

Overcoming Impediments to the Development of Undergraduate and Graduate BME Programs at the University of Tennessee

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The University of Tennessee, Knoxville had offered undergraduate and graduate option programs in biomedical engineering in an Engineering Science (ES) Department since the early 1970's. Based on growing student interest and changing priorities in the College of Engineering, the undergraduate ES degree program was dropped and in fall 2000 a new undergraduate BME degree program was initiated. The development and expansion of this new undergraduate program and the establishment of a new BME graduate program has been impeded by a number of factors. To varying degrees, the past and current impediments faced have included:

- A limited awareness and support for BME program development at the higher levels of university administration
- Competitive pressures in the College of Engineering and the parent department (of Mechanical, Aerospace and Biomedical Engineering) resulting in a small BME faculty size and a restricted budget for BME
- Limited program visibility and muted student enthusiasm for the programs offered
- A small BME graduate program

The need to rapidly achieve ABET accreditation of the new undergraduate program further stressed limited resources.

In order to overcome the many challenges faced, a highly organized, multifaceted approach was needed. Initially, the Dean of Engineering, who had earlier decided to advance the College's BME program, met with the BME faculty to publicly voice his support. An interim BME Program Director was named. The Director was charged with drafting a formal business plan that could be presented to the university's upper-level administration. The plan identifies the potential favorable impacts of an expanded BME program and justifies the allocation of new financial resources. The business plan document includes sections on vision and objectives, market analysis, competitive analysis, strategy, actions planned to assure program success, timeline of planned actions, summary of program needs, financial plan and a brief overall summary. Key components of the plan include the establishment of an industrial advisory board and the development of a graduate BME program. Directly or indirectly, the plan addresses all of the impediments to BME program development cited above. A summary of the specific actions already undertaken or identified to overcome the impediments to program growth is presented below.

Gaining the Support of the University's Higher Administration

To gain the attention of the university's higher administration, the "chain-of-command" should be followed. For this reason, it is imperative that there first be strong support for BME at the level of the Dean of Engineering. The dean will then be in an effective position to sell the merits of BME to higher-level administrators. In many cases, it may be beneficial for the BME faculty to make a presentation directly to the administrative staff with the Dean's participation. In either case, the presentation should highlight a formal business plan showing positive economic impact of investments in the BME program. It should be clarified that BME programs are widespread and that students will seek out other universities if a quality program is not available on-campus. It is of particular importance to present the potential enrollment growth and the enhancement of institutional prestige associated with anticipated increased research funding. Another approach that may enhance the interest of upper-level administrators is a business plan element identifying the efficiency of having BME serve as a focal point for selected campus-wide programs in biomedical-science and technology. Examples may include the formation of interest groups for the pursuit of research on biomedical imaging, cellular and tissue engineering or computational biomechanics as has been initiated at the University of Tennessee.

Overcoming Competitive Pressures

The BME Program at the University of Tennessee, Knoxville is currently administered from the Department of Mechanical, Aerospace and Biomedical Engineering (MABE). This administrative arrangement is the result of an earlier merger of a Department of Mechanical and Aerospace Engineering with an Engineering Science Department (which included the BME option programs). The proposal to substantially advance BME has presented new aspects of competition with the other programs of the MABE Department. Foremost among these is the competition to fill open faculty positions in the interest areas of current faculty. For a growing BME program, current and projected enrollments may justify adding BME faculty even when an available position is vacated in another area (e.g. mechanical engineering). Based on the effectiveness of business plan arguments, there may be justification for some positions to be shifted from other departments in the College of Engineering. Another strategy for appeasing faculty desiring to build strength in other departmental program areas is to propose to recruit faculty with multi-disciplinary backgrounds pertinent to BME and another competing area. To maintain momentum in building faculty size it is imperative that each new hire results in notable success in building a funded research program. Only in this way can a strong case be made for the sequential recruitment of a substantial number of faculty as a BME program grows.

Other aspects of competition deserve attention as well. Since it is unlikely that all needs (e.g. laboratory space or equipment) can be met in a short time frame it is imperative to constantly prioritize BME program needs to assure that the most pressing need is filled first when new resources become available. In the University of Tennessee College of Engineering it is not uncommon for instructional equipment purchase funds to become available on relatively short notice. Those programs which are prepared with a standing list of equipment needs are most likely able to take advantage of the opportunity to utilize these new resources.

As indicated above in the context of new faculty recruitment, to maintain a priority for the acquisition of new resources, visible successes must be achieved with each new increment in resources provided. Thus, it is imperative that all BME faculty be periodically reminded that visible accomplishments are essential to making a case that additional resources are needed.

All academic program curriculum-related actions require the approval and buy-in of the faculty. This is particularly important in cases where the parent faculty group to be satisfied is diverse as it is in the MABE Department at the University of Tennessee. The key to avoiding faculty dissent is often simply to keep all faculty informed of new initiatives and needs for resources and to involve affected faculty in decision-making processes. Of course, it is equally essential that senior faculty be consulted in advance of open-forum decision-making and that a sound set of arguments be developed before discussions leading to allocation of new resources.

A final means of achieving faculty support for the commitment of new resources for the BME program is to invite active participation in the new initiative. For example, if it is desired to purchase a costly piece of BME research equipment, features should be specified to allow the widest applicability to the research activities of competing faculty.

Enhancing Program Visibility and Student Enthusiasm

Particularly in the case of the establishment of a new academic program, students have relatively high expectations for their satisfaction in gaining a meaningful educational experience. In the face of this high level of expectation is the reality of starting or advancing programs with significantly limited resources. Thus, the pressure to advance research funding may preclude the expenditure of faculty time needed to assure that new BME courses are optimally designed and delivered. It is important to realize that students' reflections on their academic experience is shared with their peers and occasionally with program administrators. Clearly, such feedback can positively or negatively affect BME program reputation and strengthen or weaken the case for further program development. A number of actions have been undertaken in the University of Tennessee BME program to ensure student satisfaction is maintained at a high level including:

- As a part of establishing a "program presence," a BME office suite has been established. This "program home" provides a location for the Director's office and affords students a location for securing BME program information and advising.
- A hallway bulletin board provides information on curriculum updates, course offering schedules, notices of internship and permanent job opportunities and recent medical and related news.
- A departmental web site has been established for ready access to BME program information.
- A faculty mentor oversees a BME student society that sponsors professional activities (e.g. seminar speakers) and social events (e.g. picnics). Society activities build student comradeship and foster BME professionalism.

Since most students are "grade conscious" there is much attention to course quality and outcome assessment by students. Thus, it is imperative to commit adequate attention to maintaining relevant course content and effective delivery to maintain student interest and satisfaction with the BME academic program. Fortunately, new ABET program accreditation requirements for continuous improvement aid in promoting the regular assessment of curriculum and individual course effectiveness. The maintenance of "satisfied customers" is essential to the garnering of resources for the further development of new BME programs.

Establishment of Viable Research Programs in the Face of Limited Resources

All BME graduate programs seek to offer an attractive variety of research focus areas with a high level of program funding. The development of such a program at the University of Tennessee, Knoxville is challenged by a small faculty size and a heavy burden of undergraduate teaching. While the process of adding faculty is underway, means must be undertaken for the meaningful development of research to support a developing graduate program. Three approaches are being used to enhance the opportunities for the development of funded research including:

- Leveraging from existing departmental strengths. The MABE department includes several faculty competent in computational solid and fluid mechanics. A number of these faculty have expressed interest in exploring the application of developed computational tools to the solution of biomedical problems. Thus, by involving faculty outside of the core BME faculty group, a BME research focus area can be developed in a relatively short time frame. Similar teaming with area radiologists and an imaging equipment manufacturer is being explored as a means of rapid development of a biomedical imaging research focus area.
- Leveraging out-of-department and regional strengths. Several campus departments and programs employ professional staff having interest in bio-technology related to biomedical engineering. Some of these groups include materials science and engineering, nuclear engineering, electrical and computer engineering and the College of Veterinary Medicine and University of Tennessee Medical Center medical and research staff. In addition, several staff members at the nearby Oak Ridge National Laboratory, local area physicians and representatives of biomedical product manufacturers have expressed interest in collaborative research. A broadly-based BME interest group has been identified and a series of meetings coordinated by the BME program has been initiated to explore joint research in several focus areas in which there is substantial regional strength.
- Funding agencies with programs encompassing the BME field have been targeted for grant solicitation. In particular, grant applications have been directed to the Whitaker Foundation which exclusively funds BME research and program development projects.

In summary, many factors can determine the number of impediments faced in initiating or advancing a BME program. Most of these factors relate to lack of knowledge or competing interests among university administrators and affected faculty. Among the key elements of a successful effort to overcome impediments are the following:

- Designation of a program head who is knowledgeable, persistent, well-organized and respected by his or her fellow faculty members.
- Support for BME program success at all levels of university administration.
- A carefully crafted business plan to guide program development with anticipation of impediments and needed remedies.

BME program development initiatives that are guided by these essential steps will ensure that likely impediments to progress are anticipated, that few impediments become significant, and for those that do arise, effective mitigating actions will be quickly identified.

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