An On-line Course in the History of Engineering and Technology

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Background

It is clear that on-line learning, particularly in the form of "massive online courses" (and, especially "massive online open courses, or MOOCs) is among the most important issues facing higher education in 2013[1]. This technological/pedagogical model has the potential of transforming the way institutions with varying local resources can fulfill their educational mission by tapping into resources made available from elsewhere.

In engineering, ABET is the primary accreditation organization for post-secondary engineering and technology programs in the United States. ABET requires that all engineering curricula include courses that teach students about the relationship between engineering practice and society. As argued in an earlier paper[2], while economics and ethics courses are most often used to fulfill this requirement, history offers the ideal stage on which to illustrate the engineering-society relationships. To briefly summarize the argument, purely technical and economic issues alone do not always shape the innovation process. Politics, religion, and culture are also among the numerous societal issues that can influence the contents, direction, location, and rhythm of technological change. Professional ethics are extremely important, but so is the understanding of the relationship of science and technology to culture, to social organization, and so forth. Economics, in the classical way it is taught today in U.S. universities, it is not the ideal discipline for raising sensitivity to cultural issues. All social scientific approaches to technology in society are valid and important, but the historical approach gives the students the broadest view, and allows them to transcend the narrow perspective caused by focusing on the cultural milieu familiar to them. The distant and recent past offer many illuminating examples that allow engineering students to appreciate the possible roles that societal issues can play during the various phases of the innovation process.

As the paper went on to argue, however, based on a survey of websites of top-ranked U.S. engineering programs, many engineering schools are having difficulty meeting the social-impact requirement in a meaningful way. The authors are affiliated with an engineering association that has the potential capacity to develop an on-line course that would help to fulfill this requirement and that could be delivered nationwide. Indeed, the course could be delivered globally; as discussed in the 2011 paper, many countries' engineering accreditation requirements, often modeled on ABET, contain a social-impact standard. The authors recognize that, as delineated in the *Prism* article cited above, the delivery of content to a large, widely distributed and diverse audience is not without issues. Nevertheless, on-line technology would seem to offer a solution for the institutions that have difficulty in offering such courses to their students.

To explore the viability of such a course, the authors have followed their earlier website analysis with a direct survey of engineering educators. The survey was designed to confirm the need at U.S. institutions of higher education and to determine the perceived desire for one or more courses on the history of engineering and technology, the current level of fulfillment, and, where fulfillment is lacking, the preferred modalities for offering such a course.

Survey Method and Response

For the first phase, a quantitative web survey, also containing open-ended answer opportunities, was established (see Appendix I for questionnaire), and an email invitation to participate was sent out to an in-house list of 246 U.S. and 39 non-U.S. (Anglophone) deans of engineering schools and chairs of electrical and computer engineering departments. The survey was held open for two weeks, from 21 May to 3 June, 2012. Fifty-eight individuals responded, divided into 55 U.S. and 3 non-U.S. Thus the response rate was 22.4% U.S and 7.7% non-U.S., and 20.4% overall. The number of responses yielded a margin of error at the 95% confidence limit of ±11.5 percentage points.

Respondents were given an opportunity to indicate their willingness to participate in a second phase of the survey, an in-depth follow-up telephone interview. Ten (18.2%) of the U.S respondents agreed to participate and were subsequently interviewed. Three engineering deans and seven chairs or vice-chairs of Electrical and Computer Engineering departments from a wide range of public and private institutions were interviewed. Program sizes ranged from 50 to 1,500 undergraduate students, and all programs are currently ABET-accredited.

It should be noted that no attempt was made to define "history of engineering and technology" for the respondents. The introduction to the questionnaire places the survey in the context of the ABET social impact requirement. ABET itself defines its scope as "applied science, computing, engineering, and engineering technology[3]. The authors believe that to be effective any course in this field, even if viewed as a "service" course for the engineering profession, must be taught from the historians' perspective. Such an approach will mean engaging the students in historiography of technology and broader issues such as the definition of chronology itself. The purpose of this survey was not, however, to engage the engineering educators on these issues at this time. Rather, it was merely to gauge the acceptance of the concept of the importance of such a course, and to explore the viability of offering such a course in various configurations.

Results

Concerning formal coursework, 31% of the respondents require students to take a specific course in social impact, and 21% encourage their students to do so. Among those requiring or encouraging this action, they are about evenly split between offering the course within the engineering school and requiring or recommending such a course from a School of Arts & Sciences or equivalent unit. Among those not requiring or encouraging such a course, the two most cited barriers to supplying such a course were low interest within the academic unit, and organizational barriers outside the academic unit.

On the distance learning side, 50% of the responding academic units do not currently offer online courses, 20% offer one to 10 courses, 12% offer 11 to 20 courses, and 7% offer over 20 courses. Of those offering online courses, the overwhelming majority (74%) feel that they are just as successful as in-person courses. Finally, it is interesting to note that of those offering online courses, the platform background is as follows: Blackboard 48%; Sakai 11%; Moodle 7%; eCollege 4%; and other 30% (from the open-ended responses, these are mostly proprietary platforms). These numbers reflect what is known from other surveys, where it has been

observed for some time that Blackboard—the early entrant and dominator of the field—has had its market share reduced to about 50%[4]; thus we feel confident that our sample represents the world of on-line course management.

Having established the current state of societal impact coursework and of distance learning, the survey went on to ask about future preferences. A number of trends were clear in the responses. Of the respondents who offered an opinion, 31.4% would be interested or very interested in procuring an on-line, stand-alone course on the history of engineering and technology, while 62% would be interested in procuring new online material or modules that could be incorporated into existing courses. In either case, the material should be available asynchronously. Of those interested in procuring a stand-alone course, 8% were likely or very likely to purchase it from the appropriate professional association. Of those interested in a modular approach, 35% would be likely or very likely to purchase it from a professional association. On the content side, the respondents expressed an overwhelming (86%) preference that a history of engineering and technology course cover all fields of engineering. Within that, they were evenly split on covering the entire chronology of technology vs. the more recent past. In fact, the open-ended responses suggested that the hesitancy to purchase such a course from an association was the result of a concern that the association could only produce content in its particular technological area.

On the distance-learning side, the preferred modality was for primarily self-study with some local instructor support (64%) followed by completely led by local instructor using the online material (28%). There was virtually no interest in a completely self-study course. The greatest concern based on both the quantitative data and the open-ended responses seemed to be student assessment. Finally, the great majority of respondents (67%) would want such a course hosted on their own platform.

In phase 2, there was an opportunity to probe some of these issues in greater depth. Though the participants were, admittedly, self-selected, it is interesting to note that they were unanimous in their belief that an appreciation and understanding of the historic role of engineering in society would produce better engineers. They reiterated the interest in a course covering all fields of engineering and technology, which they felt would be particularly useful for first-year engineering students. They also reiterated the concern that a course offered by a single association might be biased towards that association's fields of interest.

At the same time, they were sanguine about student interest in history, and suggested that such a course should be required, but there is no longer any space in the curriculum. Having such a course also fulfill the university's general education requirement was proposed as a solution.

On the delivery side, the preferred modality was for the institution to establish a course in its system and contract with the association to provide instruction. However, the institution would establish its own instructors who would be supplied with the evaluation material and other curricular material, and would, in the end, be responsible for carrying out and grading the course.

Ultimately, however, as one respondent put it, "the devil will be in the financial details."

Conclusions and Future Considerations

There is a need for courses that fulfill the ABET social impact requirement and recognition that history of engineering is one way to fill that need. However, engineering programs lack the interest and ability to supply such courses themselves, and institutional barriers make it difficult to obtain those courses elsewhere in the university. Engineering programs would be interested in obtaining such courses and delivering them to their students, provided that:

- The business/financial model was appropriate
- The course could be delivered on their own platform
- The contents of the course encompassed all aspects of engineering and technology
- The course involved some local instruction, particularly in the area of student assessment

The course was modularized so that some or all of the material could be incorporated into other, perhaps hybrid courses. The even split of respondents on the preference of covering recent technology or the entire history of technology combined with the desire for modularity suggests the possibility of developing a sequence of two or three chronologically-based courses.

Therefore, the authors intend to work with their association to develop a business model that will enable such a course to be planned and delivered. A critical component of the business plan will be the development of metrics (besides such obvious ones of number of institutions that sign on and number of students to take the course) to assess the efficacy of the course. In fact, a course delivered to multiple institutions has the potential to provide a test bed for the assumed importance of history in engineering education, since most assessments are done on an internal basis in ways that may not be compatible for general study.

References

[1] See, e.g., The literature is extensive; for a recent discussion see "Bold Experiment," *ASEE Prism*, 22, 2(October 2012):28-33.
[2] [Reference withheld to preserve anonymity of draft]. This idea is not original to the authors; see, e.g., P. H. Oosthuizen and J. T. Paul, "Teaching the History of Engineering: Reasons and Possible Approaches," *Proceedings of the 3Rd International CDI Conference,* MIT, Cambridge, Massachusetts, June 11-14, 2007; J. K. Brown, G. L. Downey and M. P. Diogo, "The Normative of Engineers: Engineering Education and History of Technology," *Technology and Culture*, 50, 4(October 2009):737-752; for a non-U.S. example, see R. Lewis and J. Stewart-Lewis, "The Teaching of a History of Technology Course in an Engineering Program: Comments and Observations on Relevance to Graduate Attributes and Learning Outcomes," Proceedings of the 2008 Conference of the Australasian Association for Engineering Education, Yeppoon, Queensland, 7-10 Dec 2008.
[3] www.abet.org, retrieved 11 March 2013.
[4] "2010 Campus Computing Survey," www.campuscomputing.net, retrieved 13 March 2013

Appendix I. The survey instrument.

Ten years ago, ABET (Accreditation Board for Engineering and Technology), the primary accreditation organization for post-secondary engineering and technology academic units in the United States, revised its requirements for undergraduate programs leading to a bachelor's of science degree in engineering. The new standards, known as EC2000, require that students receiving the B.S. degree "understand the impact of engineering solutions in a global, economic, environmental, and societal context. "

The following questionnaire is divided into five short sections:

A. **Your college or university's response to the ABET standards**
B. **Your academic unit's experience with online courses**
C. **Your academic unit's interest in offering additional online courses to meet the ABET requirements**
D. **Your academic unit's preferences related to the logistics of an online course.**
E. **This last section solicits further input from you and your unit.**

A. Please answer the following questions related to your college or university's response to the ABET standards.

1. **Which of the following are you currently doing at your college or university?**

Requiring engineering students take a course that exposes them to the social impact, specifically the social history, of technology
Encouraging students to take a course that exposes them to the social impact, specifically the social history, of technology
Developing a course that will expose students to the social impact, specifically the social history, of technology
Other(please specify)
None of the above

2. **If you are requiring, encouraging, or developing a course on the social history of technology, who supplies the course?**

Your engineering school or an engineering academic unit within your school
A specialized non-engineering academic unit in your engineering school
An academic unit in the School of Arts & Sciences or equivalent academic unit at your institution
Other(please specify)
None of the above

3. **Meeting the ABET requirements for having students understand the global, economic, environmental, and societal contexts has been challenging for some colleges and universities. What challenges, if any, has your college or university faced?**

Low enrollment in courses
Difficulty creating and implementing courses due to organizational barriers
Low interest in such courses within your academic unit or faculty
Low interest in such courses within other stakeholders in your college or university
Other (please specify)
None of the above

B. The next section asks you about your academic unit's experience with online courses.

4. **How many online courses does your academic unit currently offer?**

[Validate only whole numbers 0 or greater]

5. **How much more successful or less successful are the online courses in your academic unit in comparison to other courses in your academic unit?**

Much less successful 1	2	About the same 3	4	Much more successful 5
❍	❍	❍	❍	❍

6. **Has the number of online courses being offered in your academic unit increased, decreased, or stayed about the same over the last two years?**

Increased
Stayed about the same
Decreased

7. **Has the number of students enrolling in online courses in your academic unit increased, decreased, or stayed about the same over the last two years?**

Increased
Stayed about the same
Decreased

C. This next section asks you about your academic unit's interest in offering additional online courses to meet the ABET requirements.

8. **How interested or uninterested is your academic unit in procuring content on the history of technology that would meet the ABET requirements for understanding the social impact of technology?**

	Not at all interested 1	2	3	4	Very interested 5	Do not know 6
Stand-alone course	❍	❍	❍	❍	❍	❍

A new component or module that could be integrated into a currently existing course	❍	❍	❍	❍	❍	❍

9. How interested or uninterested is your academic unit in procuring an online credit course <u>from IEEE</u> on the history of technology that would meet the ABET requirements for understanding the social context of technology?

	Not at all interested 1	2	3	4	Very interested 5	Do not know 6
Stand-alone course	❍	❍	❍	❍	❍	❍
A new component or module that could be implemented into a currently existing course	❍	❍	❍	❍	❍	❍

[If 1 or 2 is selected in both rows in the Q9 <u>AND</u> 4 or 5 is selected either rows in the Q8]

10. You indicated that your academic unit <u>is interested</u> in procuring online content on the history of technology, <u>but</u> your academic unit is <u>not interested</u> in procuring that content from an <u>online credit course from IEEE.</u> Please explain why not.

[If 3-5 is selected in the either row of the grid question above]

11. You indicated that your academic unit is interested in procuring such a course from IEEE. <u>Assuming the cost is reasonable</u>, how likely or not likely is your academic unit to purchase this online credit course if it is <u>offered by IEEE</u>?

	Not at all likely 1	2	3	4	Very likely 5	Do not know 6
Stand-alone course	❍	❍	❍	❍	❍	❍
Module to augment a currently existing course	❍	❍	❍	❍	❍	❍

[If 1 or 2 is selected above in both rows of the grid question above]

12. You indicated that your academic unit is not likely to purchase this online course. Please explain why not?

13. Could a credit course on the social context of technology meet the college or university's core requirements, general education requirements, or equivalent?

Yes
No
I do not know

14. Would it be beneficial to your college or university to have a course like this as a general education requirement?

Not at beneficial 1	2	3	4	Very beneficial 5
❍	❍	❍	❍	❍

15. Upon what aspect of the history of technology should such a course focus??

Overview of the entire history of technology
History of 20th and 21st century technology
History of a specific technological field (please specify)

[If 3, 4, or 5 is selected in at least one item in Q9]

D. This next section asks your academic unit's preferences related to the logistics of an online course.

16. What delivery model for this online course would most interest your academic unit?

Completely self-study with no instructor support
Primarily self-study with some instructor support
Completely Instructor lead with full support
Other (please specify)
None of the above

17. What would an online course in the history of technology need to possess in order to be considered a credit course? (Please select all that apply.)

Personal contact with an instructor
Weekly (or more frequent) reading assignments
Weekly (or more frequent) writing assignments
Regularly scheduled quizzes or tests
A substantive essay paper ("term paper")
Other (please specify)
None of the above

18. Would you prefer the online course be hosted on the college or university's platform, or that of the outside vendor?

College or university's platform
An outside vendor's platform
Other (please specify)
I have no preference

[If they say "College or university's platform"]

19. What Learning Management System, if any, do you use?

Sakai
Blackboard
Moodle
ecollege
Other (please specify)
None

E. This last section solicits further input from you and your unit.

20. If you are willing to be contacted by a member of the research team in order to discuss the content of this survey in more depth, please provide your name and email address below. Note, the answers to your questions above will still remain confidential and will not be connected with you your name and email.

Name
Email

21. If you have any other comments or suggestions regarding this survey, please indicate them here.