



## Industry Immersion: The Impacts of a Sabbatical Deep-Dive

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## Abstract

Sabbatical experiences provide an opportunity for faculty to immerse themselves in current scholarship, to explore new areas of research, and/or to pursue professional development. This paper reports on one capstone design instructor's experiences during a year-long sabbatical in industry. The author spent six months working as part of an engineering team at one company, and then spent four months on short visits to 24 engineering companies across the country to gain an inside look into a variety of engineering disciplines, multiple approaches to engineering design, and different workplace environments. This paper shares feedback from companies regarding important skills for entry-level employees. The paper describes how the sabbatical experience impacted the author's approach to teaching the capstone design course, and modifications the author made to the course as a result. In addition, the paper discusses the process for coordinating such short visits and recommendations for pursuing a similar sabbatical experience.

## Introduction

Sabbatical experiences provide an opportunity for faculty to immerse themselves in current scholarship, to explore new areas of research, and/or to pursue professional development. For capstone design instructors, many of whom coordinate projects with industry sponsors, a logical option for sabbatical is to spend it in industry. This option is particularly attractive and useful for faculty members who have followed the standard academic pathway and have not previously worked as practicing engineers.

The engineering literature is surprisingly sparse on faculty sabbaticals, and what literature exists focuses more on the use of sabbaticals for research endeavors, teaching opportunities, or international experiences. A few papers, however, report on faculty sabbaticals in industry, extolling their virtues for reinvigorating teaching, collecting current and relevant examples for students, connecting with current practice, and extending one's network.<sup>1-4</sup> In some cases, enterprising faculty coordinated their own industry-based sabbaticals, such as Richard Goff's experience spending a semester at Harley-Davidson in Milwaukee.<sup>5</sup> In other cases, institutions such as Middle Tennessee State University have implemented faculty internship programs in industry to facilitate applied professional development for their faculty.<sup>6</sup> The author of this paper organized a multi-faceted industry immersion experience for herself to expand her own knowledge and inform her teaching.

## Background and Motivation

The author of this paper coordinates and teaches the capstone design course at Smith College, a role she has had since the first year of the course in 2003. During that time, she has worked with capstone design students on 80 projects in collaboration with more than 35 sponsoring organizations. Her academic background is in civil engineering, but she teaches engineering

design across disciplines in the capstone design course, in keeping with Smith's general engineering degree (B.S. in Engineering Science). She followed a primarily academic pathway in her career (M.Eng., Ph.D., post-doc, faculty), joining Smith without having worked in industry. As a result, she has developed her applied engineering skills across disciplines during her time at Smith through involvement in the numerous capstone design projects, interaction with liaisons from multiple sponsor companies/organizations, and a small amount of consulting for local companies during the summers.

Given the prevalence of capstone design projects sponsored by industry and government,<sup>7</sup> an understanding of current industry practices is an important attribute for capstone design instructors. As such, when the opportunity for a sabbatical became available, the author jumped on the chance to pursue an industry "deep-dive", to strengthen her connections with and knowledge of industry and to enhance her teaching. Through conversations with multiple contacts in industry, the author recognized that she would likely need at least four to six months (and perhaps longer, depending on the company) to immerse herself in the company. On the other hand, the author was reluctant to limit herself to a single company for the whole sabbatical; rather, she desired to gain exposure to a wide range of industries and engineering design approaches given Smith's general engineering degree and capstone design projects that span multiple engineering disciplines. From previous experience implementing a "job shadow" program in which undergraduate students shadowed a practicing engineer for a day,<sup>8</sup> the author knew that short visits could be very powerful and informative despite their limited duration. The author therefore decided on a hybrid sabbatical model that combined one longer placement and a number of short visits, thus ensuring both deep-dive and broad exposure.

### **Sabbatical Planning**

The first step in coordinating the year-long sabbatical, as discussed above, was determining the general structure: in this case, one faculty internship placement for four to six months at one company (for depth) and multiple short visits (one to three days each) to a wide range of companies (for breadth). Having established this framework about a year in advance of the sabbatical, the author prepared a cover letter explaining her role at Smith and technical background, her goals for the sabbatical, and how companies could benefit (versatile employee, fresh perspective on company design process, connections with Smith students/graduates) from hosting her for either a short visit or a longer experience. The author also condensed her academic CV into a one-page resume, in keeping with industry expectations.

While the author could have looked for the four-to-six month placement at companies connected with her technical background (structural engineering), she specifically steered away from that path, seeking instead companies in other disciplines so as to enhance her knowledge and experience. Moreover, in an effort to expand her network, neither did the author seek opportunities at any of the companies that had previously sponsored a capstone design project at Smith. To identify opportunities for both the longer faculty internship and the short visits, the author reached out to her network of engineering alumni from Smith, previous guest speakers in the capstone course, and other professional contacts. In most cases, the author described her plan

and attached the cover letter and resume. The author did not intend to relocate for the faculty internship, so limited the search to a 100-mile radius.

The author had discussions and interviews for several internship opportunities in advance of the sabbatical, ultimately signing with Covidien, a medical device company. The reasons for selecting Covidien included the opportunity to experience a highly regulated environment (FDA), the range of disciplines represented (mechanical, materials, biomedical, electrical, manufacturing, etc.), the compelling nature of the products and the healthcare industry in general, and the company's interest in piloting such a faculty internship in their R&D facilities. The author agreed to Covidien's suggested duration of six months, but limited the position to four days per week, reserving one day each week for ongoing research projects and other lingering responsibilities at Smith. Given the timing of the specific project on which the author was to work, both parties agreed the internship should start in early September and run through February. The author also negotiated for compensation while at Covidien, an important complement to the one-semester sabbatical pay from Smith.

In parallel with the faculty internship search, the author also solicited opportunities for shorter visits, offering in exchange connections with Smith students, graduates, and faculty. Companies were quite receptive to the short visit idea, especially those at which the author had a personal contact such as a former student. The author consistently noted her willingness to sign a non-disclosure agreement (NDA), and emphasized her goal of gaining a window into current practice rather than conducting specific research at the company. The author secured multiple visit opportunities prior to the sabbatical, but finalized the timing of the visits only once the six-month position at Covidien had been established, since that longer commitment ultimately dictated the schedule. The author continued networking for springtime short visit opportunities while working at Covidien, generating a growing list of options. In contrast to the longer-term faculty internship, the author did not limit the locations for the short visits, agreeing to travel to various places across the country. When possible, the author scheduled multiple short visits in a single location, especially for those locations that required airplane travel (San Francisco, Seattle, Denver).

### **Sabbatical Experiences**

At Covidien, the author worked for six months with an engineering team on the design and development of devices for laparoscopic surgery. The project is an (ongoing) multi-year endeavor with Covidien to update and streamline a product family; the work is divided by product category into four main phases, each of which spans the product development cycle from initial design to development to transfer and commercialization. The author interacted regularly with collaborators from development engineering, design engineering, operations, manufacturing and materials, quality, procurement, supply chain, marketing, project management, regulatory affairs, and legal affairs. The author met with suppliers and visited several supplier facilities to see their work in progress. As a bonus, the author participated in a three-day short course on the FDA Design Control process as well.

Logistically, the hardest part of the Covidien internship was the commute, for Covidien is located 80 miles south of the author's home near Smith in Northampton, MA. Most weeks, the author would work two days in a row, staying overnight with in-laws nearby Covidien, telecommute on the third day, and drive down/back on the fourth day. The author thus experienced both the cubicle environment and the telecommuting approach. For more details about this deep-dive experience, see the IEEE *Pulse* column on faculty internships for which the author was interviewed.<sup>9</sup>

Following that single-company experience, the author then spent four months on short visits (one to three days each) to 24 engineering companies across the country to gain an inside look into a variety of engineering disciplines, multiple approaches to engineering design and project management, and different workplace environments. The complete list of companies, plus primary engineering discipline(s) and location, is detailed in Table 1. The author covered her travel expenses from research funding she had been saving at Smith for this purpose. The author signed NDAs for all companies who requested, about half of the total short visits.

Table 1 - Company List for Sabbatical Short Visits (Spring/Summer 2014)

<b>Company</b>	<b>Engineering Discipline</b>	<b>Location</b>
Analytical Methods	Aerospace	Seattle, WA
BETH	Biomedical, Entrepreneurial	Boston, MA
Boeing	Aerospace, Mechanical	Everett, WA
Bolt	Technology, Entrepreneurial	Boston, MA
Cirtec	Biomedical	Longmeadow, MA
Covidien (CO)	Biomedical	Boulder, CO
Evoqua Water Technologies	Chemical, Electrical	Lowell, MA
Fiat Chrysler Automobiles	Automotive, Innovation	Auburn Hills, MI
GE Global Research	Materials, Mechanical, Electrical, Chemical, Biological	Niskayuna, NY
Glumac	Mechanical	San Francisco, CA
Hart Crowser	Environmental, Geotechnical	Seattle, WA
HeartFlow	Biomedical, Entrepreneurial	Redwood City, CA
IDEO	Product Design, Innovation	Cambridge, MA
KL&A	Structural	Golden, CO
Kuvée	Product Design, Entrepreneurial	Boston, MA
Leonard Rice Engineers	Environmental, Water Resources	Denver, CO
LOCI	Mechanical, Geotechnical, Entrepreneurial	Boston, MA
Microsoft	Product Design	Redmond, WA
Pacific Gas and Electric	Electrical	San Francisco, CA
Pavlok	Product Design	Boston, MA
Schneider Electric	Mechanical, Electrical	Foxboro, MA
Sikorsky	Aerospace, Mechanical	New Haven, CT
Tesla Motors	Automotive	Fremont, CA
TriPyramid	Structural, Mechanical	Westford, MA

Most of the short visits were a full day, some up to three days. The author had a single contact person at each visit destination, but in nearly all cases interacted with at least several people during the visit. In general, the short visits included a combination of meetings with multiple employees, facility tours, and opportunities to shadow people in their daily tasks. The author experienced a wide range of approaches to engineering design (few industries are as heavily regulated as the medical device industry) and many different styles of engineering project/workplace management. At every visit, the author also solicited input on what skills engineering students should learn in college, especially during their capstone design experience, to be prepared to be effective entry-level engineering employees.

### **Impacts on Teaching and Advising**

The capstone design students at Smith are direct beneficiaries of the author's sabbatical experience because the author returned to Smith with a wealth of new ideas to implement in her capstone design course. Pedagogically, the author is now teaching a more structured version of the design process that is better aligned with industry practices and emphasizes transparency and justification. Particular elements that have been added include stage-gate design reviews and a traceability matrix for design process documentation. To engage students beyond their own project, the author has piloted the concept of "shadow teams", in which students follow a second project throughout its development, serving as external reviewers for their peers. The author has reframed all of the assignments for the course in the format of Standard Operating Procedures (SOPs) to prepare students for what many of them will encounter in industrial settings after they graduate. In addition, the author has introduced a revision control system for formal documentation, in keeping with industry standards. Initial student feedback to these new course components has been positive. An assessment specialist from Smith's teaching and learning center conducted a mid-course assessment with the capstone design students at the end of the fall semester following the author's sabbatical and reported the following in her report to the author:

*Your students had many positive comments about the SOPs, Design Reviews, and Shadow Projects that you have included in the course content, all new course elements inspired by your sabbatical last year in the engineering field. The students believe these elements enhance their understanding of what will be required of them as engineers and allow them to develop real-world skills.*

The many connections with people and companies that the author made on her sabbatical have dramatically increased her network and that of the capstone design course overall. In particular, three of the six design projects in the course this year are with new sponsors based on the sabbatical visits. The author has several other leads for projects in future years from similar visits, in addition to a host of potential options for student internships and employment opportunities, and a number of enthusiastic and willing guest speakers. The author has already hosted two guest speakers from one company this fall who led an innovation workshop in the capstone design course. She has similar visits planned this spring for speakers from two other companies to discuss design case studies and technology commercialization, plus an additional three speakers for short "career spotlights" via videoconference. As a bonus for alumni relations,

the author reconnected with 18 Smith engineering alumni during these short visits and had the opportunity to see them thriving in their current workplaces, successfully leveraging their Smith education. Many of the companies that the author visited have the potential for internship/job opportunities for Smith students/graduates; the author's personal connection with people at the companies will undoubtedly assist in such placements.

More informally, the author has been able to enhance many capstone class sessions and team project meetings with vignettes from her sabbatical experiences, providing additional meaning and relevance to the material at hand. From some of her visits, the author can discuss specific design projects that companies are pursuing, thus providing students with a window into current engineering initiatives. For those companies with NDA restrictions, the author cannot share project details, but can describe differences in design strategies, meeting styles, and project management approaches across companies, particularly contrasting product development with consulting engineering. The author's exposure to a wide range of companies also informs her advisory conversations with students seeking internships and jobs; the author can provide current and varied examples of work environments, corporate schedules, company hierarchies, commuting practices, and other characteristics of professional experiences.

### **Skills for Entry-Level Employees**

At many short visits, the author solicited input on skills that companies seek in entry-level employees and/or what skill students should learn in college, particularly during capstone design, to be prepared for employment after graduation. The author specifically did not structure this inquiry as a formal research project, opting instead for informal conversations with individuals or groups about their needs and suggestions. As the author had expected, multiple people either explicitly or implicitly responded with their expectation of a solid technical foundation, including both depth and breadth. In addition, a number of people strongly advocated for hands-on and applied experience in addition to exposure to manufacturing. Some people mentioned specific technical skills, such as facility with particular software programs or knowledge of statistics. The majority of comments addressed broadly applicable professional skills, with a particular emphasis on communication and teamwork. The underlying theme across the companies, aptly stated by one respondent, was that "all the skills beyond technical are equally or more important."

The author collated all the comments from 47 discussions at 18 different companies and matched each distinct comment with a single representative word (or hyphenated word phrase). Figure 1 depicts a word cloud from these representative words in which word size reflects frequency.





and expand one's horizons. The author especially enjoyed learning about the medical device industry, something quite unrelated to her previous background in structural engineering.

- Share insights with students. Industry-based knowledge and experiences are a rich addition to the classroom. In the author's experience, students welcome applied examples, seek insights into current practice, and hunger for a window into the world they will enter after graduation.
- Don't wait for sabbatical. The author originally thought that she would wait until her next sabbatical to continue the industry immersion, but she found that the single day visits provide substantial value in limited time, and required very little overhead to coordinate. Accordingly, the author plans to conduct a few short visits every year to experience more companies and remain current regarding industry practices.

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