AC 2008-583: DEVELOPMENT OF A NEW MECHANICAL ENGINEERING PROGRAM IN A TIME OF CHANGE

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Development of a New Mechanical Engineering Program in a Time of Change

Introduction - The University of Southern Maine (USM) is implementing a new mechanical engineering program. Previously, the only other engineering program at the university was a baccalaureate in electrical engineering. Typically, engineering programs are housed within a department dedicated to that specific discipline. For example, the new mechanical engineering program at the University of Michigan was developed in the department of Mechanical Engineering[1]. However, both scale and economics precluded this type of departmental structure.To implement the new program, then, an organizational model was adopted in which one engineering department housed both programs. This model utilizes existing faculty, along with adjuncts, to deliver the new program during the start-up phase, maximizes facilities sharing and fosters interdisciplinary work. It provides flexibility and is cost-effective. The model allows for the introduction of other future engineering programs and is being developed during a time of change both at USM and in the state of Maine. It is an effective model for small universities to develop multiple programs from a limited offerings base.

Background - The University of Southern Maine is a comprehensive university with major campuses in Portland and Gorham, Maine. It is located in the population and industrial center of the state. For many years the university offered an engineering transfer program which consisted primarily of basic science, mathematics, some humanities and a few lower division engineering courses such as statics and digital logic. Students then could complete the first two or three semesters of engineering living at home before transferring to the land-grant University of Maine (UMaine) in Orono, Maine, some ninety miles north of Portland, in a rural area where papermaking was the predominant industry.

Traditionally, manufacturing in Maine was concentrated largely in natural resource-based industries such as paper or in textile mills which were widely dispersed geographically around the state, the textile mills in the more populous southern part of the state and the paper mills in the north. In the 1960's, however, these industries began a slow, precipitous decline which accelerated in the 1970's and 1980's. At the same time, new industries, which required higher skill sets, began locating in the greater Portland area. These included such companies as National Semiconductor, Fairchild Semiconductor, Pratt and Whitney, Idexx Laboratories and other. These industries were interested in having a local institution which would not only provide educational opportunities for their employees but also would be a source of new engineers. Moreover, these individuals, because they were from the region, would be more likely to be inclined to stay and work in the area upon graduation. Employee recruiting and retention had long been a problem for companies in northern New England.

Initial Engineering Education in Southern Maine - In 1988, because of heavy support from the local industrial community, USM received permission from the Board of Trustees to begin a baccalaureate program in electrical engineering. At that time a generic engineering department was formed to develop the program. The course offerings

covered the requisite topics necessary for an electrical engineering major. The curriculum was somewhat skewed in favor of integrated circuit-related courses because of the growing importance of this industry in the region. The offerings included several mechanical engineering courses which were given both as service courses and as part of the electrical engineering curriculum. Faculty were added, one per year, for a total of six full-time tenure-track. In addition, specialists in local industries were used as adjunct faculty. The program began in 1989 and received ABET accreditation in 1994.

For the most part the department offered a basic curriculum tailored to the needs of the local industrial community which, in turn, provided much-needed monetary assistance, equipment and political support. The latter was particularly important in a state with little tradition in the strategic placement of university resources to leverage the growth of modern industries. The new department was regarded by some traditionalists as being duplicative because there already existed a strong engineering school in the state, albeit physically located in a sparsely populated area with little proximate industry. The new program was defensible only because, by being located in a populous area with the great majority of the technology industry in the state nearby, it could serve the large population of place-bound students who could only afford a college education if they could live at home. It also gave employees of the manufacturing firms, typically technicians, access to engineering education which give them the vertical mobility which they needed to advance in their employment. Providing engineering education for these two populations became the *raison d'etre* both for the electrical engineering major and for the forthcoming mechanical engineering program.

Onset of the Mechanical Engineering Program – The mechanical engineering program, like its predecessor electrical engineering, was initiated by demand from local industry. A survey taken in 2001[2] showed strong industrial support for such a program. At the same time, a state bond issue provided monies for the expansion of the technology center, the building in which the existing engineering program was housed. The department then began the formal process of planning a mechanical engineering program.

The Challenge – The opportunity to start a new program came at a time in which USM was (and still is) experiencing financial challenges. One immediate effect of these challenges was that faculty lines were frozen. New hiring would not be permitted until program enrollment generated enough tuition revenue to justify a new line. At the same time, it was anticipated that, in the future, the university will be called upon to develop new engineering programs in support of local industry. So a model was developed which, in the short term, used existing faculty plus distance education to provide much of the lower-division foundational courses and adjunct faculty to provide selected upper-level courses. This model was designed to be a cost-effective means of growing a program until enrollment justified adding full-time, tenure-track faculty.

Design of the New Program – The program was planned in an environment of tremendous support from local industry, budgetary problems in the university and a general university culture which did not understand the norms of professional schools in general and engineering in particular. An additional constraint, which turned out to be an

advantage, was that the university was in the process of implementing a new general education curriculum, distributed throughout the whole four years. This new general education curriculum, since it constituted one third of the total engineering curriculum, was used as a framework to build the engineering curriculum around. This also required realignment of the existing electrical engineering program.

Some of the key principles in the design and offering of the new program were:

- Commonality as much as possible for courses and laboratories between mechanical and electrical engineering. An example of this is the concentration in robotics, an area in which students in both majors jointly take coursework. Other examples are controls and materials science.
- Sharing of equipment with an existing industrial technology program. This provided immediate access to CAD laboratories with appropriate software, PLC-based mechanical systems and an automated manufacturing cell.
- One department of engineering housing both programs with flexible faculty, some teaching both mechanical and electrical engineering courses, as appropriate.
- The existing faculty teach the foundational courses. In the implementation stage a number of the upper-level and elective courses are taught by adjuncts. This allows the program to develop and to be "tweaked" before commitments are made to full-time, tenure-track faculty.
- The new program focuses on just two areas, materials and electromechanical systems. These two areas aligned well both with the existing skill sets in the department and with the needs of local industry.
- The senior design project, the capstone project (which actually begins in the junior year) will involve M.E. and E.E. majors working together. This concept is pedagogically sound in that the principles of design are not discipline-specific. Moreover, this better mirrors the normal practice in the profession where engineers from different disciplines work on design teams and learn to use each others expertise. It has the additional effort that it encourages faculty from both disciplines to work together.

Local industry contributed substantial monies to construct and equip a mechanical engineering laboratory. Permission to offer the new curriculum was given by the Board of Trustees in January 2006. Because of the aforementioned concerns about duplication and also budgetary concerns, a memorandum of understanding was signed between USM and the land-grant University of Maine (UMaine) by which UMaine would deliver four basic mechanical engineering courses in real time, using distance education technology, to USM mechanical engineering majors. One of the faculty members from UMaine who teaches these courses is also a member of the USM engineering department's advisory board. He attends advisory board meetings, virtually, using distance education technology.

Because permission for the program was not given until early 2006, it would seem that, assuming that the first class would be admitted in the Fall of 2006, currently the upper-most students would be in their second year. In reality, because rumors that USM was

about to start a mechanical engineering program had circulated for several years, a small group of students anticipated the new program and actually enrolled as undeclared majors in Fall 2005. We call them the "pioneers". These students took basic science and general education courses and the department, in turn, offered a course in statics to them, the only engineering course, other than the introductory one, required in the first year. So we have a small (6-7) group of students going through the third year. Providing adequate courses for this group has been problematic; the department has had to rely heavily on adjuncts. However, having these "pioneers" will allow us to implement joint senior projects earlier than we had anticipated with a smaller, more manageable group.

Learnings from the Process – Combining classes in a number of areas has forced us to look at both curricula to see when foundational skills are best and most appropriately introduced. A case in point is Laplace transforms, necessary for understanding control systems. Electrical engineering majors typically get these in their second year circuits sequence, mechanical engineers later. Because we are trying to align both curricula next year we will offer the first circuits course, which goes through sinusoidal steady-state analysis, to both mechanical and electrical engineering majors, and then replace the second circuits course with a more generic dynamical systems course which students in both majors will take. Doing so will allow students to take, for example, controls in either their third or fourth year. This, in turn, gives the department some flexibility in scheduling this, and other joint courses, perhaps only offering them every other year.

Offering some courses only every other year, of course, requires flexibility on the part of the faculty in that they must be prepared to teach a greater range of courses than in a university where all courses are offered every year, or in some cases, every semester. We have been fortunate that the existing faculty has responded to this model but it puts constraints on future hires. Conversely, it offers future faculty an opportunity to teach in a broader, less confining environment.

Cooperation with other institutions is key to this model. The four courses provided by UMaine via distance education technology were central to providing the curriculum at USM. The effort aids UMaine also since they collect the tuition revenues for those courses. The only cost to them is an on-site proctor. So the model utilizes existing university system resources, rather than relying solely on new instructional capacity.

The Future – Since this program began two years ago, enrollment in engineering at USM has increased 40% and is projected to increase another 30% next year. This will justify 1 ½ new faculty lines. Projections are that in two years the faculty should be at a size which would permit ABET accreditation. Also, the model is being considered to develop two more engineering programs, one in environmental engineering and the other in biomedical engineering. Such programs will require collaboration with other institutions.

Summary – The University of Southern Maine is in the process of offering a mechanical engineering degree. Budgetary and size constraints require close collaboration and alignment with the existing electrical engineering program, sharing of courses and facilities and joint project development. Some courses in the program are being delivered

by the land-grant university via distance education technology. Both the curriculum and the delivery sequence are in a state of flux. We believe what we are developing is a model for the offering of expensive, high-value programs like engineering by institutions of limited means.

REFERENCES

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