3-13-2012

BME FIU Strategic Plan 2012-2017

Department of Biomedical Engineering, Florida International University

Rising to New Challenges

Five Year Strategic Plan (FY 2012-2017)

Department of Biomedical Engineering
College of Engineering and Computing
Florida International University
March 13, 2012

Rising to New Challenges

Ranu Jung, PhD
rjung@fiu.edu
Wallace H. Coulter Eminent Scholar Professor and Chair

Access to top quality health care is still not in reach for many, the worldwide economic downturn has affected multiple facets of American life, and America's ability to maintain its leadership in innovation and ingenuity is being questioned. It is in difficult times like these that the academic backbone of the country must rise to the challenge by preparing the next generation of thought leaders and innovators to shape the technological and economic landscapes of tomorrow.

Educating Tomorrow's Biomedical Engineer

The interdisciplinary nature of biomedical engineering (BME) affords the discipline a tremendous opportunity to bring forth advances in technological development and new discoveries in life sciences to foster improved quality of life for all individuals. The US Bureau of Labor & Statistics projects a 72% growth in Biomedical Engineers from 2008 to 2018 with tremendous impact of Biomedical Engineering in all the sectors they track: manufacturing, wholesale trade, professional, scientific and technical services, management, education services, health care and social services, and government. It is thus not surprising that the last decade has seen a surge in the training and education of a cadre of biomedical engineers and a growing momentum in the role of biomedical engineering in leading edge research and development of science and technology and medical innovation.

The broad extent of the potential impact of BME on society raises several challenges for academia. The next generation of BME graduates has to be better educated and better prepared than any of their predecessors. They have to be skilled at synthesizing information from across the STEM (science, technology, engineering and mathematics) disciplines, capable of unconventional inquiry and adept at providing innovative solutions to the current challenges of health care delivery. Furthermore, they must meet these challenges in a rapidly changing environment governed by multiple ethical considerations, fiscal responsibilities, policy regulation, and global competition. The next generations of biomedical engineers are faced with the challenge of pushing the envelope on what is possible in medical care and the challenge of broadening the impact by making diagnostics and therapeutics that are practical for use in a wide variety of socioeconomic environments and healthcare systems and ethnic diaspora. Innovation in BME educational programs should be directed at preparing our students to meet these challenges.

Signatures of Excellence

As the breadth of BME's impact on society expands and as the need for specialized training increases, BME academic programs are likely to be more effective if they remain focused on selected sub-disciplines within the field. As the multiple BME programs across the nation and internationally mature, the strong programs will likely be identified with 2-4 specific self-selected signature areas of excellence. These areas of excellence will have their foundations in outstanding research programs and will permeate the undergraduate and graduate educational programs. The areas should be broad enough to allow innovation, growth and adaptability over time, but should be narrow enough to provide depth of training and identity for the students. BME education will be transdisciplinary and intimately tied with educational programs in medical, life and physical sciences and computing as well as ethics and regulatory policy.

BME education is also likely to play an expanding role in the training of future physicians. An undergraduate degree in BME has always been an attractive option for students interested in going on to medical school. The quantitative rigor of the BME curriculum speaks highly of the students' academic *capacity* as well as their ability to deal with the instrumentation and complex data sets that are increasingly important in the modern clinical environment. These advantages of BME training for physicians will become more prominent in a future with prescription of biohybrid systems that merge the engineered and the living system to maintain health or treat disease. These systems may involve engineered tissue, implanted devices, or adaptive engineered sensors,

robotic and imaging systems that interact with the living system. Thus, BME educational programs will become an increasingly important base for educating the future physician; programs that acknowledge this need will not only serve these clients better, but may also be at the leading edge of innovation in medical education.

Leveraging Location: A Growing Wheel of Impact

As a BME program grows and seeks to define its core areas of expertise within the field, an effective strategy would be to leverage the location. That is, a BME program should acknowledge that in this interdisciplinary field, a key to its success will be the extent to which it can utilize the expertise, resources and opportunities available within the University and its surrounding areas. Through such interaction, the institution and the community can be molded and integrated through the processes of innovation. For sustainable and meaningful growth, the industrial and clinical organizations within the region should be engaged to help create a vibrant educational & research enterprise that will prepare the next-generation of BME graduates for the complexities of tomorrow's work environment. Classroom pedagogy, laboratory research and delivery of outcomes to the public thus become fused in a synergistic manner. This framework for leveraging the location extends to concentric circles of region, state, nation and global connections. At all times, the areas of excellence act as spokes in this ***growing wheel of impact***.

Executive Summary

Introduction

This document presents the Five-Year Strategic Plan (FY2012-2017) for the Department of Biomedical Engineering (BME) at Florida International University (FIU). The plan presents the goals and strategic vision guiding the growth of the Biomedical Engineering department as a member of the College of Engineering and Computing and the Academic Health Center at FIU.

Established in 2003 with a $10 M endowment from the Wallace H. Coulter Foundation matched by support from the State of Florida, the Biomedical Engineering Department is leading the State in biomedical engineering education. The department is embedded in a University that seeks to grow cross-disciplinary programs, is committed to access for students, and embraces the local and global communities. Amongst the department's most notable accomplishments since its inception are the development of productive research programs in key areas of biomedical engineering and establishment of graduate degree programs and an accredited undergraduate program, the only such program amongst all the public Universities in Florida. It is also the only Biomedical Engineering department in the nation offering an accredited BS degrees in Biomedical Engineering at a public Minority and Hispanic Serving Institution. One of the strengths of the growing BME department is its enhanced alignment with the Herbert Wertheim College of Medicine, the College of Nursing and Health Sciences and the College of Arts and Sciences. The vision and diligence of the founding members, investment by the University, and the development of strategic relationships with clinical and industrial partners have fueled the advancement of the department. With the recruitment and appointment of a new Chair in January 2011, the department has embarked on a new phase of growth and development.

Vision

The Biomedical Engineering Department will be nationally recognized for research excellence and innovation in clinical medicine and biomedical industry applications and lead education, research, and technology development in Florida.

Goals

The goals of the Department of Biomedical Engineering are guided by the 2010-2015 *Worlds Ahead* Strategic Plan for FIU, the College of Engineering and Computing (CEC) Strategic Plan for 2010-2015 and the philosophy espoused in Chair Jung's paper *Rising to New Challenges*. Of special importance for Biomedical Engineering is the *Worlds Ahead* plan related to *Health* that includes establishment of an Academic Health Center, interdisciplinary education and research and new degree programs as well as the CEC plan related to *Health Related Technologies,* increased retention and graduation rates for undergraduates and graduates, and new doctoral degree programs.

The 2017 Vision Biomedical Engineering Strategic Plan addresses the goals for the Department and will help BME maximize its impact on society by identifying key areas of **Research Excellence** within the broad field of biomedical engineering and enhancing research productivity, developing **Educational Excellence** through a new model for BME education and by **Community Engagement** by leveraging its location through community and global activities.

Goals (2012-2017)

2017 Vision Goal: Enhance Research Excellence and Productivity

2017 Vision Strategic Plan:

- Establish three signature areas of research excellence:
  - 1-Engineered Tissue Model Systems
  - 2-Diagnostic Imaging and Sensor Systems
  - 3-Therapeutic and Reparative Neurotechnology
- Become a leader for interdisciplinary science and technology discovery and development
- Enhance research and discovery competitiveness via large collaborative grants
- Establish structured undergraduate research pipeline
- Establish procedures to promote innovation and entrepreneurship in medical device development for translational research
- Establish translational research partnerships with clinical departments of Neurology, Neurosurgery, Ophthalmology and Radiology in the College of Medicine
- Establish translational research partnerships with clinical departments of Physical Therapy and Occupational Therapy in College of Nursing and Health Sciences
- Establish basic science partnerships with Medical Physics and Cognitive Neuroscience in College of Arts and Sciences
- Expand collaborative academic, industrial and clinical partnerships

2017 Vision Goal: Enhance Education Excellence and Productivity

2017 Vision Strategic Plan:

- Increase freshmen persistence to exceed FIU targets
- Enhance four-year undergraduate graduation rate to exceed FIU targets
- Establish a summer REU program
- Increase Graduate admissions from high-caliber students from Universities in the US and it's Territories.
- Attain national standing for the program
- Become the leading program in the nation in Bachelor's, Master's and Doctoral Biomedical Engineering degrees granted to Hispanic students
- Establish pathway for obtaining a Master's degree in Biomedical Engineering for medical students
- Establish joint doctoral programs with Medicine and/or Health Sciences and/or Cognitive Neuroscience
- Enhance laboratory infrastructure by addition of laboratory space and state-of-the-art equipment
- Introduce new career pathways for Biomedical Engineering undergraduates (e.g. BS-JD)
- Strengthen career option mentorship for graduate and postdoctoral scholars

2017 Vision Goal: Establish Community and Local Industry Engagement

2017 Vision Strategic Plan:

- Engage with alumni through yearly Homecoming events
- Enhance linkages to local high schools through student programs
- Attain industrial partnerships for Senior capstone design for 90% of student groups
- Establish community public seminar dialogue

2017 Vision Goal: Establish Sustainable Growth Model

2017 Vision Strategic Plan:

- Enhance the current endowment to promote translational research

- Increase Endowed Professorships
- Establish an Industrial Support Program for educational initiatives and student support
- Establish alumni directed Giving Program

MISSION

The mission of the Biomedical Engineering Department is to bridge engineering, science and medicine

- To educate and train the next diverse generation of biomedical engineers
- To conduct research leading to significant discoveries in medical sciences
- To conduct design and development of innovative medical technology
- To translate scientific discovery and medical technology to industry or clinical practice for delivery of health care
- To engage with the local to global community for knowledge dissemination

Strategic Issues

The Vision Goals lead to some key strategic issues that need to be addressed by the Strategic Plan. These and potential approaches to address the issues are elaborated below.

Strategic Issue #1 – Establish Signatures of Excellence in Research
Strategic Issue #2 – Enhance Research and Discovery competitiveness
Strategic Issue #3 – Strengthen the Educational Programs
Strategic Issue #4 – Introduce innovative career paths for BME graduates
Strategic Issue #5 – Leverage Connections with Local Industry and Medical Practices
Strategic Issue #6 – Grow Vibrant and Sustainable Areas of Excellence
Strategic Issue #7 – Get Media Exposure

Strategic Issue #1
Establish Signatures of Excellence in Research

A collective effort (involving faculty, students, administration and key stakeholders) is necessary to establish signatures of excellence. This process may be facilitated by adopting a framework that utilizes two dimensions of expertise: technical expertise (i.e. core engineering competencies) and application expertise (i.e. medical areas of application). This framework can be used to guide the development of signature areas of research and can also be used to facilitate the development of interactions with research and clinical partners and to guide the evolution of the undergraduate and graduate curricula. The intersection of the technology platform and application areas should be broad enough to respond to changing demands of societal need but focused in addressing a strategic mission for developing long-term excellence.

Strategy 1: Identify unique infrastructure resources (radioisotope laboratory, nanofabrication capabilities)

Strategy 2: Identify faculty with complementary expertise (oncological sciences, neurological sciences, ophtalmological science, physical and occupational therapy, nanochemistry, biophotonics, diagnostic imaging, neural engineering, tissue engineering, medical physics and biomechanics) to form research clusters.

Strategy 3: Recruit faculty in gap areas

Strategy 4: Identify major application areas of clinical need

In 2011, a strategic planning meeting amongst Biomedical Engineering Faculty was conducted. Informal resource maps were created to identify resources available, existing areas of technical expertise and identification of strategic growth in technology platforms. A SWOT (strength, weaknesses, opportunities, threats) exercise was performed.

Three Signature Areas for Research Excellence were identified as:

- Basic Research in Engineered Tissue Model Systems
- Diagnostic Bioimaging and Sensor Systems
- Therapeutic and Reparative Neurotechnology

These are to be served by Advanced Technology Platforms in:

- Bioimaging and Biosignal processing
- Bioinstrumentation, devices and sensors
- Biomaterials and bio-nano technology
- Cellular and tissue engineering

In the next five years, the research and technology advancements will serve clinical applications targeted to:

- Oncological Disorders
- Neurological Disorders
- Cardiovascular Disorders

Recruitment of faculty will be guided by the objective of strengthening research clusters that intersect a strategic area of research excellence, technological advancement platform and clinical application area. Faculty primarily focused in development of platform technology may find application in multiple areas of research excellence and clinical applications identified in the strategic plan.

Clinical partnerships will be established to enhance research and technologies translation for medical impact. This will be accomplished by directly linking with the needs identified by the Chairs of the College of Medicine with initial focus on Department of Radiology, Ophthalmology, Neurology and Neurosurgery as well as the College of Nursing and Health Sciences Departments of Physical therapy and Occupational Therapy as well as community clinical partners. Basic Science partnerships will be established with links to the departments, schools and Center in the College of Arts and Sciences.

In an iterative process, under the stewardship of the chair and input from multiple constituencies, the BME faculty could modify and refine the categories in the framework described and could develop a version with higher resolution. Together they would ascertain strengths, weaknesses, opportunities and threats, and with university support lay out a roadmap to achieve specific milestones for achievement. Translational research and development could be a hallmark of their effort.

Strategic Issue #2
Enhance Research and Discovery competitiveness

To complement University investment, a proactive multifaceted approach by the faculty will be needed for securing external funding to support research and development. Funding strategies will strive for a balanced portfolio, with each signature area supported by both single investigator grants and large "3M" grants (multi-million, multi-investigator and multi-institutional (a 3M approach). Towards this end, the large team proposals will seek partnerships such as those with the College of Medicine (Basic and Clinical Sciences), College of Nursing and Health Sciences, College of Arts and Sciences (Chemistry, Medical Physics, Cognitive Neuroscience) and School of Computing and Information Sciences (Bio/Medical/Health Informatics), as well as Clinical and Industrial organizations within Miami and the broader region.

For sustainable growth, the department will also seek federal or other private foundation/industry support for establishing Centers for research, academic excellence and translational outcomes. The centers, driven by the confluence of research excellence, advanced technology and clinical applications will have a well-defined mission and include a cohesive set of paradigm shifting research thrust areas. They would also put focused efforts on public outreach to the local constituency of the University.

Strategic Issue #3
Strengthen the Educational Programs

The first step in strengthening the program is to inculcate ownership of the BME program in all students and faculty. With the recent breaking of the boundaries set up by the 2+2 approach of education at the undergraduate level, concerted effort will be made to get BME faculty involved in the first two years of the curriculum in a manner that does not substantially impact teaching commitments. An innovative approach to be explored is utilization of a module-based curriculum to provide freshmen and sophomores exposure to medical problems, opportunities to apply their engineering skills to biomedical problems, and opportunities to develop BME specific skills. Such a module-based approach could leverage the expertise of colleagues from the school of medicine, clinical practice and industry to participate in two term (A and B per semester) modules designed to provide freshman and sophomores with an identity as BMEs and to nurture their enthusiasm for the field. The module-based approach can also be used to provide targeted technical electives for juniors and seniors that will enable them to explore a range of opportunities in BME.

In addition to introducing engineering coursework within the first two years of BS, the goal will be to establish a vertically integrated mentoring program, where postdoctoral fellows and doctoral students mentor undergraduates. Training grants can be targeted to provide "mentorship stipends" for the doctoral students in addition to their academic research/teaching assistantships. This will establish a strong pipeline of FIU undergraduates for growing excellence and leadership in BME.

The next step is to leverage the environment and identify opportunities for interaction within close vicinity. The first place to look is within the University. Outside of engineering, the foremost opportunity lies in enhancing the link and intertwining components of the BME educational mission with that of the new School of Medicine. This intersection could occur at both the undergraduate and graduate levels and even for medical residents. FIU offers a unique opportunity to introduce clinically relevant team based approaches to learning for undergraduate students in BME. The need for such an approach to BME education has been recognized federally and competitive federal funding (PAR-10-140 from NIH) is available to foster team-based senior design for BME undergraduates. Such a program would include a "clinical immersion and user need assessment period". The FIU students would be uniquely positioned for entry into medical school, BME doctoral programs and medical industry.

On the other hand, BME has an opportunity to directly contribute to the technology driven richness of the modern medical practice by contributing to the education of the future physician. Thus educational partnerships that would significantly amplify the visibility and value of both the medical school and the engineering school education are a joint MD/PhD program or a BME- MS/ MD program. The latter could also take shape in the form of a BME certificate in a particular area of BME technology for medical students. One or more of these above approaches will be explored and targeted for implementation.

Recruitment, retention and graduation of students that will be tracked could be analyzed to see if the above actions to strengthen the educational programs impact these rates.

Strategic Issue #4
Introduce innovative career paths for BME graduates

A place for Ethics and Law in BME Education

Ethics and or regulatory policy should become a core feature of a BME education both at the undergraduate and graduate levels. Rather than having it sprinkled through an individual lecture every now and then, the curriculum could include in-depth case studies, lectures by ethicists and policy specialists and become a component of the research plan for the graduate students.

Similarly, with the mission for keeping the US competitive edge in innovation and entrepreneurship it is going to be increasingly necessary that our lawyers are versed in innovative technology. Hence, overtures could be made to the School of Law to explore the preparation of BME students for obtaining a JD, in particular with reference to patent law. During the next five year we will explore developing a competitive 3+3 program in which the students receive a BS in BME and a JD in six years. FIU already offers JD-MS programs with other colleges. A JD-MS program with BME could also be considered. The importance of preparing future lawyers conversant with both patenting and regulatory issues of medical technology as well as legal issues of using imaging, sensors and devices to probe and interact with the human body and mind is likely to grow. BME@FIU could have a selective program for preparing such lawyers.

Strategic Issue #4
Leverage Connections with Local Industry and Medical Practices

The FIU BME program will make a concerted effort to greatly strengthen the link with the industry and clinical partners. An industrial advisory board will be set up. The interactions could include establishment of a short lecture series that includes lecture modules in entrepreneurship, regulatory and policy issues in undergraduate and graduate courses by the industrial partners, lectures and workshops by the faculty at the industrial sites or at FIU for these partners, strengthening of the internship opportunities for both undergraduate and graduate students and establishment of academic-industrial research partnerships. These links could be leveraged not only for enhancing research and development but also to obtain initial federal funding for support of undergraduate senior design. Similarly, community clinical partnerships not captured by FIU will be pursued as necessary to enhance translation of medical technology to practice.

Strategic Issue #5
Grow Vibrant and Sustainable Areas of Excellence

The BME research enterprise at FIU has tremendous opportunity to leverage the environment. It has the unique status of being located in a vibrant area with a large Hispanic constituency. The city and vicinity are home to a population that spans the life-span and Miami is a gateway location for the Caribbean and Latin American countries. BME research and application areas should take advantage of these attributes in the development of the cohesive plan. Once a cohesive plan and application areas are in place, a deliberate effort will be made to target funding opportunities to support the areas of excellence for vibrant and sustainable growth. This effort can only be accomplished if the areas of excellence are populated by sufficient numbers of dedicated faculty and research personnel, who have the appropriate administrative and operational support to conduct cutting-edge research that meets the milestones.

The Department's endowment fund from Coulter Foundation provides a secure, powerful and versatile resource. To maximize the impact of this endowment, it may be best to utilize it as a leverage to raise non-university investment and not to replace the University investment.

A capital campaign is necessary to enhance directed giving to Biomedical Engineering to support the signature areas of excellence and educational mission by support of state-of-the-art building and equipment infrastructure as well as endowed professorships, postdoctoral fellowships for targeted translational research and student internships.

Strategic Issue #6
Local and Global Engagement

As the BME program strengthens its research and education base it will be necessary to make global connections. The program will leverage its environment by seeking connections with educational and industrial collaborations from Latin American and Caribbean countries- countries that the majority student body identifies with and the University is programmatically reaching out to. One option is to establish student and faculty exchange with these countries. The education and research exchange programs would add a unique value for a BME education at FIU.

Strategic Issue #7
Get Media Exposure

A leading research enterprise requires high-caliber graduate students and post-doctoral fellows. To recruit the best candidates, the BME program must have a unique signature that is on the radar screens of the international BME community and of the local community of South Florida. To accomplish this BME will regularly host and sponsor specific workshops and training sessions either on-site or as part of a national or international conference. The most prominent approach for visibility would be to host national/international conferences in the signature areas of research. We will also sponsor technology and commercialization promotion events.

To establish a presence within the diverse community of south Florida, the department will seek out innovative approaches to obtain media exposure that promotes the research accomplishments of faculty and students. One approach will be to link with the faculty and students in the School of Journalism and Mass Communication for development of radio stories, podcasts and other modes of public communication.