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Branding the Bio/Biomedical Engineering Degree

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Abstract— **The future challenges to medical and biological engineering, sometimes referred to as biomedical engineering or simply bioengineering, are many. Some of these are identifiable now and others will emerge from time to time as new technologies are introduced and harnessed. There is a fundamental issue regarding "Branding the bio/biomedical engineering degree" that requires a common understanding of what is meant by a B.S. degree in Biomedical Engineering, Bioengineering, or Biological Engineering. In this paper we address some of the issues involved in branding the Bio/Biomedical Engineering degree, with the aim of clarifying the Bio/Biomedical Engineering brand.**

I. Introduction

THE future challenges to medical and biological engineering, sometimes referred to as biomedical engineering or simply bioengineering, are many. Some of these are identifiable now and others will emerge from time to time as new technologies are introduced and harnessed. Chief among these is a fundamental issue regarding "Branding the biomedical engineering degree" in order to result in a common understanding of what is meant by a B.S. degree in Biomedical Engineering, Bioengineering or Biological Engineering.

Some of our industry still does not get the meaning of these degrees. There is evidence that some medical device companies in the United States will not hire (see Fig. 1), or will underpay (see Table #1), biomedical engineers with only a B.S. degree [1]. The newly hired B.S. graduates generally have participated in an industry internship as an undergraduate. Median salaries for B.S. Biomedical Engineers can be $6,000 less than those with more traditional B.S. engineering degrees (Table #1). According to PayScale 2010-2011 College Salary Report, the median salary for students with a B.S. in Biomedical Engineering is $54,800 [2]. The U.S. Bureau of Labor Statistics (BLS), however, identifies Biomedical Engineering as among the fastest growing occupations in the United States; The BLS's Occupational Outlook Handbook, 2010-11 Edition, "Biomedical engineers are expected to have employment growth of 72 percent over the projections decade, much faster than the average for all occupations" [3].

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Medical and biological engineering is also growing rapidly in Europe and Asia [4].

Although the U.S. Bureau of Labor Statistics identifies the bachelor's degree as the "most significant source of postsecondary education or training," it appears that the entry-level degree for biomedical engineering is the M.S. degree. The reason why industry generally does not favor the hiring of biomedical engineering graduates with only a B.S. degree is attributable to a lack of understanding of the strengths of the biomedical engineering undergraduate curricula, coupled with a misconception that these are weak engineering degrees filled with biology courses. In addition, the number of Universities offering the biomedical engineering, bioengineering or biological engineering programs in the United States has increased dramatically in a short period of time. While some of these programs were intended to be accredited programs, others were not. As of 1 October 2009, there were 65 ABET-accredited bioengineering and biomedical engineering programs in the United States (~70%) and two in other countries (Saudi Arabia and Jordan). In addition, there are 9 ABET-accredited biological engineering programs, all in the United States. Recent efforts to document the variations within these programs have been collated by the VaNTH program [5]. This may lead, eventually, to an understanding of what is considered essential to the education of a Biomedical or Bio engineer. Debate continues, however, as to how to converge to a curriculum that is "Universal." Many feel that these curricula need not be identical; we agree. We also believe, however, that the curricula need to be based on a system of core values. It is essential that the heart of this core be engineering-rich. Bio/Biomedical Engineers need to be ***engineers*** first.

Some universities, with good intentions for those undergraduates seeking admission to medical school or graduate school, have sent mixed messages to students, their parents and to industry about the Bio/Biomedical Engineering bachelor degree.

Until recently, the University of California, San Diego Department of Bioengineering offered four undergraduate majors:

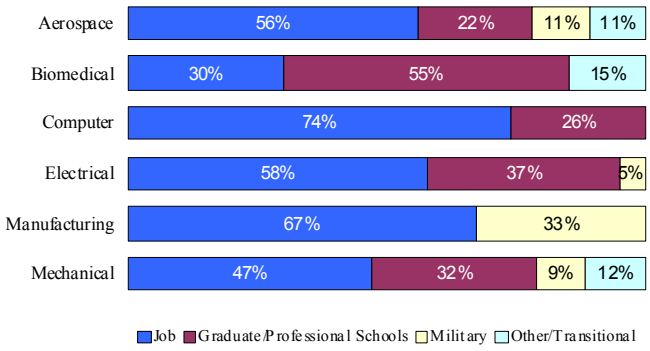
- Bioengineering
- Bioengineering: Biotechnology
- Bioengineering: Bioinformatics
- Bioengineering: Premedical

Table #1: Boston University 2010 Median Salary Data

Median Salary: $58,900

Aerospace	$60,380
Biomedical	**$52,180**
Computer	$64,563
Electrical	$60,333
Manufacturing	$64,340
Mechanical	$54,033

Fig. 1: Boston University Class of 2010 Outcomes



UCSD's Bioengineering and Bioengineering: Biotechnology degree programs have a relatively heavy emphasis on engineering, whereas Bioengineering: Premedical has a relatively heavy emphasis on biological, chemical, and physical sciences with the aim of training those bioengineers whose ultimate education goal is admission to medical school.

- The Bioengineering and Bioengineering: Biotechnology programs are accredited by EAC/ABET.
- The Bioengineering: Bioinformatics and Bioengineering: Premedical programs ***are not accredited by a Commission of ABET.***

The Bioengineering: Premedical program was recently discontinued when it was found that those students completing the ABET-accredited Bioengineering program were more successful in gaining admission to medical schools[i].

The University of California, Irvine mirrored UCSD in offering both ABET accredited and non-accredited programs:

From their website:

- **"Undergraduate Programs**

Welcome

- Biomedical engineering combines engineering expertise with medical needs for the enhancement of health care. It is a branch of engineering in which knowledge and skills are developed and applied to define and solve problems in biology and medicine. Students choose the biomedical engineering field to be of service to people, for the excitement of working with living systems, and to apply advanced technology to the complex problems of medical care. Biomedical engineers may be called upon to design instruments and devices, to bring together knowledge from many sources to develop new procedures, or to carry out research to acquire knowledge needed to solve new problems.
- **Major in Biomedical Engineering**
- **Major in Biomedical Engineering: Premedical**
- The undergraduate major in Biomedical Engineering: Premedical (BMEP) is not designed to be accredited, ***therefore is not accredited by ABET, Inc."***

Another approach to broadening the appeal of the Biomedical Engineering program to those students more interested in attending medical school or graduate school has been to introduce the Bachelor of Arts (B.A.) in Biomedical Engineering. Both Johns Hopkins University and the College of New Jersey offer non-accredited Biomedical Engineering programs in addition to ABET-accredited Biomedical Engineering Programs. In each B.A. program, the students are excused from a senior design project [6, 7].

II. A BIO/BIOMEDICAL ENGINEERING CORE[ii]

Unlike Mechanical, Electrical or Chemical Engineering, Bio/Biomedical Engineering does not espouse core educational values at the undergraduate level. This is a reflection of the expertise of faculty in each of the departments. Faculty research in bioengineering range from experimental and theoretical biochemistry to biophysics to other branches of engineering to medicine. Educating undergraduates across all these areas is an impossible task. As a result the curriculum in each Department reflects the expertise of a few faculty along with a common understanding that some life science and some engineering courses are required. The lack of coherence and definition of "core values of bioengineering" introduces an element of confusion amongst students as well as potential employers.

So we pose the fundamental question: What are the needs in modern healthcare, in the pharmaceutical or medical device industries or in frontier research in biomedicine? While there can be several answers, most practitioners would agree that there are some common trends. First and foremost, the practice of medicine is becoming more technology and quantitatively driven, given the advent of molecular (genomic) and cellular measurements in

physiology. This in itself warrants trained professionals who can deal with engineering and quantitative aspects of physiology. We posit that fundamental to this expertise is solid foundations in physics, mathematics and chemistry followed by training in a combination of electrical, mechanical and chemical engineering course basics. For instance, a well-rounded bioengineering graduate would have knowledge of circuits and signals, biomechanics (solid and fluid), thermodynamics, process control and engineering and robust experience in engineering design. In addition to this, this graduate would have sufficient familiarity in life sciences including genetics, molecular and cellular biology and physiology, so as to know the lingua franca of biomedicine. It is our observation that a student trained in physical sciences has the potential to learn life science advances given some foundation and perseverance.

While there can be arguments on specific details, most Bio/Biomedical Engineering educators would agree entirely that there needs to be a core value for medical and bioengineering, which alone may be sufficient to provide a "stamp" of engineering training that would be accepted by the industry at large as well as by related disciplines in academia. It is our intent to define such curricula which can become the standard of training in bioengineering of the future.

III. SUMMARY

There should be no unaccredited Bio/Biomedical Engineering programs. It is essential that mixed messages regarding the field are avoided. Industry, students, parents and the media must be clear on exactly what can be expected from a Bio/Biomedical engineering undergraduate degree. First and foremost these are engineers. Although many practitioners in industry are aware of the fundamental strengths of the Bio/Biomedical engineering degree, we need to be vigilant in protecting the technical worth of these programs as evidenced by ABET accreditation.

IV. CONCLUSION

Bio/Biomedical Engineering programs are training the brightest students of both genders attending college today. The future job opportunities for such students are very bright. Industry needs to appreciate the value of hiring Bio/Biomedical Engineers with B.S. degrees. Universities should seek to provide a consistent message regarding the contents of their Bio/Biomedical Engineering degree programs. We need to articulate a brand that is consistent from program to program. Our challenge is to clarify the Bio/Biomedical Engineering brand.

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REFERENCES

[1] Data provided by A. David Brown, Boston University College of Engineering Career Development Office.
[2] (http://www.payscale.com/best-colleges/degrees.asp) referenced on 15 April 2011.
[3] (http://www.bls.gov/emp/ep_table_103.htm) referenced on 13 April 2011.
[4]Nagel JH Bioengineering and Biotechnology: A European Perspective G. Madhavan et al. (eds.), Career Development in Bioengineering and Biotechnology, DOI: 10.10071978-0-387-76495-5-4, @ Springer Science+Business Media, LLC 2008.
[5] (http://www.vanth.org/index.htm) referenced on 13 April 2011.
[6] (http://www.tcnj.edu/~engsci/biomedical/curriculum.html) referenced on 12 April 2011.
[7] (http://www.bme.jhu.edu/academics/ugrad/ugrad_advising_man.htm#ba) referenced on 12 April 2011.

[i] Personal Communication from Shankar Subramaniam.
[ii] Contributions acknowledged from Professor Shankar Subramaniam to this section.