

AC 2007-1498: FACULTY WITH INDUSTRIAL EXPERIENCE BRING A REAL WORLD PERSPECTIVE TO ENGINEERING EDUCATION

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Faculty with Industrial Experience Bring a Real World Perspective to Engineering Education

Abstract

This paper addresses the advantages, experiences, and course enrichment that professors with industrial experience bring into the classroom. The two authors, who together represent nearly 50 years of full time engineering practice, discuss how they have presented material to students that allow them to share in those years of practical experience. Engineers that have worked full time in industry and returned to the university to pass on their knowledge and experience bring a depth of real world case studies that they lived through. These practitioners bring an entirely different perspective to the classroom. Although research is valuable, the traditional progression through B.S., M.S., and Ph.D. Degrees directly to teaching should not be the only perspective students receive. The vast majority of students will begin careers in industry after graduation and therefore would benefit from the experience and lessons learned from those who have really encountered the problems while functioning as a full time practicing engineer. The theory is the same but the practical execution and frame of mind are different than that of the researcher.

Today's students need both perspectives if they going to be able to compete in the highly competitive global economy. The student of today needs to be more job ready and know more than just theories if they are to compete for the jobs of tomorrow. Exactly how this unique perspective has helped to shape the curriculum at Eastern Washington University's (EWU) Engineering Technology Programs will be described. Engineers who return to the classroom are also able to relate with industrial partners more easily. They "talk their language" and can therefore help forge additional bonds with industry. Examples of these alliances along with how students and employers have responded to the curriculum changes are also explored. Students have indicated that as a result of including these real world engineering experiences in the curriculum they became more job ready and were actually receiving job offers as a result. Finally the paper will present the authors reflections for the future and how they intend to stay in touch and keep the pulse of a changing industrial landscape.

Introduction

Graduates of engineering programs today are expected to be productive from their first day on the job. This implies a very limited transition period from student to engineer as well as an accelerated learning curve. After all the educational process doesn't end at graduation, but rather it is actually just beginning. For many students this translation process can be an extremely challenging, frustrating, and difficult time. One of the objectives of the educator should be to make this a much more transparent and seamless process. One method to achieve this goal has been successfully utilized. Preparing the students for this conversion can be more readily accomplished when faculty members have actual real world engineering experience.

Typically engineering courses are taught by individuals with extensive academic knowledge but rather limited industrial experience. They are theoretical experts but often lack the practical exposure that is also required to be a successful practicing engineer. Even the assignments, laboratory experiments, and projects reflect this academic slant to their engineering education. Traditionally this is how engineering classes are taught focusing on theoretical solutions to hypothetical problems. The real world engineering perspective is classically absent or minimal at best from the coursework and curriculum. However, the importance of this real world engineering experience cannot be overlooked.

Two seasoned engineering professors in the Engineering & Design (E&D) Department at EWU were determined to bring this practical dimension of engineering education into the classroom. Utilizing a combined total of over 50 years of industrial experience to draw from, actual and realistic problems were incorporated into every aspect of the coursework. Instead of using standard textbook exercises, problems and their associated constraints are drawn from their previous industrial experience in order to reflect more accurately exactly how engineers function on the job. These practical problem solving projects challenge students to perform like practicing engineers as an integral part of their learning experience. The end result is a greatly enhanced real world aspect of their education, while preparing them for their eventual transition into industry.

Value of Industrial Experience

The value of industrial experience in the classroom cannot be overemphasized. Professors with industrial experience bring a different viewpoint and perspective into the classroom. Understanding the theory behind engineering will always be significant and important. However, the importance of their industrial experience is enormous and invaluable as it is shared and used in the classroom. The students are now perceived as engineers in training and treated as such. Excuses are no longer tolerated and results are expected. The harsh realities of the industrial world are imposed in the classroom environment closely reflecting what happens in real life.

The use of real industrial projects changes many aspects of the typical engineering class. The atmosphere of the course is changed from doing routine exercises to attacking, solving, and completing real industrial projects. This occurs in many ways. First, the professor becomes more than just an instructor but an engineering manager as well. Second, constraints are assigned in addition to a simple due date for the project. Third, the product must perform and a customer needs must be satisfied with the end result. Finally, the project may require working on a team in order to complete. All of these aspects, along with many others closely replicates actual engineering work.

The professor is now the engineering manager of the class, or imaginary company, assigning tasks and expecting results. Deadlines are established along with the overall functionality of the deliverable. Exactly how the deliverable will perform the specified functions is determined by the students as part of the project. Planning meetings are scheduled to monitor progress and review the status of the design. When adequate progress is not being made, ways to catch up must be determined by the students since the deadlines cannot be extended. Then depending

upon the scope of the project, either a proof of concept demonstration or a delivery of the finished product is required.

Every project has constraints and the ones assigned in class are no exception. Obviously cost constraints are paramount reflecting the limited availability of resources of all types. Size or dimensional restrictions, weight limitations, and power requirements are established. In many cases, even interface requirements are specified along with operational functionality. Perhaps the biggest constraint is simply the due date or deadline for completion.

Some of the assignments can be successfully completed by the individual. However, many projects require a team effort. This adds another real world aspect to the course since most engineering projects in industry require a team to complete. The ability to function as part of a team performing a variety of tasks is a valuable engineering skill. For some students it comes natural while for others it must be acquired and developed. It is best to overcome these problems in a training exercise rather than a real industrial setting.

Finally the deliverable or end product must satisfy the customer's needs. It must perform and function as specified while meeting all of the other constraints in terms of cost, size, weight, and the like. In many cases, the professor may also act as the customer and a very fussy one at that. In some cases, other professors or an actual customer may review the performance of the finished product. It must be appealing, easy to use, and perform as needed. After all it is the customer that either accepts or rejects the finished result. This is another dimension engineering training tied directly to the real world.

It all relates to experience. Students given the opportunity to solve actual engineering problems in simulated industrial conditions gain exposure to what will be expected of them after they graduate. It is this experience that prepares them for their industrial careers and gives them a head start over other graduates on their first job. This is where the value of industrial experience reflected in the professor's direction and guidance leads.

Integrating Real World Experience into the Classroom

Integrating this industrial knowledge into the classroom experience is really a multi-faceted task. Almost every aspect of the course can include some level of exposure. It is easy to see where laboratory experiments and projects could address industrial applications. However, everything from lectures to class discussions can be affected and enhanced as well.

Perhaps it is during lectures that the biggest impact can be made. Rather than just doing example problems from the textbook on the whiteboard, utilize problems from industrial experience to solve. After all the students can read the textbook and follow the solution of those problems while they study. However, solving real problems actually encountered in industry adds a new dimension to the course. The student's interest level increases as they realize a practical use of the material being studied. Of course, this take extra preparation time on the professors behalf but the results are well worth it. Care must also be exercised by the professor in order to prevent any proprietary information from being disclosed from the industrial contact.

Classroom discussions become more interactive and lively when real world engineering problems are talked about. Students are interested in what actually happens as engineers solve problems or develop new products. They want to understand what it is like to be a practicing engineer before they actually become one. Often a scenario from past industrial work is presented to the class and the students are asked how to proceed. The professor then becomes a facilitator of the discussion neither supporting nor opposing any approach to the solution. Typically a number of ways to address the problem are suggested. Then the class is asked to pick the best option to actually implement. It is at this point that the professor then reviews the alternatives and discusses each one. Finally, the real or actual solution that was used is revealed along with the pros and cons of its implementation. It is truly a very interactive learning experience for the students.

Many homework assignments can be selected from industrial experience as well. Typically these are solved by the individual student and reviewed during class time. These problems are supplemental and assigned in addition to the usual problems at the end of every chapter. They enhance what is often a very boring and mundane task of simply solving problems from the textbook. Once again, the emphasis is on actual problems encountered while practicing as an engineer in industry.

Preparing laboratory exercises from past industrial experience takes considerable time for the professor but is most rewarding for the students. For electrical type laboratory experiments actual circuits from industry are used for the students to either analyze or design. A circuit that performs a task familiar to them is far more interesting than one that just illustrates a theory. The same is true for mechanical laboratories where devices from actual products can be evaluated or devised. In these and many other cases, the students are offered the opportunity to gain some real world experience as part of their laboratory experiments.

Changes to the E&D Department's robotics and automation course are one such example of how industrial exposure improved the student experience. In this course the instructor reshaped laboratory experiments based on scenarios observed in industry. Essentially giving the students the same practical knowledge and understanding that was obtained on the job. The students were very engaged in the problem and were willing to spend whatever time it took to solve the case studies in the lab. An industrial partner heard of the experience and hired one student fulltime while also hiring a second student as an intern due to the perceived added value that the course has given the students. This same industrial partner has also given additional real design problems from the company for students to work on in the course. Now a team of engineers along with the owner attend and critique the proof of concept demonstrations by the students. To prove the effectiveness of this program, the company has implemented with slight modifications the solutions the students prototyped in the lab. The changes that were implemented based on the instructor's industrial experience have led to student engagement, industrial support and program relevance.

Finally course projects can be based on work while an engineer in industry. These can encompass every aspect of the student's engineering training and in many ways tie material from a variety of courses together. Students can be challenged just as practicing engineers are to solve unique problems that may stretch their knowledge while offering them an exceptional

opportunity to learn. These projects can reflect the fact that the solutions to many problems are not known when first encountered but rather have to be researched and developed. Students need to realize that this is a common occurrence in industrial situations.

It turns out that integrating real world industrial experience into the classroom environment is actually easier than it might at first seem. Foremost it offers the professor the opportunity to relive their industrial experiences, both the good and the bad. The students can share in the professor's experiences and learn for them. Even though it takes extra effort to incorporate real world industrial experiences into the classroom, it can be a very rewarding experience for both the students as well as the professor.

Industrial Relationships

In order to have a real world relevant program a very strong relationship must be formed with industry. These industrial relationships are key in order to keep technical currency in today's ever changing engineering environment.¹ Keeping the curricular programs relevant will enable an institution to make the learning experience more meaningful to the students. This sense of keeping the learning experience more meaningful to the students is one of the major recommendations of the Committee of Engineering Education of the National Academy of Engineering.² These industrial relationships are true alliances. We must remember that as Segil states "An alliance is a relationship that is strategic or tactical, and that is entered into for mutual benefit by two or more parties having compatible or complementary business interests and goals."³ Therefore, there must be true benefits to both parties, in the academic to industrial partnership, if the partnership is to be successful.⁴ The benefit to the academic program was best stated by Liaw when he states that strong industry ties and industrial involvement brings breath, depth and continuity to the engineering educational experience.⁵ One of the many benefits to the industrial partner is that the practicing engineer will be able to suggest and influence activities of the undergraduate program.⁶ Often these alliances/collaborations have helped even smaller regional universities with much needed support in donations both of money and gift in kind donations of equipment.⁷

The question then becomes if industrial relationships are good and to be desired how do we create and foster these alliances. One of the best means to facilitate the creation of these alliances is the use of faculty on staff that has industrial experience. Often faculty with industrial experience can approach prospective partners from their perspective since they have "walked in there shoes" before. If approached in the correct way local industry will be more than willing to help, all we have to do is ask.⁸ Industrial partnerships can take many forms. A brief discussion follows for four of the main forms or types.

The first is the industrial advisory or steering committee. This is a group of industrial partners that agree to collaborate with the academic department on curricular issues. This group meets regularly and reviews the curriculum in detail. This review encompasses both a macro view of needed subject areas but also a micro view of what is being taught and topics covered in a particular course. This is a great way to introduce a new industrial partner to the university. You do not have to ask for any money or equipment. All you are asking for is help and advice on how to better structure the program to meet the needs of their company when they look for new

engineers. Since time is the only commitment and they can see that they have the opportunity to make a difference, this becomes an easy sale. Having an industrial advisory committee is some what of a two edge sword. You get great input and advice but they do expect you to listen and act on that advice. Again having some faculty on staff with industrial experience can help overcome the “we are the experts in education/research and therefore we know what the student needs to know” syndrome that all to often stifles industry from giving advise more than once. The faculty with industry experience often can help the rest of the faculty understand the “what and why” of the industrial partner’s request. Also when there are times when the industrial partner’s request cannot be acted on positively the faculty with industrial experience can help the industrial partner understand or help form an alternative that meets the needs of both industry and the academic department.

The second type of partnership is with internships. Here industry hires a student to work directly for their company as an intern. We like to call this the “try before you buy” approach. The student gets great experience of working in a company and seeing what an engineer does first hand. The employer gets to have work done at an economical price and often time get projects done that they can not spare full time staff to do. Often internships are used to help fill a temporary need without any long term commitments. If the employer has an opening they can observe the intern to see if he/she will make a good fit for the company again without any long term commitment. The company also gets to know how well the students from your program can meet the needs of his company. This will often times helps wed the company to the institution. Once this bond is formed the natural outgrowth is a willingness to step up to the next level of active support to the program because they have again experienced a positive gain from the relationship thus far.

The third and perhaps most significant industrial relationships have been formed through our alumni. This occurred as a direct result of graduates keeping in contact with the Department and either offering or suggesting projects for the students to tackle. These graduates have recognized the importance of their training performing real engineering work as part of their undergraduate experience. In many of their cases, this exposure actually led to employment opportunities that would normally have required years of industrial experience. Their input and participation in the program has not only been of tremendous value to the students, but it has also helped to keep the faculty members technically current with what is happening in industry.

The fourth type of industrial partnership is the active role in the classroom experience. This can take several forms from bringing in real world problems for a class to solve as part of a particular class, to sponsoring projects for students. Each of these forms has the elements of bringing real world problems to the student and at the same time helping the industrial partner. Again this produces a win-win situation for the student, university and the industrial partner. Industrial partners can often times be professionals in the field that are brought into teach part-time. Some of these turn out to be the best associate faculty and bring a wealth of current practice in the field.⁸

Industrial partnerships can be formed as seen above at all levels of participation. It is often the case that the industrial partner will start at one level or type given above and then progress or expand into others. One of the key things to note is that you do not have to ask for money to

form or develop an industrial relationship. Support from the industrial partners is a natural outgrowth of their involvement with the program. Another key is having faculty with industrial experience that industry sees as “one of them” that they feel comfortable with and can understand the practical problems industry faces as well as the academic realities that the university faces. Some times it is helpful to have a foot in both worlds so to speak.

Using Faculty with Industrial Experience

The E&D Department at EWU has actively sought professors to hire that have industrial experience. The professors hired with industrial experience have made a real positive difference in developing a more meaningful learning experience to the students. They have brought a wealth of real world experience to the classroom that has help the students understand the relevance of the theory being taught. By the use of these examples student learn why it is important to truly understand the concepts being presented. Course content has been realigned to match needed skill sets in the students based on the actual knowledge of what they had to know and were expected to do when they were in industry.

A case in point is the Robots and Automation course which was mainly a theory based course was altered to include a robust laboratory experiences with actual industrial robots. The course also added an introduction to Programmable Logic Controller’s (PLC) and ladder logic programming, again with industrial PLC laboratory programming experience. These changes were a direct result of a professor with industrial experience knowing what he had been expected to do in industry and observing this short coming in the student’s experience. Students were given opened laboratory experiences that not only made them want come to the scheduled laboratory times but the students have insisted on having open lab times to work on the assignments. Students are spending two to three times the schedule lab time on there own because they like what they are doing and see the relevance to their future as an engineer. Students have not only received internships because of this course but full time job offers as engineers with one of the major the decision factors in their favor was that they had this real world practical experience to reinforce the theory they learned in class. In short they became more job ready.

EWU’s E&D Department was also able to synergize its use of faculty with industrial experience to mobilize the local industrial partners in the area to obtain a sizable grant from the Society of Manufacturing Engineers (SME). The relationships formed by the faculty with the local industry enabled the E&D Department to have the local industry demonstrate their commitment to the university during the SME grant inquiry visit to make the difference. The SME officials stated that they came to look and most likely would not award the grant to EWU since the E&D Department was at that time a dark horse in the process. But after the visit and huge turn out and commitment demonstrated to the SME by the faculty and the industrial partners, the SME left the campus sold on the vision and dream of the program. This was only made possible by the great relationship that one of the faculty members, with industrial experience, had with the local industry. This relationship had been formed over several years of knowing and working with the local industry which led them to view the professor as “on of them” and not just someone asking for money and time.

Faculty members with industrial experience have also been able to bring real world problems from our industry partners into the classroom. Industry has felt comfortable in bringing some real world practical problems to the Department. This link has allowed us to bring real relevance to the curriculum.

Lessons Learned

The E&D Department has learned some valuable lessons from hiring professors with industrial experience. Theory is very important but just as important is the ability to bring relevance to the curriculum through real life examples of how that theory has been applied to solve real world problems. Professors with industrial experience are in a unique position to accomplish this drawing from their past experience case studies that show direct relevance to the student on the theory being presented. There is also a difference in approach to the subject matter from a practicing professional's view point and that of the researcher. Students need both perspectives.

The ease with which the professor with past industrial experience can form relationships with industrial partners can not be over emphasized. The industrial partners seem to form relationships faster due to the common bond of both having "walked the same roads" so to speak. The local industry seems more willing to treat the faculty member as one of their own and often seems more at ease with the faculty member. This leads to a better free flow of the conversation and input from the local industry partner.

The faculty with industrial experience is better at facilitating change in the curriculum initiated by the local industry requests. This input from industry could be from formal industrial advisory meetings, alumni, or from informal conversations with industrial partners. Often since the faculty member has a leg in both worlds so to speak he/she can relate to need being articulated by the industrial partner and then is able to help facilitate the acceptance of the idea to the rest of the faculty. The faculty members is in a unique position to understand the needs and requirements of both the academic (accreditation and university requirements) and the industrial world (needing engineers that are practical and have the skills sets in a job ready format). As a direct result, courses have been revised and new ones added to meet the needs of local and regional industries.

There are also some cautions. Care must be taken to insure that faculty members with industrial experience don't become dated or worse, outdated in their field. The teaching position is simply not meant to be a retirement job for former engineers from industrial. With all of the demands on their time, this is not always an easy thing to accomplish. Faculty members are expected to maintain their technical currency by studying journals, participating in trade shows, taking classes, and even consulting. However, building and nurturing close relationships with industrial partners along with their vendors has made this effort easier.

Feedback from graduates on their preparation for that all important first industrial engineering position has been overwhelmingly favorable. In fact, their employers are equally impressed with the program and have responded by hiring additional graduates. Word of this success has spread through professional societies and trade organizations resulting in additional projects for the students to engage increasing the ties with local and regional industries. However, the best indicator of success is simply the requests for more trained engineers or graduates of this

program for them to employ. The utilization of faculty members with industrial experience and real world projects is truly a winning combination for the students, faculty, industrial partners, and the University.

Conclusions, Reflections, and the Future

Faculty members with industrial experience have the ability to add a new dimension to engineering education. This perspective includes utilizing real world problems in classroom experiences to enhance the educational process. This in turn prepares the students for their careers in engineering by giving them a taste of what the work is really like. The end result is making the transition from student to engineering easier, more transparent, and seamless.

Looking back, those faculty members also have greatly improved the E&D Department's relationship with local and regional industries. This fostered additional opportunities for internships, senior projects, and job offers for graduates. Further commitments from these industrial partners included time to serve on advisory committees, curriculum review, and a continued stream of new projects for the students to work on and solve.

The trend for the future is to include real world industrial problems in additional courses offered by other professors and continue to build the industrial relationships. The example stated above for the robotics and automation course mirrors the experience in at least four other courses currently offered in the E&D Department with similar results. With this positive feedback in mind, the concepts of transferring real world industrial experience directly into the classroom have therefore proven advantageous and it is intended to expand this methodology into as many other courses in the Department as possible. Finally, it is suggested that this type of model could be of benefit to other engineering schools as well with the aim of demonstrating to the student real world relevance through the use of industrial experience from instructors.

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