The Engineer as a Professor:
Bringing Experience to the Engineering Classroom

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Abstract
Relevant examples from industry can be beneficial in the engineering classroom. Real life stories and examples from experienced professionals can be used to help explain an issue and to demonstrate how theory is applied in real cases. Traditional students often like to get an idea of what the working world is like, and working students often relate to the experiences. Several examples from industry are discussed, along with how these can improve the quality of education in the classroom. Methods of obtaining business experience are also offered.

Introduction
Many university instructors have long careers in academia. Some of these instructors have had contact with industrial companies in the form of research projects, grants, internships, and various other forms of work. All of these can be beneficial to the quality of teaching in the engineering classroom. Many adjuncts and a few full time faculty members bring significant experience to the classroom. Some universities find value in this experience and seek out experienced professionals for their faculty. Many universities find little value in "real world" experience, preferring people who focus almost exclusively on academic research. I happen to be one of those people who changed careers, entering academia after spending 27 years in engineering and engineering management positions.

Stories from the business world can be used to demonstrate how theory plays out in the real world. These stories help students understand that classroom concepts really can be used to solve problems, overcome obstacles, and improve chances of success in the business world. Students who have no work experience usually want to know what the real working world is like. Experienced students, many of whom are working full time and going to school part time, also enjoy the stories; they find that they are not the only ones facing some of the same crazy situations. I have learned that most experienced students prefer experienced teachers, no matter what the educational level of the instructor.

Example 1. NyQuil LiquiCaps
The development and launch of NyQuil LiquiCaps works as a good story on several levels. The product was test marketed during the cold and flu season of 1990-91 and launched nationally in the fall of 1991.

The launch of a new product can be used as an example of project management. Here we have a new product idea that had not been done before. Several organizations were needed (Manufacturing, R&D, Marketing, Finance, a contract manufacturer, Distribution, Sales, and others), all having a vested interest in the success of the project. No one organization could successfully execute the project alone. There was a clear timeline, a clear budget, and a clear definition of quality and customer satisfaction. At the time of the test market, only two manufacturing batches had ever been made; the process was not yet validated and the manufacturer had not yet been proven. Risk abounded. As a project manager, my task was clear: get 50% of the expected first year sales volume into the company's distribution warehouses by July 1, with good quality, under budget, and ready to ship. I had six months. The NyQuil LiquiCaps launch works especially well as a project management example because it is a new product in a course where construction examples are everywhere. Most students can identify with the product because it has now been successful for over 16 years.

The NyQuil LiquiCaps story also works as a product management and a strategic management story. If we back up about 2 years before the launch, the issue becomes one of how the firm might grow the sales

of the NyQuil brand, leveraging product strengths, overcoming product weaknesses, and leveraging opportunities that are present in the industry's environment. Issues such as "product concept" and "strategy" become more clear.

Three major goal areas need to be met in any project: cost, schedule, and customer satisfaction. The NyQuil LiquiCaps project accomplished all three. More than the required quantity of product was in the warehouses on July 1, and all of it was of good quality. Customer service to customers was good because there were no delays in product availability; the launch schedule was met. The product received excellent acceptance by the trade, and sold quite well to consumers. The budget was met, and profit was achieved in the first year of sale.

Example 2: Threatened Picket

The Bayer facility in West Haven, Connecticut was going through a period of expansion. There was a new administration building, several significant manufacturing projects, and a new R&D building planned. Bayer used a variety of contractors in these construction projects, and employed both union and non-union contractors. One particular electrical contractor (a union shop) had been awarded jobs for several consecutive projects. A different electrical contractor (non-union) was chosen for a new manufacturing project, primarily because we wanted to keep more than one qualified supplier available. We were "spreading the wealth." The union contractor lost the bid.

A few days later, the construction manager received word that the International Brotherhood of Electrical Workers (IBEW) was considering putting up a picket at our contractor entrance because a non-union supplier had been awarded the job. Like most industrial locations, suppliers had an entrance separate from the employees' entrance. The IBEW could not picket the employee's entrance, but could disrupt construction and other activities at the site. This needed to be resolved immediately.

The construction manager arranged to meet the union representative at a nearby bar, and have a talk over a beer. Of the various options, the construction manager chose his strategy: if there were no picket, then there would be a good chance that the union electrical contractor would get business in the future. There will be work in the future, and that specific contractor and his electricians were highly regarded. However, if there were to be a picket, then no union electrical contractor would be chosen in the future, and the IBEW would be guaranteeing a loss of future work for their people.

The union decided against the picket. The union electrical contractor was later awarded a job, where the customer was very pleased with the quality of the work.

Every story needs a moral. In management, project management, or leadership courses, students are often told that tough decisions need to be made, often very quickly. It's often not clear what decision is best, but quick, decisive action is often needed. The IBEW story is used to reinforce this idea, and is presented with the problem, asking what students would do. Young, inexperienced students usually have a very different recommendation than older, more experienced people.

Stories are often remembered longer than the written theory behind it. If students can remember the story, they remember the message that goes along with it. Education takes root and stays with the student better in this way.

Example 3: DayQuil LiquiCaps Startup

In 1992, one year after the startup of NyQuil LiquiCaps, the startup of DayQuil LiquiCaps was begun. The first two batches were made without incident. Routine quality inspection of the third batch revealed a metal contamination: small slivers of what appeared to be stainless steel were inside many of the gelatin

capsules. A day later, the same contamination was found in the fourth batch. Further production was stopped, and I was notified of the problem. Because the issue occurred at a contract manufacturer, it was the contractor's responsibility to identify and correct the problem. I had already planned on being at the plant the following Monday. Some of our R&D people were already at the plant to assist in the startup, and they committed to help in the investigation. I headed to California very early Monday morning with the knowledge that the problem had not been resolved.

There is a fun sideline to this story that I use if there is time: it always keeps everyone's attention. It was winter in southern California, and just like the song, "It never rains in California, but girl, don't they warn ya, it pours, Man it pours."[1] It was pouring. As I drove on I-405 from the LA airport north to the San Fernando Valley, there was heavy rain, terrible traffic, and mudslides. I crested the mountains and headed down into the valley. For the first time ever, I saw a number of military style helicopters flying very low over the highway, right in the middle of a thunderstorm. This really got my attention.

Flood control dams. In the east, we have many flood control dams. Upstream of the dams is a lake, the trapped water behind the dam. But in California, it only rains a few months out of the year, and they don't have enough water to form a lake all year long. So instead, they install golf courses. It was winter, and it was raining, and the golf course behind the flood control dam started filling with water. The golfers played through until the water got so deep that they were trapped. Golfers climbed trees in the middle of the storm to escape the water and those helicopters were literally pulling golfers out of the trees, flying them to safety.

I arrived at the plant about an hour late and walked into the plant looking like a drowned rat. There were phone calls from headquarters, with people desperately yelling that the problem needed to be resolved immediately. Several managers from the plant came to me and threw up their hands, asking what I wanted them to do. Our own R&D people asked the same thing. In the last few days, no progress had been made, and no one knew the source of the metal contamination. We had plenty of willing workers, everyone wanted to get the problem solved, and no one knew what to do. Everyone looked to me to pull a proverbial rabbit out of the hat. I asked for everyone involved, including some of the production technicians, to all meet in the conference room that afternoon.

This was crisis management. First, we were not going to blame anyone; that was not the intent and was not the answer. We needed everyone's input, and I did not care about what position someone had or did not have. We needed facts from whoever had them. In that meeting, the hourly people had the same importance as the Plant Manager (and he agreed).

We needed to separate fact from theory. We needed to clearly understand what we knew, what we thought we knew (which was not the same thing), and what we did not know. I used old-style Kepner-Treqoe troubleshooting tools. We identified time boundaries (when did the problem start and end), space boundaries (where in the production process metal shavings could be and where they were not), and started to identify all of the activities (potential changes) that had occurred since the second batch (which was free of the contamination).

We broke up into small teams to identify inspection records, manufacturing records, and maintenance records. We had small teams of two or three people go out to the production process to disassemble all production equipment for inspection, including those items that were not meant to be inspected.

The first problem identified was a pump that was associated with making the liquid fill that went into the capsule. The inside of the impeller housing was badly scored; there was no written record of when that pump was worked on. This was a possible source of metal shavings, but was not proof. The entire process was torn apart in the next few hours. One of the teams found a strainer below the tank where the

liquid fill was made, just downstream of the suspected pump. The strainer was full of small stainless steel shavings. Some of those shavings were working their way through the mesh of the strainer. We found them. About two hours after the meeting, the problem was identified: the pump had been put together improperly; the impeller was rubbing against the housing, making slivers.

When any process is subjected to such scrutiny, you find essentially every problem and defect that exists. We created a laundry list of issues that needed to be resolved before I would allow the plant to start back up. We lost two weeks which had to be made up over the coming few months, but DayQuil LiquiCaps launched on schedule. The contaminated batches were scrapped.

Back in my undergraduate days in the 1970s, I had one professor that had many years of experience. We didn't like him very much, but he did tell us stories. I don't remember the details of his lectures, but I remember a number of his stories, and so I remember the points he was trying to get across. I even use some of his stories myself. In retrospect, he was probably one of my best teachers.

Stories are fun, but they need to make a point. That point can be a moral, an example of how to do something right, an example of how to do something wrong, or simply an example. Be sure that the point is clear and not confused. Tell the story so that the point will be remembered; humor is a great tool for this. Tell it so that the students can see the theory brought to life, and can use the lesson when they are faced with a similar issue years later.

When should examples be used? Many examples are planned ahead of time, and are inserted into a lecture at an appropriate time. I save particular stories for certain courses, using them at planned times in the semester. Sometimes an idea will pop into my head in the middle of class, and a decision is made on the spot whether to add the story or not. Spontaneous story telling is often a good thing, keeping the class fresh and informal. Care needs to be taken to not go too far off of the current topic of the class.

Ways to bring experience into the classroom

There are two general ways to bring experience to the classroom: either get some experience or bring in guest speakers. Both can be very beneficial to the students.

Guest speakers

Many companies and individuals are happy to participate in guest lectures. During my time teaching project management, I often invited a group from a project management company in a nearby city. Even though I had used stories in the classroom, the fact that practicing engineers were repeating many of the same points I had made brought additional value to the classroom. Most speakers will talk to a class for free, though I usually offer a lunch or dinner as a form of thanks. Contacts with professionals can often be made through your adjunct faculty or through the alumni association.

Obtaining experience

There are three excellent ways that academics can obtain "real world" experience: during sabbaticals, during summer breaks, and through research support. Clearly, the quality of the experience improves as direct contact time with the supporting firm increases.

An associate professor that I know who taught supply chain and operations management spent a six-month sabbatical working at a distribution warehouse of a large retail chain. The experience gave him a different perspective on how business was run, and provided him with many examples for the classroom. His style of teaching changed, as the examples were often used to demonstrate how issues from the textbooks were applied in real life.

I know of several professors who have spent their summers working for either industry or government organizations. While these opportunities appear to be less available than they were in the past, they still offer excellent experience as well as some good income. "Summer internships" are not only available to students; internships provide many of the same benefits to faculty.

Research work can provide excellent experience. Time spent outside of the campus research lab, working on current projects at a firm's facilities, often provides a greater opportunity for experiences that can be brought back to the classroom. Insight gained at an industrial or government research facility offers an academic researcher a different view from that of the campus.

Informal surveys indicate that both domestic and international students prefer faculty members to have experience outside of academia. Part time graduate students who work full time are especially vocal about this. Engineering faculty who have no formal industrial experience are encouraged to obtain experience through sabbaticals, summer internships, or research experiences.

References

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Neal A. Lewis received his doctorate in engineering management in 2004 and B.S. in chemical engineering in 1974 from the University of Missouri – Rolla, and his MBA in 2000 from the University of New Haven. He is an associate professor in the School of Engineering at the University of Bridgeport. He has over 25 years of industrial experience, having worked at Procter & Gamble and Bayer. Prior to UB, he has taught at UMR, UNH, and Marshall University.