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Faculty Internships for Capstone Design Instructors: Maintaining an Up-to-Date Capstone Design Course

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Capstone design courses help prepare students for professional practice. The demands of the workplace are constantly changing, requiring students to be aware of the latest changes and trends affecting the medical device industry such as:

- contemporary issues in biomedical engineering (access to health care, patient safety initiatives, electronic medical records, and product recalls)
- project management (virtual project teams, electronic project notebooks, and new project scheduling software)
- impact of health care delivery systems on design (managed care, insurance reimbursement, and cost containment initiatives)
- new analytical and modeling tools
- changes to industry standards, regulations, and laws (medical device tax, patent reform, and new international standards).

Maintaining a relevant, up-to-date senior capstone design course is the best way of ensuring that students are prepared for professional practice. This requires design

instructors to become familiar with the latest trends described above. There are several resources available to help keep design faculty up-to-date and ensure that capstone design courses present the most current, relevant information to students. These include trade publications, seminars and workshops, input from industry advisory committees, and faculty internships with medical device companies during summers or a sabbatical leave. The first three of these have been discussed elsewhere,¹ so I will focus on faculty internships in this column.

Faculty internships in industry are not new but can be very helpful to design instructors with no industry experience. For instructors with experience, the longer the time spent away from industry, the more things have changed and the more helpful a refresher internship experience can be in helping stay current.

I recently discussed this topic with Dr. Susannah Howe, the design clinic director in the Picker Engineering Program at Smith College, Massachusetts (Figure 1). Her Ph.D. degree is in civil (structural) engineering, and she has more than ten years of experience teaching design and mentoring capstone design teams consisting of general engineering students. Several of the projects in her program have involved medical devices.



Figure 1: Susannah Howe is the design clinic director in the picker engineering program at smith college, where she coordinates and teaches the capstone engineering design course. Her current research focuses on innovations in engineering design education, particularly at the capstone level. She received the B.S.E. degree from Princeton university and the M. eng. and Ph.D. degrees from cornell university.

To help better prepare her students for professional practice, Dr. Howe wanted to gain firsthand experience with the design process in industry. To complement her experience mentoring capstone project teams sponsored by different companies, she decided to pursue an opportunity to work in the industry as an engineer during part of her sabbatical leave. This led to a six-month internship in R&D with Covidien, a leading global health care products company, from September 2013 to February 2014. The following is a summary of my discussion with Dr. Howe.

Q: What was your motivation to work in industry, and what type of opportunity were you seeking?

A: I have had limited industry experience since I followed an academic pathway (Ph.D., postdoc, faculty position), although I have consulted for two local product design firms and worked with many industrial sponsors of capstone design projects. I learned a lot about industry from these experiences but wanted to experience the industry environment firsthand, preferably in a large company. Smith College's engineering program offers a general engineering degree (B. S. degree in engineering science), and I am responsible for capstone projects representing a variety of engineering disciplines. I wanted to learn more about how different disciplines approach design and deal with unique design constraints. I hoped to find an experience that would expose me to multiple engineering disciplines and wanted experience in a heavily regulated industry so I could see how additional constraints impact the design process.

Q: How did you pursue the idea and convince Covidien to create this opportunity?

A: Since I did not want to relocate, I focused on companies located within a commutable distance (90- minute radius). I prepared a short written description of my goals for the sabbatical experience and distributed it to various people in my network (capstone project sponsors, former students, and other industry contacts). The connection with Covidien came through a former guest speaker in my class who passed along my interest to his industry colleagues on a regional university's engineering advisory board. I had several phone calls and in-person interviews with Covidien and quickly realized that the company, and the medical device field in general, would be a very good fit for my goals. The people I spoke with at Covidien were also very interested in this idea of a faculty internship. They recognized it as an innovative approach with several benefits to the company and were willing to try something new. They were interested in building relationships with local academic institutions and establishing a connection with Smith College as a source for student interns and potential employees.

Q: What kind of work did you do for Covidien?

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A: I was part of a project team working on the design and development of devices for laparoscopic surgery. I can't talk about the specifics, but the project is a multiphase, multiyear endeavor that involves a family of devices, so I got to experience almost all aspects of the product design process. I did not have an exclusive role on the project team due to my short, six-month assignment' but contributed to different areas of the project where needed, particularly the development engineering tasks.

Q: Did you have any difficulties in working in a field in which you had no previous experience?

A: Although my background is structural engineering, I have been teaching engineering design broadly for the past ten years but largely in an academic setting. When I began working at Covidien, my experience was mainly with early-stage design, but I wanted my students to be aware of the entire design process and expand my own knowledge of design, development, transfer to production, and commercialization. This required that I learn about some new areas such as specific manufacturing processes, design controls, and supplier interactions. I had to get up to speed on basic medical processes and regulatory requirements. This experience reinforced my belief in the importance of knowing the competitive landscape and understanding the needs of customers and stakeholders.

Q: What were some of the adjustments you had to make?

A: I needed to quickly learn a new language consisting of the vocabulary and acronyms that were either company or industry specific, or both. I spent a significant amount of time in the beginning reading standard operating procedures (SOPs) to understand how Covidien worked and what terminology and processes they used. I also had to get used to working in a cubicle environment with no privacy and no door to close. (This actually proved to be beneficial as I was able to interact even more easily with various people in the open cubicle setting than I would have in a private office.) Since work hours in industry are more fixed than in academia, I tried to coordinate my 80-mi commute (each way) to make the most of my time in the office.

Q: What did you learn from your internship, and how will you use it in the classroom when you return?

A: My internship experience validated my opinion of what is important in industry regarding both technical and professional skills and what students should be learning in their capstone course to prepare. I plan to transfer my experiences to my

students by sharing stories and case studies, incorporating real-world examples where relevant, and highlighting industry expectations.

Some of the specific ideas I plan to implement in my class as a result of what I learned during my internship include the following:

- **Industry terminology:** I plan to bring industry vocabulary and terminology into the classroom, and create an awareness of the different functions in a company and how each group contributes. My goal is for students to realize that, as engineers, they will work with colleagues from many different functions and that the complete supply chain involves multiple entities external to the company as well.
- **SOPs:** I like the concept of SOPs and want students to become familiar with them while in college; I plan to incorporate SOPs for course deliverables in capstone design.
- **Revision controls:** Formal revision controls are an important tool in managing projects. I plan to implement revision controls in capstone design by applying them to course deliverables, drawings, and other project documents. This will help students see the connection between early and late design work and provide them with experience with design history files and formalized document control.
- **Traceability matrices:** To connect early and late phases of the design process, I plan to have students use traceability matrices to tie customer needs through the verification and validation phases of their projects.
- **Global companies, financial drivers:** My experience taught me more about how global companies operate, regulatory requirements for foreign approvals, needs of foreign markets, and foreign production. I plan to emphasize the importance of financial drivers and market positioning within product design.

Q: What suggestions do you have for faculty who would like to participate in a similar faculty internship?

A: Here are a few of my suggestions:

- Go in with open mind, ears, and eyes, and be willing absorb and learn from each experience.
- Try to strike a balance between individual project work and interfacing with other people and other functions. Attending meetings can be a great way to see different aspects of a project.
- Every week, find at least one new person to speak with about their job, including suppliers and outside vendors.

- Provide value to your employer, and be willing to take on a variety of tasks as needed. Even seemingly mundane tasks can be a learning opportunity.
- Be aware that it is difficult to unplug completely from one's academic institution during a sabbatical leave. Try to allow time for both predictable and unforeseen academic responsibilities such as ongoing research projects' letters of recommendation, peer reviewing, etc.
- Seek training and education opportunities that the company is offering or for which it is willing to pay. (I attended a workshop on U.S. Food and Drug Administration design controls, for example, that was excellent.)

The Company's Perspective

Faculty internships cannot be one sided; they need to benefit the sponsoring company as well as the faculty participant. I recently spoke with Gene Stellon, vice president R&D, General Surgical Products, at Covidien, regarding the faculty internship Dr. Howe completed in his department.

Q: What was Covidien's motivation for moving forward with this faculty internship?

A: Our R&D group has always had good relationships with local universities, and we typically hire close to 40 interns each year from these schools. The students get real-world project experience, and we get personnel to work on our project teams. We also create a pool of qualified candidates for employment after graduation; however, new graduates typically have difficulty making the transition from academia to industry. We recognized the value in helping a faculty member obtain real-world industry experience, which could be translated to students in the classroom. We saw this as another way to better prepare students for the transition.

Q: How did Covidien benefit from this experience?

A: With any faculty internship, there is a risk of investing our time to train a new team member with no return in the form of productive contributions to the project. To reduce this risk, expectations were discussed and well defined at the start of the internship. We matched Dr. Howe's needs with that of the company by assigning her to a project team that needed assistance and would provide opportunities for her to learn about the design process for medical devices.

The result was a positive return on investment. Because of her work ethic, desire to learn, and positive attitude, the company benefitted from Dr. Howe's contributions to the project and team. As an educator, she understood the value of the faculty internship as a learning opportunity and used her teaching skills to help team members learn from her experience as a design instructor. We feel that this

experience allowed us, as a company, to contribute to the education of future engineers in a unique way. It was a great experience for all involved, and we would consider sponsoring another faculty internship at Covidien.

Benefits of Faculty Internships

It is clear that faculty internships in the medical device industry can provide several benefits to capstone design instructors. They allow faculty to experience the industry environment, improve their understanding of the design process used in the industry, and obtain an industry perspective of design and new product development. They also help capstone design instructors better prepare their students for careers in the medical device industry by keeping current regarding the latest changes and trends in the medical device industry, which helps in maintaining an up-to-date, relevant biomedical engineering capstone design course.

Faculty internships can also provide benefits to sponsoring companies. When proposing an idea for an internship experience to a medical device company, faculty should emphasize the value of the experience to the company. Many companies are interested in helping improve engineering education, but they need to see a benefit to their organization before they will approve a faculty internship.

If you have any questions or comments regarding faculty internships, you may contact Dr. Susannah Howe at showe@smith.edu or me at jay.goldberg@mu.edu.

References

- 1J. R. Goldberg, "Maintaining a relevant up-to-date capstone design course" in *Capstone Design Courses Part II: Preparing Biomedical Engineers for the Real World.*, Morgan & Claypool, pp. 55-57, 2012.