Engineeirng at Texas A&M University. *Int. J. Engng Ed.* Vol. 17, No. 3, pp. 222-235, 2001.

[7] Massy, W. *Honoring the Trust*, Anker Publishing Co, Inc., 2003, 376 pgs.

[8] Cady, E., Fortenberry, N., Davenport Sypher, B., Haghighi, K., Abel, S., Cox, M., Reed-Rhoads, T., and Berkelaar, B. Work in Progress – Developing a Certificate Program for Engineering Faculty as Leaders of Academic Change. *Proceedings of the 39th ASEE/IEEE Frontiers in Education Conference*, pgs. M4E-1-M4E-2, IEEE 2009.

[9] Brent, E., Felder R. M., Hirt, D, Switzer D., and Holzer S. (1999, June). A Model Program for Promoting Effective Teaching in Colleges of Engineering. *Proceedings of the 1999 ASEE Annual Meeting*, 1999.

Appendix A: Pilot Project Titles and Goals

Year 1 (2007-08)
Curriculum Development for a Certificate in Engineering Risk, Uncertainty, and Decision Analysis (Goal: To develop a new certificate program to provide engineers and other students an in-depth exposure to modern methods for analyzing reliability, risk, and uncertainty.)
Energy and Sustainability Course for Energy Certificate Program (Goal: To develop a high-level course focusing on energy generation with a focus suitable for preparing engineering seniors to make quantitative comparisons between current and alternative processes.)
Engineering and Biology: Technological Symbiosis (Goal: To create a cross-college, introductory course designed to explore and highlight the ways in which biology and engineering can be successfully integrated.)
Engineering for Energy Sustainability (Goal: To develop a suite of cross-cutting courses that span the engineering curriculum, addressing energy sustainability, and with firm roots in "real world" design, and engineering practices associated with participating disciplines, leading to a "Certificate in Engineering for Energy Sustainability.")
Engineering Problem Solving with Computers (Goal: To create three hybrid courses that share common curriculum related to specific software tools but that use examples and exercises taken from specific engineering fields, to demonstrate the problem-solving or data-collection aspects of using the software.)
Fostering of Student Participation in Study Abroad in the Junior Year by Offering UW-Madison Engineering Courses Abroad (Goal: To make three junior-level engineering courses available to all students studying abroad, to enable these students flexibility in satisfying curricular requirements while overseas, and provide a model for replication.)
Integration of EPD 397 Technical Communication with Two Multidisciplinary Engineering Design Courses (Goal: To develop a stepped, two-semester, collaborative approach to teaching technical communications in multidisciplinary, service-oriented design courses.)
International Genetically Engineered (iGEM) Machine Competition (Goal: To establish an interdisciplinary iGEM team and promote education and research in biological engineering.)
Introduction to Society's Engineering Grand Challenges: A Modular Curriculum[1] (Goal: To create a modular, introductory, cross-disciplinary course building on NAE's Grand Challenges project.)
Zhejiang University Summer Program (Goal: To develop a new 8-credit, 8-week summer study-abroad program (following the successful model of the Toulouse Summer Program) at Zhejiang University in Hangzhou, China.)
Teaching and Learning Insights (Goal: To develop an electronic newsletter and corresponding archives on the web that would distribute concise answers to instructors' questions about diversity, advising, and teaching.)
Year 2 (2008-09)
Computational Methods in Materials Processing (Goal: To develop a new materials science course that will connect computer-based simulations with math content.)
Inter-ENGR 150-SI Problem Solving Workshop (Goal: To create online materials to strengthen the instructional part of the supplementary program aimed at reducing attrition in engineering enrollment. Materials will allow students with different learning preferences to study

and solve problems at their own pace in "gateway" courses.)
Enhancing Liberal Studies for Engineering Students (Goal: To better expose engineering students to the humanities and social sciences by providing recommendations on how students can maximize elective credits to gain a comprehensive understanding of the social contexts of engineering careers.)
International Engineering Development (Goal: To provide leadership training for students participating in international projects, and in particular in countries where the Engineers Without Borders chapter is active.)
Video-Enhanced Instructional Material for Statics (Goal: To help students better understand basic engineering mechanics phenomena that are difficult to comprehend or visualize.)
Engineering Leadership (Goal: To help students develop core leadership skills that will apply to leading roles beyond the classroom.)
Introduction to Society's Engineering Grand Challenges (Goal: To inspire students to become engineers to improve the quality of life around the world, based on challenges outlined by NAE. The technical communication components will advance the Writing Across the Engineering Curriculum system within the CoE.)
Engineering Problem Solving with Computers (Goal: To assess the computer problem solving courses in civil and environmental engineering, chemical and biological engineering, and engineering physics that were developed as a prior funded project in Year 1, and to add a fourth course in electrical engineering. This faculty involved will collaborate in finding effective methods to introduce sophomore students to the principles of computer problem solving.)
Integrating Professional Development into Undergraduate Design and Research Experiences [2] (Goal: To develop undergraduate-level training materials on professional development topics associated with the context of design and research.)
Year 3 (2009-10)
Modules for Data Acquisition and Experimental Measurements Development and Integration (Goal: To leverage the coincidental occurrence that three departments (Mechanical, Chemical and Biological, and Civil and Environmental Engineering) are implementing similar upgrades to laboratory experiences in data acquisition and experimental measurements by coordinating these efforts and developing common modules.)
Engineering Communication Across the Curriculum: A Plan to Develop Online Modules and a Wiki to Supplement Communication Education in CoE (Goal: To develop web-delivered video modules that can be used across the College of Engineering to reinforce best communication practices and that are flexible enough to serve the needs of multiple courses and faculty members.)
Exploring Interdisciplinary Fluid Mechanics (Goal: To explore the common content of the various fluid mechanics courses, as well as explore the effectiveness of various course structures and use of technology. The ultimate goal of this project is to develop a set of materials that can be utilized in a modular, interdisciplinary, dynamic course on fluid mechanics.)
Removing Redundancy in Control Theory-Based Courses in Mechanical Engineering and in Nuclear Engineering Using eCOW2 and On-line Streaming Video (Goal: To improve student learning in the topic area of dynamic system analysis for the courses *Introduction to Dynamic Systems* and *Nuclear Reactor Dynamics* through on-line recorded problem solution examples and on-line quizzing tools which implement step-by-step solution checking.)
A Coordinated Teaching Structure Between the Departments of Engineering Physics and Mechanical Engineering to Promote Enhanced Learning of Mechanics of Materials (Goal:

To coordinate the teaching of *Mechanics of Materials* between the Departments of Engineering Physics and Mechanical Engineering and improve student learning of the concepts covered in this key core course.)
Engineering and Biology: Technological Symbiosis Goes Online (Goal: To establish a sustainable system for converting existing course content in *Engineering and Biology: Technological Symbiosis* as well as modules developed in future years to be readily repackaged for effective distance learning, and perform a thorough educational assessment to evaluate how well the educational goals of the course are met among different student populations.

[1] S. Azarin, N. Ferrier, S. M. Kennedy, D. Klingenberg, K. Masters, K. D. McMahon, J. Russell, S. C. Hagness, "Work in Progress: A First-Year Introduction-to-Engineering Course on Society's Engineering Grand Challenges," 38th ASEE/Frontiers in Education Conference, Saratoga Springs, NY, October 2008.

[2] Katie D. Cadwell, Greta M. Zenner, Naomi C. Chesler, Wendy C. Crone, "Teaching Undergraduate Engineering Students Auxiliary Design Skills via Online Video Modules and Active Learning Exercises, *ASEE Annual Conference and Exposition, Conference Proceedings*, 2009, 518, 1-11.