Austin Journal of Biomedical Engineering

Austin Publishing Group

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Editorial

The Case for Entrepreneurship in Biomedical Engineering Education

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Received: March 21, 2014; **Accepted:** March 22, 2014; **Published:** March 24, 2014

As the field of biomedical engineering (BME) matures, the education at the Bachelors level is being formalized in many colleges and universities across the nation. The newly formed BME departments are always striving to find the perfect balance of classes that expose the students to a wide range of topics that span the breadth of science, medicine and engineering. Different perspectives exist on the best strategy, each with its own advantage. Many prestigious universities focus on providing the undergraduates with avenues for research which sparks the interest in advanced degrees and graduate-level research. Some programs also require internships which not only allow the students to experience corporate culture but can turn into full-time jobs. Still other schools have developed specific concentrations which are perfect for students who have a passion for a certain field of study but are perhaps not yet ready for a Ph.D.

The statistics for job opportunities for BME are highly encouraging, with the Department of Labor Statistics projecting a growth of 27% in employment in the next ten years. Biomedical engineers find jobs in manufacturing, hospitals labs, education, research and development divisions of companies as well as government labs and regulatory agencies. However, a closer look shows that many of the available jobs require graduate degrees in BME. The opportunities for biomedical engineers with Bachelors are more limited and many jobs are farther removed from the forefront of cutting edge technology. For students who enter BME with the noble goal of making a difference in the quality of life, this distance may result in a certain level of disappointment. This is where an entrepreneurial mindset can give BME professionals an edge and an option to increase their involvement in the process of innovation.

Many BME students choose to commercialize products based on ideas developed during capstone senior projects; however, successful entrepreneurs need more than just a good idea. Current engineering education has a shortage of learning experiences that promote entrepreneurial thinking. Many students do not even get the slightest exposure to ideas such as *opportunity recognition* and *customer interaction* until their senior projects, if at all. Consequently, many BME students lack the persistence, the confidence and faith in their ability to carry through with innovative ideas, qualities that are the core competencies of an entrepreneur.

The curriculum for all engineering disciplines, including BME, has no capacity for an additional required class specifically on entrepreneurship. One can argue that it is better to introduce entrepreneurship in small doses throughout the undergraduate education for these ideas to take root. Recognizing the need and importance of entrepreneurial skills, efforts are underway on many campuses across the US to give the student an opportunity to engage in the innovation process. There are several foundations such as, Kern Family Foundation (KFF), Kauffman Foundation, Coleman Foundation and the National Collegiate Inventors and Innovators Alliance (NCIIA) that are focusing on faculty training and student education to create the next generation of leaders, innovators and entrepreneurial thinkers.

BME, in particular, is going through a boon with many new and exciting ventures and startups. There are rapid advancements in the development of medical devices and prosthetics. Even peripheral social movements such as 'Quantified Self' and wearable sensors are benefitting from the trend to bring health and fitness to the user's doorstep through technology-based products. In order for recent BME graduates to be included in the current trends, they need to develop the entrepreneurial core competencies that are seen by industry and professional organizations as competitive advantage. In fact, academic institution and classroom instructors need to help students recognize that an entrepreneurial mindset is an asset even in traditional, large organizations; the so-called *intrapreneurs,* who are focusing on creativity and innovation and are adding incremental value to their organization. This model has been a successfully implemented in corporations like Google® and Apple® and is valued by biomedical industry as well.

At Lawrence Technological University there are several initiatives underway that are bringing proven technique such as problem-based learning (PBL) and active collaborative Learning (ACL) in the classroom, by training the faculty in teaching workshops. These methods incorporate team building and group thinking to solve real world problems. All students are required to take a course in leadership. Students in engineering disciplines that are taking the capstone senior project have the opportunity to get funding for commercialization of their project ideas through a KFF program called LESA (LEGENDS Entrepreneurial Student Awards). More recently, a topical grant by KFF is specifically focusing on inclusion of entrepreneurial modules throughout the engineering curriculum from freshman to senior level courses.

The hope is to eventually graduate a new generation of biomedical engineers that are risk-averse but not afraid of failure; who are better placed in generating technology-based opportunities and ready to tackle the particular challenges of effectively identifying, acquiring, developing, and transferring technology into viable new products and services.

Citation: Nasir M. The Case for Entrepreneurship in Biomedical Engineering Education. Austin J Biomed Eng. 2014;1(2): 1006.