

## **Biomedical Engineering Masters Degree Coupled with a Graduate Level Minor in Business Administration**

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### Abstract

The Department of Biomedical Engineering (BME) at The University of North Carolina at Chapel Hill (UNC-CH), in close association with the Kenan-Flagler Business School at UNC-CH, has developed a graduate minor in Business Administration which is awarded with the M.S. degree in Biomedical Engineering. Participating students are required to take three specific business courses through the Business School in order to meet the Graduate School requirements for an official minor. These courses, selected by faculty from the Department of Biomedical Engineering and the Business School, include Operations Management, Organizational Behavior, and Marketing. Students have the option of making the program a formal minor, with official recognition on their graduate transcript, or an informal minor. The formal minor requires students to take the three courses in addition to the 31 credits required for the M.S. degree in BME; the informal minor allows the students to take the three business courses as free electives within the established structure of our M.S. degree program. Our first students are currently completing the program and found it to be challenging and rewarding. The program will continue to leverage the resources of the internationally-renowned Kenan-Flagler Business School with the research and education missions of the School of Medicine to prepare select students for leadership roles in the private-sector as biomedical engineers.

### Introduction

No other field in engineering is experiencing the explosive growth currently enjoyed by Biomedical Engineering. While this discipline has always encompassed an extraordinary breadth of direction, the recent advances in cell and tissue engineering, genomics, and nanotechnology have greatly expanded the business potential for commercially applying the innovations introduced by this technology-based discipline. Thus, many BME students are attracted by the entrepreneurial potential of the field. Also, most students graduating with the M.S. degree are employed in industry and would benefit from training in business practices and the business environment [1].

In the Department of Biomedical Engineering (BME) at The University of North Carolina at Chapel Hill (UNC-CH), annual student surveys frequently requested more exposure to the BME industrial sector. In a 1998 survey in our department, only about half of the students entering our graduate program had taken an introductory course in economics in their undergraduate programs. Further, almost none of the students had taken courses in business beyond

introductory economics. While our graduate program has always been research oriented, nearly all of the M.S. students who do not continue to the Ph.D. degree go to work in industry or government. A recent survey of fifty M.S. graduates from our program from 1994 to 2002 showed that 50% went to work in industry for their first job after graduation, and another 18% went to work in the public sector (Figure 1). In follow-ups to the student surveys, it became clear that students who did not have previous industrial experience were feeling unprepared for the industrial world.

In response to those surveys, the Department of Biomedical Engineering, in collaboration with the Kenan-Flagler Business School at UNC-CH, developed an optional graduate minor program for M.S. students. The program focuses on topics in Business Administration. While the program is expected to benefit students interested in entrepreneurial pursuits, it is primarily aimed at those who will act as team leaders and project managers in industry and public-sector organizations.

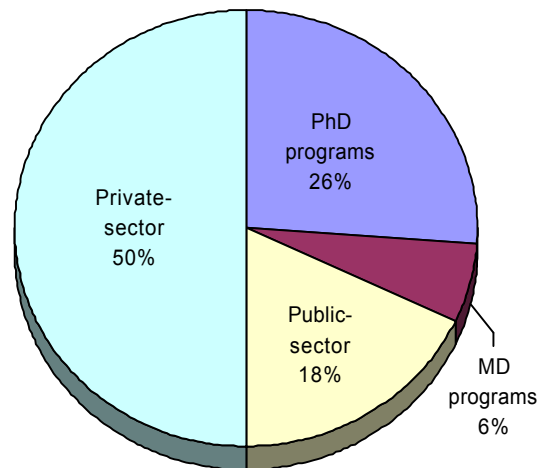


Figure 1: Distribution of post-graduation employment of fifty M.S. graduates of the UNC-CH Department of Biomedical Engineering from 1994-2002.

Below, we describe the coursework in the program and the administrative issues. Next, we discuss the history of the program so far, and conclude with a description of our plans for the future.

### Curriculum

Students in the program are required to take three courses focusing on different aspects of business administration. These courses are offered by the Bachelor of Science in Business Administration (BSBA) program in the Business School and are, therefore, courses intended for junior- and senior-level business majors. While these courses normally require Introductory Economics as a prerequisite, the Business School has agreed to waive that requirement for students in the BME Graduate Minor program. Still, the BME Department advises students applying for the program that they should take a course in Introductory Economics prior to beginning the business coursework.

The required courses for the Graduate Minor are BUSI 130 Operations Management, BUSI 150 Organizational Behavior, and BUSI 160 Marketing. Each of these classes addresses a particular aspect of the industrial world to which students get little exposure in their standard BME courses:

- Operations Management teaches students the basics of managing both manufacturing and nonmanufacturing organizations. Students gain an appreciation for the role of the

operations sector in a variety of organizational types, and learn to develop policies that enable the operations sector to contribute effectively to the goals of the greater organization. This course gives engineering students a perspective on the role of the project team leader or manager, and enables them to see a project from the perspective of the larger organization.

- Organizational Behavior teaches students the psychology of group dynamics. Students learn about how individuals, teams, and large organizations interact and how variables at the different levels of the organization impact organizational goals. Students also learn to examine how organizational policies affect individual employees. Engineering students particularly benefit from this course because they are frequently asked to work in teams with no training in how teams *should* work. Graduates of the program will find this training useful in the early stages of their careers as project team members as well as later when they take on more supervisory responsibilities.
- Marketing teaches students the social and economic aspects of marketing and distribution. Students gain an appreciation for how products are marketed, and the considerations involved in successful product marketing. In industry, product development engineers frequently interface with marketing personnel early in the design process. These engineers are forced to confront marketing constraints on the product design that have nothing to do with the technical constraints that engineers are typically trained to address. Thus, a perspective on marketing can be especially beneficial to engineers early in their careers.

Students in the Graduate Minor program must complete all three courses with a grade of at least P (the graduate equivalent of the undergraduate B grade) in each course in order to earn the minor. Students can take the courses in any order, thus increasing the flexibility of scheduling.

#### Administration

Several issues had to be addressed in setting up the Graduate Minor program. Many of these required negotiations between the BME Department, the BSBA Program, and the Graduate School. First among these was the mechanism of registration for courses. The BSBA program is a highly sought-after major among undergraduates and the courses are under restricted registration. BSBA reserves seats in the courses first for their undergraduate majors and minors, and then gives preferential registration to students in the Graduate Minor program. Because of demand for the BSBA courses, the Graduate Minor program is limited to five BME students at any given time; the number may be expanded later if resources allow. Further, to reduce the load on the BSBA courses, students in the minor program are not permitted to take more than one business course in a given semester. Some of the courses are offered in the summer, and students are allowed to take business courses in the summer if their advisor approves.

As an alternative, students may attempt to complete the Graduate Minor program without formal admission to one of the five slots by scheduling the courses through normal means. These students do not receive preferential registration from the BSBA program.

The Graduate Minor program is administered by a Program Director, a designated faculty member in the BME Department. Interested students in the BME Department or those who have

accepted offers of admission may apply for the program. On application, the students must submit to the Program Director a schedule of how the business courses fit into their planned M.S. program. The Program Director admits students on a first-come, first-served basis, and maintains a waiting list for those unable to be fit into a slot. In case of conflicts, preference is given to (a) more senior students who have a realistic chance of completing the program and/or (b) students who have already completed one or more of the required courses without formal admission to the program. The Program Director has discretion for removing students from the program for lack of progress toward completion under well-defined rules. Finally, the Program Director is responsible for working with the Business School to register students for the courses they need to complete the program.

The program is only available to M.S. students in the Department of Biomedical Engineering. Students pursuing the Ph.D. degree directly, students who have already completed the M.S. degree, and students of other departments are not eligible for admission to the program. Transfers of equivalent courses from other institutions are not accepted toward completion of the formal minor. Similarly, other business courses taken at UNC cannot be substituted at present.

Students can opt for the minor to be formal or informal. The chief advantage of the formal minor is that it includes a designation on the student's permanent transcript as having completed a minor in Business Administration. In keeping with the rules of the Graduate School, this requires the student to take the three business courses in addition to completing all normal requirements for the M.S. degree in Biomedical Engineering. This would require most students to spend an extra semester in completing the M.S. degree.

Because many students would not pursue the minor if it delays their completion, we offer an informal option. The current BME M.S. program has nine credits of free electives within the 31 credits required. For free electives, students may take any junior/senior- or graduate-level course as long as it is approved by the student's BME academic advisor. The BME Department has agreed to automatically approve as free electives any course in the Graduate Minor program. Thus, students in the program can complete their M.S. degree in the normal time using the business courses as free electives. Students taking the informal option do not receive an official minor from the Graduate School on their transcript, but they do receive a letter from the chair recognizing their accomplishment.

## History

The Graduate Minor program was opened up to students beginning in Fall 2001. The first group of students began taking courses that semester. In order to ensure that some slots would be available each year, we opened up only three of the five slots in Fall 2001, one to a student already in the BME program and two to incoming students. In Fall 2002, the other two slots were filled with incoming students. The waiting list currently stands at two students who are expected to be able to begin the program in 2003.

As of Fall 2002, one student has completed the program with a formal minor. We look forward to others completing in Spring of 2003. All other students thus far appear to be opting for the informal minor. Feedback from the students has been very positive. Most feel that the

business courses offer them a different perspective and welcome the change from their technical courses.

### Future Plans

To assess the Graduate Minor program, we plan to survey students both upon graduation and two years after they graduate. The survey will focus on the effectiveness of the minor program in preparing students for the industrial workforce. Specifically, students surveyed will be asked for specific aspects of the courses that were or were not beneficial. Also, they will be asked to relate briefly specific situations where the Business Minor training was useful to them, and to recommend other topics that should be included in the program.

If demand continues to grow, we will negotiate with the BSBA program to increase the number of slots for the minor program. Further, we will look at ways to modify the program based on results of the survey, possibly expanding to offer students a choice of other courses.

### Conclusion

The Department of Biomedical Engineering at UNC-CH has established a graduate minor in Business Administration available to a select group of M.S. students in our department. Students completing the Business Minor have found it to be challenging and an excellent addition to their professional credentials. The first students are currently completing the program, and we look forward to continuing and perhaps expanding the program in the future. The program will continue to leverage the resources of the internationally-renowned Kenan-Flagler Business School with the research and education missions of the School of Medicine to prepare select students for leadership roles in the private-sector as biomedical engineers.

### References

[1] IEEE Spectrum, Careers (Feb., 2002), "Is Business School Best for You?"  
<http://www.spectrum.ieee.org/careers/careerstemplate.jsp?ArticleId=e020202>

#### David Lalush, PhD

Dr. Lalush's research interests focus on image reconstruction and image processing in emission computed tomography. Current projects include development of four-dimensional reconstruction algorithms for noise reduction in gated SPECT (beating-heart) perfusion studies, development of a unique dual-camera cone-beam collimator system for brain SPECT, evaluation of iterative reconstruction algorithm performance, and the development of algorithms using prior information to reduce image noise in SPECT and PET.

#### Tiffany Harris

Ms Harris is the departmental administrator who responsible for the operational aspects of the business minor, including the selection of students to enter the minor, scheduling courses for these students, and coordination of this minor with the Kenan-Flager Business School.

#### Stephen R. Quint, PhD

Stephen R. Quint received his BS in Electrical Engineering at Virginia Polytechnic Institute in 1970 and PhD in Biomedical Engineering in 1977. He is currently an Associate Professor in the Departments of Biomedical

Engineering and Neurology, and Associate Chair of Applied Sciences at UNC Chapel Hill. His research is concentrated in the application of Signal Processing to problems in medicine.

Timothy A. Johnson, PhD

Timothy A. Johnson holds a BSEd (1972) in education from Illinois State University, a MS (1976) in natural science from Chicago State University and a PhD (1983) in BME from UNC-Chapel Hill. Research interests include cardiovascular electrophysiology, sensors, instrumentation and data acquisition, processing and display. As an Associate Professor in Biomedical Engineering, he teaches linear controls and directs BME laboratory rotations.

Stephen B. Knisley, PhD

Stephen B. Knisley, graduate of Duke University (BSE 1973) and The University of North Carolina at Chapel Hill (PhD 1988) is currently an Associate Professor of Biomedical Engineering. His research interests are cardiac optical mapping and electrical stimulation.