

Managing Student Expectations of the Real World

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As senior capstone design instructors, our job is to help prepare our students for careers in biomedical engineering. Since the majority of them will someday work for a medical device company, our focus on design is particularly important and relevant. Capstone design courses and biomedical engineering curricula help students develop technical, interpersonal, and communication skills and provide them with the broad knowledge base they will need for successful careers as biomedical engineers. Additionally, accreditation requires programs to meet several learning criteria to ensure that the students will be prepared for careers in biomedical engineering after graduation.

There are many mechanisms in place that prepare our students to solve open-ended problems, think critically, and work well in teams. However, there are fewer mechanisms in place to let students know what to expect in their first job, what their early careers might be like, and how they are expected to behave and function in an organization. Students with cooperative, summer job, or internship experiences with medical device companies gain insight into how a business is run; how companies function to design, develop, and introduce new products; and how decisions are made within a company. They also learn what will be expected from them and what they can expect from their future employers. At Marquette University, in 2011, more than 60% of undergraduate biomedical engineering students partici-

pated in the cooperative and internship program, where they worked for medical device companies. These experiences provide students with a preview of how it will be to work in an industry and help them develop reasonable expectations of their first job.

When I began my career in the medical device industry in 1980, there were things that I did not learn as an undergraduate or graduate student that I would have liked to have known before starting my career. These are things that are typically learned on the job and may be a rude awakening to new engineers with certain expectations. Students without cooperative or internship experience should be aware of a few of these *realities* of industry before they begin their careers.

Project Assignments

In many companies, engineers do not get to choose the projects they work on. This can be a rude awakening to many new engineers. Project assignments are typically based on market needs defined by marketing and sales departments, available engineering resources, and the qualifications of available resources. New engineers may find themselves working on projects that they may not be as interested in as they are in others and need to understand that engineering resources are assigned to projects that are expected to be the most profitable and generate the highest return on investment. New engineers may need to prove themselves and demonstrate their project management and design skills before they are assigned to more desirable, higher-profile projects.

Types of Projects

Not all projects to which engineers are assigned will involve exciting, novel, state-of-the-art technologies. This can be disappointing to new graduates who expect to work on the newest, coolest technologies immediately after starting a new job. They must realize that only 10% of new product introductions are new-to-the-world products. Companies manage their project portfolios similar to a personal portfolio of investments. They will maintain a diversified mix of high-risk/high-return and low-risk/low-return investments to keep a balance. Engineers can expect to work on a similar mix of projects including new-to-the-world products, line extensions (new size or color), product enhancements (new features), cost reductions, product repositionings, and other types of projects. In some companies, new engineers may not work on the higher risk/higher return new-to-the-world products until they prove they can handle to lower risk and less-complicated line extensions and cost reductions.

Skills for Career Advancement

Students should understand that successful careers in engineering require not just technical skills but excellent interpersonal, communication, and team skills. In many companies, an engineer's project management skills and his/her ability to *get products out the door* is the key to early career advancement. Effective project managers not only understand how to create and use a project schedule, manage tradeoffs between scope, schedule, and resources, and manage risk but they must also be proficient at negotiating with and motivating team members and support staff and communicating with team members and upper management. Advancement into and through the management ranks is aided more by an engineer's interpersonal, administrative, and planning skills and less by his/her technical skills. As an engineer advances up the management ladder, technical skills become less important. Many engineers

Winners of BMEidea

The winners of this year's BMEidea national student design competition were announced during the Medical Design Excellence Awards industry awards ceremony in New York in June. BMEidea is in its seventh year and is open to university teams from National Collegiate Inventors and Innovators Alliance (NCIIA) member institutions across the United States.

The competition sponsors include NCIIA, National Science Foundation, Boston Scientific, Medical Device and Diagnostic Industry Magazine, and the Industrial Designers Society of America (IDSA).

The winning entries

- ▼ solve a pressing clinical problem
- ▼ meet technical, economic, legal, and regulatory requirements
- ▼ feature a novel and practical design
- ▼ demonstrate potential for commercialization.

First Place (US\$10,000)

"Magneto: Magnetic Induction Internal Bleed Detector," University of Michigan, Ann Arbor: The Magneto internal bleeding monitor is a portable, noninvasive, autonomous, and cost-effective device for detecting internal bleeding complications after catheterization procedures through the femoral artery.

Second Place (US\$2,500)

"Oculeve," Stanford University: Oculeve is a novel therapy that treats severe dry eyes more effectively and less expensively than do current treatments. It works by inserting a microstimulator at the size of a grain of rice into the lacrimal tear duct by using a needle introducer (similar to a Botox injection). The bead painlessly delivers an electrical current that restores natural tears.

Third Place (US\$1,000)

"OSMOSE," Medtrix Biotech, Purdue University: OSMOSE is a line of antimicrobial dressings for the prevention and treatment of infected wounds. OSMOSE relies on a physical mechanism for eliminating bacteria. It is effective against a wide array of bacteria (including antibiotic resistant strains), promotes healing, and is a low-cost solution in a high-priced field.

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fail to realize that the job of a manager is very different than that of an engineer, and good engineers do not always make good managers.

Importance of the Customer and Meeting Customer Needs

Engineers working in industry must understand that successful businesses create products that meet customer needs. Innovation involves meeting needs in a new and better way. Design validation involves proving that they made the right product (one that meets customer needs). The design process focuses on the customer, and engineers should always keep this in mind.

Identifying New Product Opportunities

Most companies maintain a pipeline of potential new projects from which to choose when deciding which new proj-

ects to fund. Sometimes the pipeline is empty, and engineering personnel work with marketing, sales, and other personnel to identify new product opportunities. Many new engineers feel that this is a marketing function, but, in my opinion, these needs-finding activities represent the initial phase of the design process and thus are within the domain of engineering design. Front-loaded (front-end) design places a heavy emphasis on properly identifying the needs and problems to be solved as well as thoroughly identifying customer needs. I feel that this is the most important phase of the design process. If not done well, companies will either develop new products that solve nonexistent problems or inadequately solve real problems. Owing to time constraints, many senior capstone design courses do not provide students with the opportunity to identify problems on which to base their capstone de-

sign projects. I feel that design curricula should include needs-finding opportunities to prepare students for these activities in the industry.

Working on Truly Multidisciplinary Teams

Most capstone design students learn to work on multidisciplinary teams. Often these teams consist of engineering students of the same discipline. Some teams include students from other engineering or technical disciplines. Other teams may include business and other nontechnical students. Team members are usually close in age, share similar goals, and have similar levels of education. In industry, engineers will work on truly multidisciplinary teams with many nontechnical team members of various ages and nationalities, in different stages of life and with different goals and priorities. Their team members will have different educational backgrounds, levels of education, and work experience; and different cultural and religious backgrounds, political views, perspectives, and opinions. Therefore, their team members will look at problems differently. New engineers must learn to value different approaches to problem solving and work with and respect the diversity of these multidisciplinary teams. They will need to respect what each team member contributes to the project and understand that different ways of viewing a problem can increase the number of potential solutions.

People with industrial experience should think about the things that they wished someone had warned them about or made them aware of. If you are a faculty member, I urge you to share your industry insights and perspectives with your students to better prepare them for their first industry experience. Based on my personal experience, I feel that if they have reasonable expectations, their early career experiences may be more positive. If you have some insights or other realities not listed here that you would like to share with students, please share them with me at jay.goldberg@mu.edu. For details regarding the Biomedical Engineering Innovation, Design, and Entrepreneurship Award (BMEidea) national student design competition, see "Winners of BMEidea."

