
AC 2011-253: INDUSTRY AND EDUCATION: A WINNING COMBINATION

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Industry and Education: a Winning Combination for Communication

Abstract

Over the last ten years the adherence to EC 2000 by engineering programs has been completed and the old ABET requirements and massive documents have disappeared in comparison to the shortened version to day. There is now a concerted effort by departments to make sure that everything that they are claiming in their six- year accreditation process has substance and can easily be proved. During this ten-year period, students have continued to leave the university during internships, co-ops, and experiential learning experiences. As accreditation visits loom on the horizon, it is important to not only look at what is going on in the classroom but to investigate the added influence of any contact the students have with industrial employers. Another area of importance that links the classroom, internships, co-ops, experiential learning experiences, and industry is the growing contact that comes with project based courses that deal directly with industry to accomplish their ends. Many schools are promoting the work that can be done by students integrating their work in the classroom with industrial influence. There are also the numbers of students who participate in extracurricular activities that produce many contact hours with engineering alumni through those projects. While the major focus for accreditation is the classroom, there is a need to look closely at the elements of learning that are being provided by all the other forms of education provided at colleges and universities alike. As we consider the classes we require our students to take, we need to also consider the above experiences that mold both the minds and the futures of those students that lie outside of the traditional classroom.

Co-op, Internships, and Experiential Learning

In our first industrial contact, it is fairly easy to see how industry plays an important role in the communication activities of those students who participate in all the forms of experiential learning. For the co-op or the intern, there is immediate contact with required text in its many forms when a student enters the working world. Emails must be sent to and evaluated by supervisors. Reports must be created that will be examined by many others in their passage to a final destination, hopefully with a positive conclusion. Students find that their communication skills are many times more critical than they ever believed as they make their way through the industrial setting. When asking about their impressions of the experiential experience, they will comment on how much they learned about the need to communicate their technical knowledge. When they return from co-ops and internships, they quickly express the need to know how to both speak and write well in industry. The influential nature of industry on these students is obvious.

Extracurricular Activities

The second area of interest involves the contact between students and industrial sponsors in the extracurricular activities. While there are many avenues that may be followed with these extracurriculars, two groups are easily shown to be influenced by industrial contacts, Baja and Formula racing teams. Both groups require monetary assistance and industrial expertise. In seeking

funds, equipment, and supplies, they must communicate with those sponsors who can greatly influence their end products in the racing world. Presentations, conversation, and many written documents emphasize the need to communicate in a professional manner to representatives of industry. This becomes even more evident when student teams participate in competitions that require written documentation of their entire design process, documentation that will not only go to the race officials but will end up in the hands of the sponsors. All of this communication is being supported by the interest of the industrial sponsors. It is always interesting to see the care that is taken with documents by students who have had much contact with industrial sponsors. The professional bond has a good foundation in extracurricular activities.

Capstone Design

The last area to be addressed is in courses that involve both the academic side of education and the industrial influence that is evident in those classes. The Capstone Design Course – ME 481- occurs at the end of the Bachelor of Science degree in the Department of Mechanical Engineering. At this time, the mechanical engineering student should be preparing to enter the work force with the skills needed to further his or her career. These skills have been explained quite succinctly by ABET and do not need to be repeated. The student enters this capstone course knowing that the assignment given and the task undertaken is like nothing that they have encountered before. No longer are they talking to a faculty member, usually repeating information in order to obtain a grade. Here the stakes are much higher, being that they are real-world issues and can affect a company’s profits or losses. The issue of communication in this different atmosphere is critical. No longer is this the normal, learn material and repeat that material; this is discovery of material that has not been seen before and the importance of conveying the findings to an audience that is not looking for regurgitated material but material that is fresh and new.

The preparation for this activity has taken four years. During the student’s undergraduate years, communication activities have been an integral part of the engineering curriculum. As is shown in Table 1, the student has been provided with multiple opportunities to investigate and practice his/her communication skills within all of the required mechanical engineering courses and many of the elective courses. By the time the student takes the capstone design course, he/she should be ready to communicate in the real world. The process of drafting reports for comments has been a part of this activity and now in the senior course, this commenting will be done by both faculty and outside advisors who are involved with each of the capstone projects. The student experiences the need for good communication skills, not simply for a faculty grade but a review by individuals who may be offering employment.

Table 1. Communication Elements in the Undergraduate Curriculum

<p>Fresh. Year</p>	<p>WRAC – Writing Rhetoric and Culture</p> <p>Remembered Events Paper, Proposed Solution Paper, Justified Evaluation Paper, Writing Profile Paper</p> <p>Tools: None</p>	
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	<p>EGR 100 – Freshmen Design</p> <p>Resumes, email, short engineering focused reports, engineering writing demands, problem solving, speaking, ethics, and orientation to the university/college/majors</p>	
Soph. Year	<p>ME 201 – Thermodynamics</p> <p>Student communication survey, refresher for past grammatical expertise</p> <p>Tools: MS Word, Email, WWW</p>	
Junior Year	<p>ME 332 – Fluid Mechanics</p> <p>Laboratory Reports: (Approx. 9 @ 4-6 pages each) Brief narrative of procedure, measured data, deduced and analyzed data, plotted results with discussion and conclusions.</p>	<p>ME 371 – Machine Design I</p> <p>Short Technical Reporting Design Analysis Reports (2 @ 4-6 pp. + App., Individual); Technical Analysis, Economic Analysis, Recommendation for Action Tools: EES.Powerpoint</p>
	<p>ME 391 – Mechanical Engineering Analysis</p> <p>Reading, thinking, and teamwork</p> <p>Tools: Matlab</p>	<p>ME 412 – Heat Transfer</p> <p>Design Project Documentation: Formal Report (1 @ 10 pp. + App., Individual) Memo Reports (X @ 2 - 5 pages App., Individual) Tools: MS Word, Excel</p>
Senior Year	<p>ME 451 – Controls</p> <p>Laboratory and Project Reports: Laboratory Experiment Written Reports (2 Formal Reports, Individual); Abstract, Nomenclature, Introduction, Analysis, Results, Discussion, and Conclusions – Teamwork (3-5 students/team), 9 short form reports, individual Executive summaries Tools: MS Word</p>	<p>ME 461 – Vibrations</p> <p>Laboratory and Project Reports: Laboratory Experiment Written Reports (2 Formal Reports, Individual); Abstract, Nomenclature, Introduction, Analysis, Results, Discussion, and Conclusions – Teamwork (3-5 students/team), 9 short form reports, individual Executive summaries, presentations Tools: MS Word, Excel, Matlab</p>

	<p>ME – 471 Machine Design II</p> <p>Design Project Documentation: Formal Design Reports Tools: C Programming, Excel, Matlab, WWW</p>	<p>ME 481 – Senior Capstone Design</p> <p>Problem Definition, Progress report, Project Report (1 @ 35- 200 pages) Detailed description of design approach, results, and conclusions, with supporting documentation Teamwork 3-5 Students/Team Multiple industry interactions, small group presentations 1 Formal presentation to industry, faculty, and student audience Tools: MS Word, Excel, Matlab, WWW, Powerpoint</p>
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The capstone design course takes the student through a set of communication tasks including written and oral components. Within the written requirements are problem definitions, formal written reports, and poster productions. The oral requirements are composed of informal presentations and discussions both on campus and off, conference calls, video conferencing, and formal presentations throughout the semester, culminating in a design day presentation before peers, junior high/high school students, family members, faculty, and staff.

The required components of the communication activities for the semester include:

1. Gantt Chart
2. Problem Definition
3. 1st Progress Report
4. 1st Presentation
5. 2nd Progress Report
6. 2nd Presentation
7. A Synopsis of the Project
8. Final Report
9. A Poster Presentation
10. Oral Presentation at Design Day

The semester begins with students vying for projects that have been obtained by industrial sponsors for completion during the semester. These projects can include the design of new products to redesigns of current products. Students could investigate how products can be built more efficiently or design processes that will save hundreds of thousands of dollars for the sponsor. A complete list of the projects is given to the students the first day of class and the assembled teams begin their first communication activity – explaining why they should be considered for their chosen projects. All these proposals of acceptance are evaluated, and the instructors assign the teams to the projects that they have the best chance of completing with the skills they possess. Instead of beginning with engineering activities, the students actually begin with something that will make or break the semester – communication. They must communicate their expertise in a way that will obtain for them the project they would like to work on. They learn quickly the importance of good writing techniques.

Immediately, they are thrust into the necessity of communicating because once they have been given their project, they must make sure that everyone in the group understands what is being asked for in that project. This requires detailing a problem definition that will be presented to the industrial sponsor who will fine tune the definition. In this way, the team must communicate to the industrial sponsor, understand what is being told them, and refine their initial ideas about the project. The team presents its ideas in an oral presentation to representatives of the sponsoring company, detailing how they will proceed and eliciting ideas on what the company might feel is the direction that they want the process to follow. Gantt charts will explain to the sponsor how they plan to proceed and deadlines that will be met to complete the project.

With the focus of the semester's work ahead clearly in the minds of the team members, they can now forge ahead to start the design process. The designs they choose to investigate will be discussed, detailed, rejected, and confirmed. Communication will go on continuously among the team members. When they have formulated the best designs for their project, they will take those designs back to the industrial sponsor and again present their findings. They will make clear arguments for the designs they have created. As they interact with the industrial sponsor, they will build their listening skills to understand exactly what is wanted by the sponsor. In oral presentation and written text, they will give the industrial sponsor the paths they will follow toward a completed project at the end of the semester.

The team also meets with a faculty advisor to clarify problems and explain the general focus of the semester's work. Here the communication requires the team to speak with authority to its faculty advisor but also to listen to comments and questions that the faculty advisor raises. The faculty member of the team is exactly that – an advisor. Each faculty member is placed with a team to function as a sounding board, not as a director of activities. The team will have to take the lead in communicating to both faculty and industrial sponsors. This is an activity for engineers. The students realize that with these projects, they are functioning in the real world, a world in which they will be working in a few short months. It is necessary that they communicate as engineers with critical projects that will benefit both the companies for whom they work and the people who will use the products.

As the semester unfolds, a second report will go to the industrial sponsor detailing the progress of the chosen design. The continuing communication allows the industrial sponsor to question issues that are raised in the design, offer suggestions for direction, and understand where the students are in the design process. Meetings are held where the industrial sponsor, faculty advisor, and design team can communicate clearly about both positive and negative aspects of the design.

Finally at the end of the semester, the final design report is presented to the industrial sponsor along with, in many cases, a prototype of the design. The final report details all the work that has been accomplished during the semester along with the design, build, and test results of that work. The presentation of these results is made to an audience of sponsors, advisors, faculty, staff, peers, and visitors at the semester's design day, which brings all the projects, teams, sponsors, and advisors together to listen to what has been done by all the teams involved in the capstone design course. Team members, through another tool – the poster, must spend time during the day communicating to all the above parties information about their completed project. Design day has become a monument to communication. Over 700 individuals participating in the day gain a knowledge of the

design process, learn about new innovations in product design, and have a chance to listen and discuss what has been happening during the design semester.

A semester ends and a design is presented to an industrial sponsor. If we look at the semester as only this, then an act of engineering has been accomplished. On the other hand, if we evaluate what has actually been accomplished we see that in this one semester students have been given a chance to interact with industrial sponsors, with faculty advisors, then at the end of the semester with peers, friends, family, and high and middle school students. Communication has been practiced in many forms – text production, oral presentations, and required listening. Within those forms the team members will write memos, progress reports, problem definitions, formal reports. They will create powerpoint presentations and practice their speaking skills, skills that will be beneficial in their engineering careers.

The projects they have worked on will benefit many, both companies and people. Four of the projects are summarized below.

Product Development Project

CasterShoX is a joint venture between a well established caster producer, *Caster Concepts Inc.* headquartered in Albion, Michigan, and a shock absorption technology company, *AxleShoX LLC*. For nearly 20 years *Caster Concepts Inc.* has provided caster assemblies for applications ranging from the automotive and aerospace industry to recreational equipment. They have recently joined with *AxleShoX* to further their ability to provide customers with “beyond standard” caster solutions. *AxleShoX* was founded out of the necessity to equip small wheeled devices with shock absorbing technology without requiring any more space than the wheel. Dr. Elmer Lee, founder of *AxleShoX*, designed a spring-damper system to fit inside the hub of a wheel. His initial focus was recreational equipment, such as rollerblades and skateboards, but a new market was waiting for *AxleShoX* in industrial casters.

The problem posed to the *CasterShoX Multi-College Design Team* was to find a new application for the ultra-compact shock absorbing technology used in *CasterShoX* wheels. *CasterShoX* requested a team of engineers and advertising students to generate and validate the application. As a team, a long list of ideas was generated and, using a rigorous process, they were evaluated against a set of attributes to arrive at the final application. The advertising students analyzed the new application with regard to its potential in the marketplace. The engineering students generated a prototype and test procedures that were used to validate the new application as an improvement over an existing product or a useful new product.

...*The CasterShox Multi-College Student Design Team*

Re-design of a Stator for Cost Improvement

The BorgWarner Thermal Systems Student Design Team was assigned the task of re-designing a stator for cost improvement. The purpose of this stator is to encase the radiator fan, and serve as a guide for the airflow produced by the fan, in order to increase its efficiency. This reduces the engine power loss to the fan and increases its overall performance. The current stator is primarily

made of glass and mineral-reinforced nylon and is formed by injection molding. This stator could ultimately be used in future *Ford F-Series Super Duty trucks*.

The main objective of this project was to reduce the overall production costs while maintaining or enhancing the function and performance of the stator. The anticipated outcome was to propose alternative materials, to refine production processes, and to propose a method for reduction of stator weight and material usage.

Research was conducted utilizing faculty resources, extensive computer analysis, and online databases. The finite element method was utilized for the structural evaluations of stress and stiffness. Weekly meetings with the faculty advisor helped devise periodic, time-based goals and group goals as well as individual accomplishments throughout the semester. Upon completion, several of the evaluated solutions were submitted to *BorgWarner* for the stator cost improvement....*The BorgWarner Thermal Systems Student Design Team*

Carbon Dioxide Pressure Relief Valve Seal

Based in Adrian, Michigan, the *Sedco Division of Primore, Inc.* has been a leader in the production of pressure relief valves since the 1960s. These pressure relief valves have been integrated into hermetic compressors, automotive air-conditioning systems, braking systems, and numerous special automotive applications. With over 400 million pressure relief valves and zero warranty returns, *Sedco* is an industry leader with respect to quality, delivery, and service.

The automotive refrigerant industry intends to switch from the current refrigerant, R134-a, to a more environmentally friendly refrigerant, CO₂, by 2010, starting in Europe. This switch could potentially significantly reduce the global warming of automotive refrigerant systems by a factor of 1,300.

There are several problems associated with switching from R134-a to CO₂ as a refrigerant. The upper pressure limit associated with an R134-a based refrigerant system is 500 psig, while the upper pressure limit for a CO₂ based refrigerant system is approximately 2000 psig. This pressure change increases the stress on system components and requires a redesign of the pressure relief valve to accommodate the new operating conditions.

The pressure relief valve component that is most significantly affected by this refrigerant and pressure change is the seal that interacts between the pressure relief valve sealing blade surface and the CO₂ from the compressor. *The Primore Student Design Team* was asked to provide a suitable seal material for the relief valve. Such a design was required to meet the leak integrity expectations for the pressure relief valve by preventing both CO₂ leakage and permeation. In addition, this seal must provide the normal pressure relief valve functions of opening and venting within the desired safety pressure range and subsequent resealing to prevent the total loss of the air-conditioning system CO₂ charge.

...*The Sedco Division Student Design Team*

A Shell Oil Company Children's Wish Humanitarian Project:

Christopher's Wish

The primary mission of *Henry North Elementary School* is to “mainstream” youngsters with disabilities with non-handicapped children, so they can work, play, and learn together. *Henry North* serves as a neighborhood school for 475 students in grades K-5 and also functions as a center for more than 55 students from a four-county area who have been identified as hearing impaired, physically or otherwise health impaired, or severely multiply impaired.

One child within the *Henry North* community is a boy named Christopher who is medically diagnosed with spinal bifida and is, thus, paralyzed from the mid-chest down. However, Chris' diagnosis doesn't slow him down whatsoever, and his need for speed remains as high as it would be for an eight-year-old boy without his diagnosis.

The goal of this project was to create a custom-built arm-powered bike for Chris to enjoy. This bike will not only be enjoyable for Chris, but it will also be a helpful tool in his ongoing physical therapy. The main issue encountered was to make the bike fit Chris in such a way that he is comfortably supported while riding the bike and, above everything else, keeping Chris extremely safe.

To solve the problem a custom seat was created specifically for Chris in order to give more lateral support. The bike was also built in accordance with Chris' aesthetic choices, so that it will feel more personal than an off-the-shelf bike could ever provide.

...*The Henry North Elementary School Student Design Team*

As we see from comments made by industrial entities about the importance of dealing with academic colleagues:

Headquartered at the University of Southern California in Los Angeles, the Biomimetic MicroElectronic Systems Engineering Research Center (BMES ERC) works to coordinate groundbreaking programs at USC, Caltech and UCSC to develop biomimetic devices designed to replace the neural function of damaged or diseased systems in the human body. BMES supports educational programs preparing students at all levels for careers in research, and fosters industry partnerships that will encourage the transfer of biomimetic technology to the marketplace. The Engineering Research Center for Biomimetic MicroElectronic Systems, while based at a university, is a collaborative partnership, drawing together individuals and resources from such entities as universities, industry partners, government, and national laboratories.

*NanoDynamics*¹

Rick Nelson, Chief Editor of *Test & Measurement World*, 9/1/2006 wrote very clearly when he said,

Universities may be providing industry with the engineers of tomorrow as well as the basic R&D that will ultimately evolve into marketable products. But the industry/academia relationship isn't a one-way street.

Daniel Mak, education program manager at Agilent Technologies, said his company works to “prepare today's students to be ready to face the real world by providing the opportunity for hands-on experience.”²

These hands-on activities are not just engineering. They involve the two-way process of communication. These collaborative projects, much like our capstone design course bring together industry and academia to instill in the future engineers the great need to communicate with multiple entities.

Conclusions

The academic community, obviously including students, must look closely at the varieties of ways that communication activities are influenced by industrial contact. Co-ops, internships, and experiential learning have many elements that involve professional communication. The number of times that students must express their knowledge through both oral and written communication along with reacting to comments on that communication takes up a large part of their working experience. Extracurricular activities should also be carefully investigated to see that many times that industry plays a role in helping students see the importance of communication in their working lives. Lastly, design, build, test has given students the opportunity to do just that – participate in an engineering activity that will benefit their future activities as engineers. It is important for them to realize that engineering is totally immersed in communication. All of the activities of the capstone design course revolve around the necessity to communicate so that peers, faculty, industrial sponsors, and a wide range of “other” audiences can understand what is being done and accomplished. Industrial sponsors can provide insights into the kinds of information that they require and the ways that industry has to make sure that this information is imparted. Faculty can also gain from their inclusion in the project work by seeing how industry communicates. The capstone design course becomes a win-win situation for all involved.

References

1 <http://www.nanodynamics.com/>

2 Rick Nelson, “Competing with Basketball,” *Test & Measurement World*, 9/1/2006.