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ENGINEERING
to Engineering Practice
EDUCATION

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Faculty in Industry: A Personal Perspective

Avery H. Demond

Why a Leave in Industry

Much has been written about the benefits to engineering education that can result from the development of closer ties with industry. In fact, the National Research Council's Board on Engineering Education (on which I served for 4 years) sees it as a key part of the process of revitalizing undergraduate engineering education (NRC 1995). Many of the innovative undergraduate curricula funded by the National Science Foundation, such as Engineering Coalition of Schools for Excellence in Education and Leadership (ECSEL), emphasize greater ties to industry.

Closer contact with industry can benefit students, faculty, and the university as a whole. For students, it may mean more opportunities to obtain co-op internships, summer and permanent jobs. Participation in co-ops often translates into higher rates of graduation because of the increase in motivation level of the students (Meade 1992b). Exposure to the problems faced by industry may result in the development of research programs by faculty geared towards the resolution of these problems. If industry perceives a direct benefit to be gained, they may be more willing to provide research grants, or enter into joint research ventures. Curricular innovations may also result from closer contact between industry and the university. Short courses may be developed by the university with an industry's needs in mind, simultaneously addressing companies' need to remain competitive through career-long learning (Girard and Kachhal 1993) and providing a source of revenue for the university. Case studies and design projects are compelling education tools (Fitzgerald 1995) which can evolve from becoming familiar with a particular company's experience.

The benefits cited above are just a sampling of those commonly given in support of a university's development of closer ties with industry. What is discussed far less often is its potential role in faculty development. How does the university insure the technical currency of a faculty member throughout his or her career? It seems that the prevailing thought is that this occurs by participating in research. But in many instances, pursuing research means staying current in a very narrow, perhaps esoteric and theoretical field. Research does not ensure the currency of industrial literacy or, the development of what Boyer (1991) referred to as "the scholarship of application." Universities seem hard-pressed to move towards a new definition of the professoriate that includes more than the "scholarship of discovery" (Meade 1992a) and have yet to tackle the issue of deliberate planning of the professional development of faculty (Anderson 1985).

Given the general acceptance of the notion that engineering education can benefit from a greater interaction with industry, the question then is how can this be accomplished? One of the most often cited means of injecting "practice" into the university environment is by hiring practitioners as adjunct faculty (Nord 1989; Kovac and Augustine 1992). By doing this, two needs may be met simultaneously: students obtain exposure to "real life" and the university fills short-term faculty openings (Locke 1989). But this approach presents a number of problems. First is the question of funding. Generally, the university cannot meet industry salaries. Thus, the university is asking the practitioner take a cut in pay, to work *pro bono*, or for his employer to subsidize the arrangement. The industry engineer who taught the undergraduate course (CEE 280 Introduction to Environmental Engineering) while I took a leave of absence to work in industry estimated that he earned less than $2.50 per hour based on the number of hours he put in and the department's compensation. Second is the question of course content. Unless the practicing engineer is hired to teach an elective, certain material must be covered. There is no guarantee that it will, in fact, be covered. When CEE 280 was taught by this adjunct, he was provided with a syllabus, textbook, lecture notes, and problem sets with answers. He chose not to use this material but to focus the course on his industrial experience. The students discussed a number of case studies illustrating the realities of engineering practice, but they did not learn the concept of mass balances. Unfortunately, in a number of subsequent courses in the Environmental and Water Resources Engineering (EWRE) curriculum at The University of Michigan, it is assumed that students learned mass balances in CEE 280 and the students who missed this material were at a decided disadvantage. Lastly, lasting systemic changes did not occur. The contact with the practicing engineer may have impacted the viewpoint of the students in that class, but there is no impact on future classes of students since the class continues to be taught with its original focus.

Alternatively, those at the university may enter practice. Students can do so through co-ops or summer jobs. The evidence (most of it is anecdotal) shows that such an experience allows a student to make the connection between the classroom and the workplace (Meade 1992b). But the impact of that experience is not felt beyond that particular student. To ensure that all students have some exposure to engineering practice, it would help if the faculty had relevant industrial experience. Some faculty come to academics from industry. For them, the question becomes one of ensuring that their industrial literacy remains current. More recently however, the increase in the time necessary to obtain a Ph.D. and the need to establish an active innovative research program to qualify for tenure means that a successful career in academics precludes spending time in industry. For faculty with this sort of background, the question is how to obtain a basic knowledge of industrial practice. How can faculty practice engineering, either to maintain their knowledge of the state of practice, or to gain some industrial exposure? The traditional means by which faculty "practice" is through consulting. Both positive and negative opinions have been voiced about the impact of faculty consulting on university education. Despite its usefulness in achieving technology transfer (Ercolano 1994) and faculty satisfaction (Eisenberg and Galanti 1981), consulting is often viewed as leading to conflicts of interest, conflicts of commitment, and the inappropriate use of university facilities for private gain (Sissom 1986; Ercolano 1994). However, many of the problems associated with part-time consulting could be resolved by a faculty member's spending a sabbatical in industry. In this scenario, the faculty would be a full-time employee of a particular company, working on the company's premises, thereby obviating issues of commitment and proper use of facilities.

Logistics of Industrial Leaves

Although a university may derive considerable benefits from a faculty spending time in industry, Kovac and Augustine (1992) note industrial sabbaticals are virtually nonexistent. The question then is why? There are problems associated with any sabbatical or leave of absence. Who will teach your courses? Advise your students? Run your research grants? If one is leaving the area, additional questions arise. Where will you live? Where will your children go to school? What are we taking with us and what are we leaving behind? But problems such as these are routinely resolve with traditional sabbaticals. There is one additional hurdle not commonly associated with traditional sabbaticals and that is the perceived value of a sabbatical in industry in the current faculty reward structure. Unless one's status in the research community is enhanced, the experience is seen as having little value, particularly with regard to tenure and promotion. When I announced my plans to spend a year in industry, I was eventually permitted to go, but many questioned the wisdom of the decision saying that I was jeopardizing my career. The question that was posed to me when I returned from my leave in industry was how many papers had I published?

Perhaps the other hurdle is that it is not clear how to make proper administrative arrangements. Since, as an untenured faculty, I was not eligible for sabbatical, I took a leave of absence from the university. It was designated a "personal leave," a category usually reserved for family emergencies, because the other choices were military service or government office. I could continue to have benefits through the university, with the exception of retirement. The difference was I had to pay for them myself. I resolved this, in part, by becoming a dependent on my husband's health and dental insurance. Thus, I was left paying for just life insurance and disability. To find an employer, I called my friends in industry. I peddled myself as an unusually capable entry-level (given my lack of industrial experience) engineer. I would work hourly with no benefits. In anticipation of spending a year in industry, I had taken the 40-hour course for Hazardous Waste Operations and Emergency Response (HAZWOPER) certification so that I already had the minimum qualifications for access to hazardous waste sites. The biggest question prospective employers asked was, "what would I do?" to which I replied, "what do you need to have done?" I accepted the offer from Geomatrix Consultants, San Francisco, CA. This firm is about 12 years old now, specializes in environmental and geotechnical consulting with about 150 employees, distributed between its main office in San Francisco and additional offices in Southern California and Sacramento.

Industrial Experience

I worked at Geomatrix for 9 1/2 months, September 1994 through mid June 1995. In all, I worked on 17 different projects, billing time to as many as 7 or 8 in a given week. Many of the assignments I received involved mostly library research with some calculations. For example, at one site groundwater needed to be withdrawn at a rate of about 2 gallons per minute to keep the water table below the zone of contamination. The question was posed whether that should be accomplished with a well, in which case provisions had to be made for the disposal of the withdrawn water. Or could this be accomplished by planting trees and if so, what type and how many trees were needed? My task was to answer that question. Off I went to the library to look for typical evapotranspiration rates for trees that were somewhat salt tolerant since they would be growing near San Francisco Bay. I also looked for pan evaporation, wind, solar insolation, and soil data in an effort to answer that question. After I picked out several types of trees which I thought were suitable, I called commercial nurseries recommended to me by a friend in the landscaping business to see what their opinion was of my choices, to get information on maintenance, and to get prices. The only question I had difficulty resolving was whether or not the type of tree selected could tolerate the levels of arsenic that were present at the site.

Most of the projects I worked on had little to do with my expertise in subsurface organic liquid movement. I designed air-stripping towers (in series to blend in with a residential setting; operated at elevated temperatures for the removal of acetone) and wrote protocol documents so that junior engineers could do likewise. I designed carbon adsorption units to treat vapors from air stripping towers. I developed a spreadsheet to allow them to calculate competitive sorption of one organic compound in the presence of water vapor, or in the presence of additional organic compounds (up to 9 compounds). Using this program, I demonstrated to them that it was generally more economic to elevate the temperature of off-gas from air stripping towers to lower the relative humidity than to passing it over carbon adsorption beds directly. I wrote reports summarizing the treatment technology options for the removal of dilute hexavalent chromium and trichloroethylene (TCE) from groundwater.

I guess the biggest stir I created was a report I wrote comparing the characteristics of a client's site contaminated with TCE with other sites contaminated with TCE. It was based on the report issued by National Research Council, "Alternatives for Ground Water Cleanup" (NRC 1994). I was a reviewer of the report and so I was aware of it, but it had not yet reached the general attention of the consulting community. Based on the comparison between the client's and other TCE-contaminated sites, I concluded that the remedial action plan for the target site, which was based primarily on pump and treat, would never achieve the clean-up goals (set at a TCE concentration of 5 micrograms/L), and could only serve to contain the central mass of the plume.

Benefits

I enjoyed my time at Geomatrix. I enjoyed working with professionals. I enjoyed working in an organization where workloads are adjusted to achieve a reasonable work week. I enjoyed working in an organization where if your computer was acting up, another was on your desk within an hour or two! I enjoyed working in an organization which appreciated my efforts. Although I did not increase my technical knowledge in the subject areas that I teach or do research in, I did learn things that are less tangible. The experience affirmed my conviction that what I was teaching students was appropriate; that the concepts and problem-solving strategies we covered in class would help them in engineering practice. (If only they could remember what we discussed after the conclusion of the semester!) I altered my approach somewhat to emphasize the integration of concepts. Students in CEE 280 now receive homework in which they essentially have to go through the calculations necessary for the filing of an air emissions permit for a vacuum extraction/combustion engine that is to be installed to remediate a subsurface gasoline spills. This problem requires them to combine information covered in different sections of the course:

emissions factors, dispersion of air-borne contaminants, and health risks from inhalation of carcinogens. Based on the feedback, I discovered that this integrative approach causes general panic. Many students said they had thought they knew what was going on in the course, but apparently they did not. Others (the good students) said it caused them to pause and think. Since any real-life problem will require pulling information from a number of sources, the students need to learn this skill. My graduate level class, CEE 593 Environmental Soil Physics, has always emphasized analytic solutions to subsurface transport equations, with the thought that time is often critical and ball-park answers are frequently all that are needed in engineering practice. My experience at Geomatrix affirmed that approach. Now, in addition, the students receive problems in which data are very limited, since this situation seems to be the rule rather than the exception. For example, "What is the inhalation exposure to a worker walking on the soil surface at a site in Ann Arbor, Michigan where there is rumored to be a subsurface spill of TCE?" (This is the complete problem statement.)

The experience also stimulated me to become a licensed professional engineer. Blueprints and many other documents had to be signed off on by either licensed engineers or geologists. It was apparent that status in the company was based, to some extent, on the number and types of certification one had. I also realized that obtaining licensure could increase the value of my having spent time in industry in the eyes of my some of my colleagues.

Conclusion

Taking a leave to work in industry is one of a number of means that closer ties between industry and academics can be achieved. Although industrial leaves appear to be fairly uncommon, they resolve a number of the problems associated with the hiring of practitioners as faculty or part-time consulting by faculty as methods of introducing practice into the engineering curriculum. The major obstacle to faculty spending time in industry is the perceived lack of value towards one's career. With changes in the faculty reward status imminent (Meade 1992a; NRC 1995), perhaps the spending time in industry as a means of developing one's "scholarship of application" will become more acceptable. Certainly, with the increased downsizing and outsourcing that is being practiced by many American companies, the skills of faculty can be put to use in the workplace!

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