Evaluation Results of an E and ET Education Forum

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Abstract

Under a two-year Department of Education FIPSE grant, the College of Technology at the University of Houston hosted a two-day forum in spring 2010 to explore a variety of issues related to engineering (E) and engineering technology (ET) education. A central focus of these discussions revolved around whether E and ET exist as separate fields or whether there was value in thinking about them as part of a continuum. The CDIO (conceive-design-implement-operate) model was used as a framework for thinking about these two knowledge areas as facets of an overarching engineering profession, where the majority of E and ET graduates flow to the middle of CDIO and engage in "design-implement" tasks within three to five years after graduation. Several implications of a continuum-based framework for engineering education were debated within the context of two alternative curricular approaches. The first approach envisions a two-year curriculum in which E and ET students enroll in a set of common technical core courses. At the end of the second year, students would make a well-educated decision to become either engineering or engineering technology majors, subsequently completing a BS degree. The second approach mimics the educational models in medicine, nursing, or law. A professional engineering degree would require a prerequisite four-year baccalaureate degree. This approach renders a BS in an ET area (e.g., mechanical engineering technology) a natural choice.

This article reports on the results of the forum. A total of 45 forum participants representing E and ET programs from 35 institutions and 23 states expressed a wide range of views. Some did not agree with the premise of the continuum model or that any changes to engineering education were needed. A significant number viewed one or both alternative curricular approaches as intriguing possibilities. However, even among those who regarded the alternatives favorably, many acknowledged that while they personally would support attempts to implement alternatives at their campuses, contextual and institutional factors posed significant obstacles to change. Participants were also given an opportunity to interact with local industry representatives to gain insight into what employers think about some of these topics. Evaluation results from observations and follow-up surveys suggest that, at least in the immediate future, any potential changes are likely to take the form of positive but small incremental changes in general awareness and attitudes regarding the correct placement of engineering technology within the engineering profession, the correct placement of engineering technology graduates in industry, and the opportunities for creating collaborative efforts between the two disciplines resulting in potential institutional savings and an increase in the pipeline of individuals entering the engineering profession. The project continues in its second year, focusing on the design of a true 2+2 transfer program from junior colleges to E and ET.

1. Introduction

In fall 2008, a position paper was presented at the IAJC-NAIT-IJME International Conference with the intention of sparking discussion about how engineering and engineering technology students are taught in the US (Barbieri and Fitzgibbon 2008). Fundamentally, the authors argued that historical trends, industrial forces, and legislative action had led to four developments: (1) a reduction in engineering-specific courses, (2) engineering courses that are highly theoretical and emphasize scientific analysis and mathematical modeling, (3) a subsequent reduction in hands-on, laboratory oriented, experiential learning, and (4) courses delving into engineering design (synthesis as opposed to analysis),

and engineering operations have been deemphasized and relegated to perhaps one or two courses in the curriculum. At the same time, the field of engineering technology has expanded to the baccalaureate level with an emphasis on laboratory experience, practice-oriented lectures, and experiential learning. The authors further asserted that each of these developments has occurred within the context of increasing constraints on available credit hours for engineering-specific courses due to expanding core requirements in mathematics, natural and social sciences, humanities and writing. The authors estimated that these constraints limit engineering education to roughly two to two and a half years in a typical baccalaureate degree plan.

Subsequent articles expanded on these observations, and two curricular models were proposed that would utilize current resources available in engineering and engineering technology programs to address some of the issues they describe while also fulfilling Department of Education requirements for a first professional degree (Barbieri, Pascali, Ramos, and Fitzgibbon 2009; Barbieri, Shireen, Attarzadeh, Ramos, and Fitzgibbon 2009; Barbieri, Shireen, Attarzadeh, Pascali, Ramos, and Fitzgibbon 2009; Barbieri, Attarzadeh, Pascali, Shireen, and Fitzgibbon 2010). The first option revolves around a two-year common curriculum for all engineering and engineering technology students, while the second is based on the idea of a professional degree in engineering analogous to law or medicine.

In spring 2010, the University of Houston hosted a forum for engineering and engineering technology faculty and administrators to discuss the merits and feasibility of these models. Industry representatives were also invited to provide their perspective on engineering and engineering technology education and the relation to workforce needs. The purpose of this article is to describe the evaluation of the forum activities, including participants' attitudes and perceptions about the proposed curricular models as well as any long-term impacts and next steps.

2. Engineering and Engineering Technology Forum

A forum funded by a Department of Education FIPSE (Fund for the Improvement of Postsecondary Education) grant was convened at the University of Houston's main campus from April 29 through May 1, 2010, to discuss engineering and engineering technology (E and ET) education. Initially, an "Invitation to Participate" email was sent to deans, chairs/heads, and professors involved with engineering and/or engineering technology education with a goal of attracting 50 participants. The invitation also encouraged nominations of other colleagues who would be interested in engaging in E and ET education conversations. Gradually, a pool of 45 participants was assembled, representing 35 institutions from 23 states. Roughly 37% of participants identified themselves as professors while 35% indicated an administrative focus. A handful suggested they currently held multiple positions (e.g., professor and chair).

Prior to the forum, the participants were provided with position papers describing the rationale for the curriculum models as well as supporting materials. These materials were made available to participants primarily via a website developed specifically for the forum.

During the event, participants engaged in small group discussions around particular issues that were then shared with the larger audience. In addition, industry representatives and specific faculty held periodic panel sessions where they would focus on a particular issue and then open the floor for questions and feedback.

Central to forum discussions were two curriculum models proposed as alternatives to "traditional" engineering and engineering technology education degree plans. These are described below as option 1 and option 2. These descriptions reflect how the options were presented to the forum participants.

2.1 Option 1: Two-Year Pre-Degree Requirement

When properly designed and executed, the first two years of accredited, four-year BS degrees in ET disciplines can serve as the pre-degree requirement for engineering-bound students. If executed, it is envisioned that a new first professional engineering degree can be defined, whereby:

1. All engineering-profession-bound students would first complete two years of E and ET requirements in an appropriate discipline.
2. With proper advising and mentoring, those students interested and skilled to follow the more abstract (conceive-design) side of engineering would transfer to a college or school of engineering and complete an E degree in two to four additional years. Four years would satisfy then the Department of Education definition of a first professional degree.
3. On the other hand, those students interested and skilled to follow the more applied (implement-operate) side of engineering would opt to complete a BS-ET degree in two additional years.

Several benefits can be listed:

1. Total enrollment in E and in ET would increase as a result of proper advising and mentoring in the early stages of the student's university experience, affecting retention.
2. Retention rates at the upper-division level of both E and ET would also increase.
3. Duplication of efforts and resource expenses

for equipping and maintaining laboratories needed in the first two years would dramatically decrease.

2.2 Option 2: Pre-Engineering Degree Requirement

It is also conceivable that engineering colleges would consider becoming, in the future, professional schools much like medical and law schools, requiring a four-year baccalaureate pre-degree for admission. As in the pre-med option, the pre-engineering degree could be in any field but would include certain requirements of mathematics, sciences, engineering, and technology. A BS degree in an ET field would surely be a most fitting pre-engineering degree. An apparent benefit of either option is that colleges and schools of engineering would be able to devote more of their resources to graduate engineering programs, leaving freshman- and sophomore-level engineering classes to ET programs.

3. Forum Evaluation Results

3.1 Evaluation Focus

To understand the impact of the forum, the organizers retained the services of external evaluators to examine effectiveness. The evaluation plan focused on examining data collected from participants (via surveys, electronic communication, and observations during the forum) against three motivating factors articulated by the organizers:

1. A renewed focus on the engineering profession, specifically on the tasks an individual performs three to five years after going through the educational system to earn a degree that the employment system finds valuable.
2. A premise that a university's offerings of engineering and engineering technology degrees can be designed and implemented to substantially increase the number of qualified individuals entering the engineering profession while improving institutional resource utilization.
3. A pressing need for laying out a road map for the next decade that could potentially transform the way an individual prepares for and enters the engineering profession to lead a fulfilling and rewarding career.

In terms of evaluating the impact of the forum, the motivating factors raise several relevant questions:

- Did proposed curriculum models present a viable option for addressing any of the concerns raised by the forum participants?
- If the models were viable, was there any indication that participants would be willing to pilot test the ideas?
- Was there any indication of the long-term impact of the forum, as described by forum participants?

These factors and questions provide the framework for the evaluation activities and interpretation of results.

3.2 Post-forum survey

The external evaluators for the project administered a post-forum survey to gauge participant perceptions and attitudes regarding the ideas and issues discussed during the forum. Specifically, the survey presented several Likert-style items in which participants were asked to provide perspectives on the utility and feasibility of the proposed curricular models. Figure 1 highlights attitudes toward the two-year common curriculum model.

When participants were asked whether they would support this model being implemented at their institution, 71% indicated they would. However, when asked whether they thought implementation of this model would be feasible at their institution, 59% responded "No."

A second set of items centered on the pre-engineering professional model (Figure 2).

Seventy-six percent of participants indicated they would support this model being implemented at their institution. However, when asked whether they thought implementation of this model would be feasible at their institution, 69% responded "No."

The survey also provided an opportunity for open-ended responses. Each open-ended item is presented along with a brief analysis of responses:

"Has your position regarding the value and feasibility of the proposed 2-year common curriculum model for E and ET changed as a result of your participation in this forum? Explain." (35 respondents)

- 15/35 respondents that did not previously support the model shifted to "support" after the forum.
- 1/35 supported the model before the forum but changed to "not support".

"What actions, if any, are you likely to take relative to the issues and ideas discussed in the forum?" (34 respondents including four ambiguous responses ["none," "not decided," "not sure yet," and "hope"]). Of the remaining 30 responses,

- 18 described doing something locally, within their institution.
- 9 described actions that could be taken across universities.

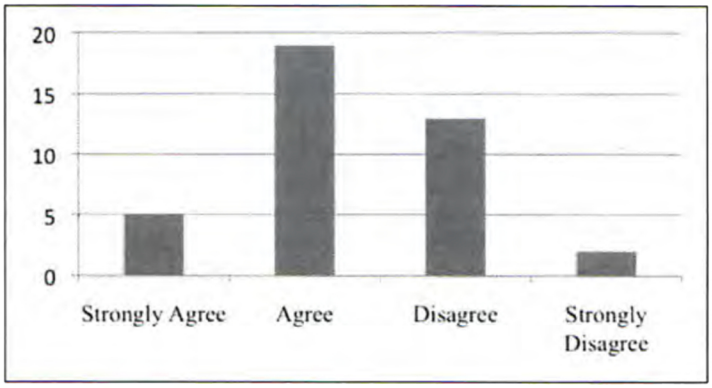

Figure 1. Results of responses to this statement: All engineering profession-bound students (whether E or ET) should first complete two years of a common curriculum in their chosen engineering discipline.

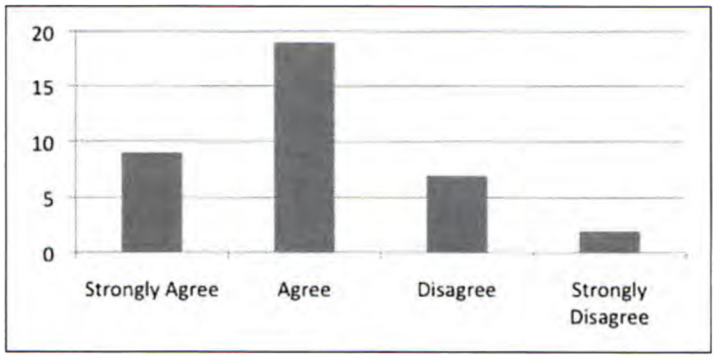

Figure 2. Results of responses to this statement: The engineering field would benefit from having a system similar to other professional fields (i.e., law, nursing).

"What are the most useful things, if any, that you learned by participating in this forum?" (31 respondents)

- Nearly one-third referred to the way industry regards graduates from E and ET programs. These individuals were, for the most part, surprised to see that, from the industry perspective, there is little difference between the abilities of graduates from the two disciplines. Approximately half of the comments expressing this sentiment were made by individuals working in E departments, possibly pointing to those forum participants' lack of knowledge about ET.
- The next most common theme in these responses centered on individuals gaining understanding about the relationship between the E and ET disciplines.

Two general themes were apparent from the post-forum survey results in terms of the curriculum models. First, although there was no consensus on specific ideas, the majority of participants did agree generally with the intent of the curriculum models. This is suggested by the number of participants that either agreed or strongly agreed to each of statements presented in Figures 1 and 2. In addition, most participants indicated they would support attempts at implementation of either model. The second theme is characterized by the participants' recognition that their own institutions have significant obstacles to implementation of either model. In other words, while the models may be appealing in theory, there are significant practical barriers to any attempts at this type of change.

According to the third set of free responses, some participants suggested they had gained some insight into the relationship between engineering and engineering technology, especially in terms of how industry perceives the two fields. This was an unintended outcome that was nevertheless a welcome result. Indeed, at least one participant would later indicate via email the potential impact of the forum discussions on editorial work related to an ASME publication focused on career paths.

3.3 Fall Follow-Up Forum Survey

In October 2010, the forum evaluators administered a follow-up survey to participants to gauge any long-term impact. The survey presented a series of items intended to determine whether participants had taken further action regarding the ideas discussed at the forum, including the following:

- Have you taken or do you plan on taking any further actions regarding the two-year common curriculum model discussed during the forum?
  Please elaborate on your response to the previous question.
- Have you taken or do you plan on taking any further actions regarding the suggested professional model where one must first earn a baccalaureate degree (pre-med, pre-law) followed by three or four additional years in the field, which was discussed during the forum?
  Please elaborate on your response to the previous question.
- Have you taken any actions relative to the issues and ideas discussed in the forum (e.g. discussions with colleagues)?
  Please elaborate on your response to the previous question.
- Has your position regarding the value and feasibility of either of these proposed models changed since your participation in this forum?
  Please explain your answer to the previous question.
- What are the biggest obstacles to change that you see at your institution?

A maximum of 15 people responded to any given item in the survey. As such, the response rate–based on forum participation of 43 people–was approximately 35%. The response rate should be noted when interpreting results, since respondents may be qualitatively different than non-responders.

In terms of the two-year common curriculum, only 3 out of 15 respondents indicated that they had taken or planned to take any action. Based on responses to a follow-up question, these actions largely centered on general discussions with colleagues about issues related to the model. Responses to an item regarding actions taken relative to the "pre-professional" model presented at the forum (e.g., pre-law) yielded similar results. In this case, 3 out of 13 people indicated they had taken or planned to take any action. As before, these actions were in the form of discussions with colleagues.

Respondents who did not intend to take any action articulated several reasons for their decision. These reasons represent at least four thematic strands:

1. There is no national consensus on the need for curricular change of this kind, particularly in engineering disciplines.
2. Engineering and engineering technology have divergent learning goals and skill expectations even during first two years, making the development of a common curriculum problematic at best.
3. The current organizational structure of universities makes any attempt at integration of program resources very difficult, especially when the program may be in different or schools.
4. There is tremendous resistance to change in the institution.

Although many respondents did not intend to engage in activities directly related to the proposed models, most did indicate they have taken action relative to different issues and ideas raised during the forum. Several of these actions have been informal discussions with colleagues; however, some have explored specific issues such as the career path options of engineering versus engineering technology students and the concept of engineering technology as part of the engineering profession. As pointed out by the evaluators, although these actions do not directly address the proposed models, they do help facilitate discussion about the nature of engineering and engineering technology education and how these fit into the broader engineering profession.

4. Discussion

The evaluation of the forum's impact revealed mixed results. The primary intent of the forum, as described by the organizers, was to examine the issues raised by the proposed models and assess whether the models highlighted a legitimate need. Survey responses collected immediately after the forum suggested the majority of participants supported at least the premise behind the proposed curricular models. However, several participants correctly pointed out that there was no consensus. In any case, a majority of respondents also indicated that actual implementation of these or similar models in their respective institutions would be unlikely, although several hinted they would discuss the ideas with colleagues.

Follow-up evaluation results in fall 2010 confirmed the findings from the spring. With a few exceptions, most respondents expressed their intent to forgo any future action with regard to the proposed curriculum models. For some, the reasons reflected a belief that there was not a convincing case for the type of change embodied by these models. For example, regarding the two-year co-curriculum model, one person cautioned that the model did "not align with our strategic plan or vision or needs or requests from employers." Others feared the implications of engineering technology being aligned too closely with engineering: "I discussed the concept with our faculty. While we believe there are positive aspects to this approach, we believe that our institution would ultimately follow the same path as [another university] and eliminate our programs in a tough budget year should we align too closely with engineering science."

A variety of reasons were also presented for not supporting the pre-professional model. For some, the current curriculum model satisfies current industry needs:

> "It is not clear to me that the majority of engineering job functions require the three or four years of additional education, such as an advanced degree. Although imposing such a requirement could in the short run increase the wages of the smaller number of US engineers who would meet that credential, if all engineers were somehow required to have the higher degree, in the long run this could result in a greater degree of exporting the engineering work to foreign countries that do not have that requirement."

At least one person pointed out that adoption of a pre-engineering model could negatively impact recruitment efforts: "That [model] would put us in a competitive disadvantage to recruit students, if we only granted a four-year pre-engineering degree, versus granting the current four-year BS engineering degree."

Over two days during the forum, participants also engaged in free-ranging round table discussions that covered a variety of topics, including resource utilization, minority education, support courses, and soft skills (e.g., communication).

When asked whether they had taken any actions regarding any of the issues and ideas discussed in the forum, a majority of respondents (11/14) answered yes. One person stated that "[t]he forum increased my desire to enhance my scholarship of engineering teaching and assessment, to improve the engineering courses that I teach (and perhaps influence other colleagues to do the same)," while another suggested "the primary overall benefit was the encouragement to look to how to be more effective in our combined work."

Although the forum evaluation found minimal impact in terms of concrete activity that supported the proposed models, the long-term value may be the opportunity it presented for faculty in engineering, engineering technology, and industry representatives to exchange ideas and reflect on education issues in their field.

5. Conclusion

In light of the evaluation findings, the forum organizers have concluded that widespread adoption and support of either of the proposed curriculum models is unlikely at this time. As a result, the project has shifted its focus to enhancing the educational pipeline from community colleges to a four-year university. Today, two-year programs in engineering technology are almost exclusively the province of community colleges. These programs typically focus on local industry needs, have a local funding base, and are frequently updated as a result of industry needs. They also have the dual mandate of preparing technicians for immediate entry to the workforce as well as preparing individuals for forward articulation into baccalaureate programs in technology and engineering. However, the current model for articulation in our region places students at a disadvantage when trying to make the leap from a two-year to a four-year institution.

It is the intent of the project organizers to hold a regional forum gathering leaders from area community colleges to explore ways of creating a concrete path to a BS in Engineering Technology. One potential idea is to develop a formal associate's degree in ET, which would be designed to seamlessly dovetail with the requirements of the BS using a 2 + 2 approach. Interestingly, one forum participant mentioned this type of scenario in the follow-up survey as a reason his institution could not support the two-year common curriculum model for engineering and engineering technology; the starting point for the two degrees was just too different. In this case, an issue raised by the discussion of the models foreshadowed the change in focus for the project. Further evaluation will determine the long-term impact of this change.

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