AC 2011-1665: AN OVERVIEW OF OUR EXPERIENCE INTEGRATING MULTIDISCIPLINARY AND INTERNATIONAL DESIGN PROJECTS WITHIN THE SENIOR CAPSTONE DESIGN COURSE

Rob O. Hovsapian, Florida State Univeristy

Dr. Hovsapian spent almost 15 years working for General Dynamics, TRW and Northrop Grumman. Currently he serves as an associate scholar scientist / faculty, instructor of record for the senior capstone design course, for the Mechanical Engineering department and a program manager at the Center for Advanced Power Systems for the Electric Ship Research and Development Consortium (ESRDC) for the Office of Naval Research. He has been responsible for the successful establishment /deployment of several flexible manufacturing facilities globally, working on multiple continents and with many cultures, which produce sophisticated defense electronics equipment, complex automotive systems, and advanced semiconductors. Dr. Hovsapian has personally been recognized nationally for his process improvement activities in manufacturing excellence. He received his Masters of Science and doctorate in Mechanical Engineering from Florida State University.

Chiang Shih, Florida A&M University/Florida State University
Bruce A. Harvey, FAMU-FSU College of Engineering

Dr. Bruce Harvey received his Bachelor degree from Auburn University in 1984, his Master of Science from University of Alabama in Huntsville in 1986 and his Ph.D. from Georgia Institute of Technology in 1991, all in Electrical Engineering. He is currently an Associate Professor in the Department of Electrical and Computer Engineering at the FAMU-FSU College of Engineering in Tallahassee, Florida. From 1984-1986 and 1991-1997 he was with the Georgia Tech Research Institute, and from 1986-1988 he was with Phase IV Systems in Huntsville, Alabama. His research interests include wireless communication, spread-spectrum techniques, error-control coding and mobile data communications and networks.

Okenwa I. Okoli, Florida A&M University/Florida State University

An Overview of our Experience Integrating Multidisciplinary and International Design Projects within the Senior Capstone Design Course

Abstract

The objective of the Mechanical Engineering capstone senior design course at Florida A&M University-Florida State University College of Engineering is to introduce the students to the real-world engineering design process through the participation of realistic design projects, preferably with external sponsors and industrial mentorship. This course introduces the students to the industrial design process, gives them the opportunity to work as an integrated and cohesive team on their project, and to become skilled at effective communication with each other and with the industrial partners, so the students gain an understanding of how to successfully manage their project. Since real-world engineering projects are mostly multidisciplinary and some have an international aspect, it is imperative to introduce the students to those settings and associated challenges. Over the years, we have steadily increased the percentage of our projects which are multidisciplinary and require international collaboration. For example, about fifty percent of this year's projects are multidisciplinary, partnering with either Industrial Engineering or Electrical and Computer Engineering. We expect the multidisciplinary team approach can leverage on the skills and disciplinary expertise of individuals with each participants approaching the project from their own perspective while gaining experience through cross-disciplinary collaboration. Additionally, one international project has included students from both U.S. and Brazil following our previous experience working with institutions from Brazil and Romania. The international project will be integrated formally into the design curriculum through a recently funded international exchange program administered by the U.S. Department of Education and Brazil's Ministry of Education. Similar to multidisciplinary approach, functioning within an international team demands a structured coordination and effective communication to overcome cultural differences, language barriers and other unforeseen obstacles. This paper will discuss the challenges of executing those multidisciplinary and international projects where students are from three different engineering departments and countries, and how these challenges are addressed in the design of the senior capstone design courses.

Introduction

The Mechanical Engineering capstone senior design course has been going through a progression of improvements, since its transition to the current two-semester format in 1999[1]. Over the years, we have made steady improvements by involving more external sponsors from industry and research institutions[2], by initiating international design projects working with institutions from Brazil and Romania[3,4], and by increasing multidisciplinary projects and design competition events collaborating with other engineering departments[5]. Presently fifty percent of its projects are multidisciplinary and more than sixty percent are Industry-sponsored projects, as shown in figure 1. The two-semester course constitutes the culmination of four years of engineering education where students will bring together their knowledge towards the completion of a design project. Some of the skills acquired by the students fall in the traditional areas of Mechanical Engineering: Thermodynamics, heat transfer, fluid dynamics, solid mechanics, materials, 3-D CAD, etc; however, the course also emphasizes on professional skills, not necessarily technical but critical for the pursuit of a successful engineering career. These needed skills include: team-oriented mentality, problem solving, project planning and control, project management and writing skills, etc. The purpose of the Senior Design Project is to pull them all together and apply them towards the design and implementation of a project and to afford the students an opportunity to experience team-based design under conditions that closely resemble those that will be encountered in real world. Students working in teams will develop and sharpen skills in team organization, time management, self-discipline, and technical writing, in order to be successful in this course. An important goal of this course is to expose students to "hands-on" experience in which they have to specify, design, and produce a complete system beginning from needs assessment which are sometimes ill-posed from the perspective of a "customer", to the documentation and evaluation of the design to the final deliverables, all while working as a team, and under the pressure of time constraints. Another important goal is to require the students to work as a team with distributed responsibilities and the experience for organizing and solving problems collectively. Beyond the design learning experience, we believe the direct involvement of the industry and mentorship from engineering practitioners is even more valuable.

Industry-sponsored Projects

Both from literature and our own experience, industry supported projects have been shown to provide great benefits in an academic design program since they often expose students to real-world challenges[6,7]. These projects offer open-ended problems with the involvement of engineering professionals as mentors with the intention to foster a more industrial-like environment. However, the industry sponsored projects generally vary widely in scope and care should be taken because they can also become problematic to manage, especially if the sponsors do not actively engage with the design teams. For industry-sponsored projects to serve an appropriate educational role in the program, and at the same time provide value to industry, they have to be careful selected, monitored, and coordinated between all stakeholders.

At our -university, we have been fortunate with the participation of many long-term sponsors who have provided high quality industry sponsored and engineering relevant projects. One of the main reason is the active involvement of the Mechanical Engineering Advisory Council (MEAC) and other industry contacts we have established over the years. Every summer prior to the start of the course, we work with our industry partners to identify the projects by defining the expectations of the industry partners and discussing the relevancy of the projects as appropriate learning experience to our students. We have steadily increased our industry sponsored projects from a very few to the majority of the projects over the years. For example, over sixty percent of this current year's projects are sponsored by industry. Another positive sign of the success of the model is the high return rate for our industry sponsors as shown in Table 1.

At the end of the school year, the capstone design course concludes with a one-day review event featuring final presentation and open house. All teams make oral presentations describing their projects and the results obtained in front of students, faculty and external sponsors; this will be followed by a poster session when teams showcase their projects and the actual hardware. We have also integrated the annual open house with our continuous assesssment process to identify any strengths and weaknesses of the curriculum for modifications and improvements. This tightly interwoven relationship between the capstone course, curriculum evaluation, and MEAC participation has served the department well in many fronts: continuous improvement of the capstone course and curriculum, harvesting of relevant projects for the capstone course through strong industrial involvement, and expanded career opportunities for our graduates.

Multidisciplinary Projects

The ability of our students to function in multidisciplinary teams is not only an important ABET outcome of engineering education programs[8] but also the reality that real-world engineering challenges and projects are mostly involved many disciplines working together. One aspect that emerged from the industry sponsored model, is the need and request to include students from other departments, to form multidisciplinary team. For example, Harris Inc. asked for the involvement of students from the Electrical/Computer Engineering (ECE) department and the Mechanical Engineering (ME) department to work together on mechatronics-related projects. Air Force Research Laboratory (AFRL) has requested the inclusion of Industry Engineering (IE) students for their familiarity of the manufacturing process especially, the use of modern composite materials processing technique developed by the IE department of the College.

For many years we have made attempts to integrate cross-disciplinary engineering students in our projects with little success as a result of the disparity of curricular requirements among the different departments when it comes to capstone experience. Until a few years ago, Mechanical Engineering department was the only one with a well-developed year-long and project-based capstone course and as a result, we have not been able to involve as many students from other engineering majors as we would have liked systematically. On the other hand, we have been successful, again, within limitations, at involving individual students from Physics (as part of their honors thesis program), ECE (as a special topic course), or Business (as part of their marketing seminar).

The situation has changed a few years ago when both ECE and IE departments have changed their capstone design courses into a more compatible two-semester project-specific format. This has allowed a more meaningful expansion of the multidisciplinary project collaboration. In the following, we will briefly review the evolution process of the capstone design project course sequence in ECE department and its utilization of competition-based design projects to facilitate the integration of more multidisciplinary projects.

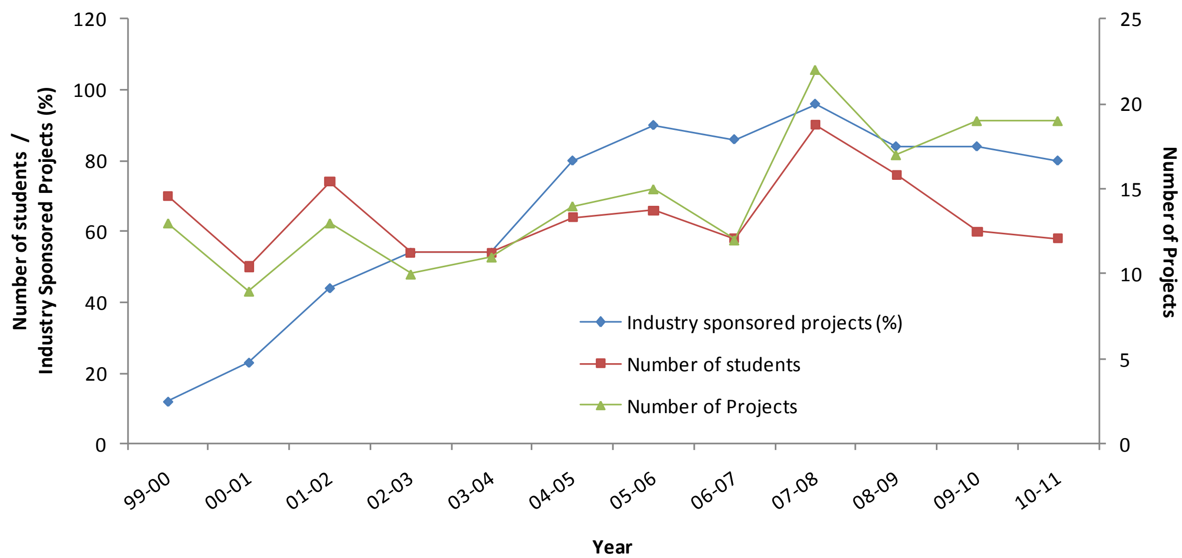

Figure 1: Growth of industry sponsored projects for the past 11 years

1999- 2005	2006	2007	2008	2009	2010
Cummins	Cummins	Cummins	Cummins	Cummins	Cummins
Lockheed	Lockheed	Lockheed	Lockheed	Lockheed	Lockheed [M]
Eglin/AFRL	Eglin/AFRL	Eglin/AFRL	Eglin/AFRL	Eglin/AFRL	Eglin/AFRL
CERN [M,I]	CERN [M,I]	Sandia	Harris	Harris [M]	Harris [M]
Boeing	Talla-Tech	Boeing	Boeing	Mosaic	CAPS [M,I]
NHMFL	Shell [M,I]	Turbocor	Turbocor	Turbocor	Turbocor
ASHARE		NHMFL	NHMFL	Mergenet Med.	Seven Hills Eng.
CAPS		FL. Dept. of Health	FL. Dept. of Health		Keuka Wind
SubZero			NASA [M]	NASA [M]	
Shaw Ind.			Tyndall-AFB	Tyndall-AFB	
Sandia					
Talla-Tech					
Benedict Eng.					

Superscript:
M= Multidisciplinary Project
I = International Projects

Table 1: Industries sponsoring projects for the past 11 years

Evolution of the Senior Design Course Structure for the ECE Department

Prior to 2003 the capstone design experience for the ECE students was a single, 3-credit hour course which consisted of weekly lectures and a design experience sponsored and supervised by individual faculty members. In the spring of 2003 the ECE senior design was expanded to a 2-course sequence. Recognizing the greater emphasis on a capstone design experience by ABET, the second semester senior design course was expanded to 3 hours starting the spring semester of 2004. Also, the requirements and responsibilities of the students and sponsoring faculty were clearly defined, clearly defined objectives for each course were defined and a grading rubric for the design was established. However, the technical depth and consideration of realistic design constraints varied greatly between individual faculty advisors for the projects.

Beginning in the fall 2006 semester, the ECE department faculty adopted a new 2-semester, 6-hour course sequence for both the electrical and computer engineering programs. Each semester consisted of a 1-hour lecture and a 2-hour laboratory component. The lectures were expanded to provide the students the information needed for each phase of the project as it is being completed, and to provide more information on how to address realistic design constraints. During the senior design course sequence the students conducted their design in a structured engineering design format. The students conducted a needs analysis, prepared a formal proposal, demonstrated their progress through 2 design reviews, produced a functioning prototype of their product and documented their product in a final report.

The organization of the ECE senior design sequence was modified so that all projects are under the supervision of a single faculty member who is responsible for ensuring that all design projects includ sufficient depth for a capstone design experience, realistic design constraints are addressed and the design projects are multidisciplinary in nature. All projects are conducted by multidisciplinary teams of 3 or more members. At a minimum each team has at least one EE major and one CpE major, and each project has multidisciplinary requirements including electrical, computer and mechanical design components. Each team works closely with three professors (usually from various disciplines) who act as project advisors and evaluators for all reports, presentations and final prototypes. In Electrical and Computer Engineering the mantra for the Senior Design is “Design, Build, Test”. These design projects involve problem formulation and the steps of product design, analysis, prototyping, and testing.

Evolution of the Senior Design Course Structure for the IE Department

Up until the spring semester of 2008, the Industrial Engineering senior design course was offered on a single semester basis to students in their final semester of the IE curriculum. The course relied upon the students' knowledge from all previous and concurrent courses to complete a final design project in a team context. Now the IESDP students work in teams of no more than three to develop a new product or service from conceptualization and design to manufacturing. The course integrates all industrial engineering components as its principal theme. Students are required to define a product, design manufacturing, and/or service processes, and to design a system to develop, produce, and distribute the product, based upon the project goals. Consideration is given to the economics of their solutions to enable the customers understand the cost implications. The environmental impacts of the proffered solutions are considered, and the students are expected to demonstrate the sustainability of their designs. Since many ethical issues present themselves in engineering design, the students demonstrate an understanding of such issues and, as relevant to their design example, discuss them, including conflict of interests and tradeoffs between costs and benefits to society. The students assess the effect of their designs, proposed facility layouts and general working practices on the organization workforce, including ergonomic considerations. The students demonstrate an understanding of applicable regulations from bodies, such as OSHA, PROSHA and ADA.

1999-2004	2005	2006	2007	2008	2009	2010
AFRL	AFRL	AFRL	AFRL	Bowen Medical	AFRL	AFRL
Boeing	ARL	Caterpillar	ARL	Capital Reg. Medical Center	Northrop Grumman	Archbold Memorial Hospital
Caterpillar	Caterpillar	Neighborhood Health Services	City of Tallahassee	City of Tallahassee	Tallahassee Memorial Hospital	ATK
Chubb Insurance	City of Tallahassee	Pepsi Bottling	GT Technology	Tallahassee Memorial Hospital	Trane	Caterpillar
Cummins Engines	MRD Energy	Tallahassee Memorial Hospital	Neighborhood Health Services	Trane		City of Tallahassee
FACCT	Northrop Grumman		Tallahassee Memorial Hospital	Turbocor		Harris Corp.
FAMU						HPMI
IBM						Solar Car Proj.
Shaw Industries						Trane
Teligent EMS						
UPS						

Table 2: Industry sponsors of the IE senior projects

In 2008, it was agreed that conducting the senior projects over one semester was too limiting. In order to better fulfill customer requirements, and to bring the IE department in line with other departments, the students now spend two semesters (fall-spring sequence) on their senior projects. With reorganization, the course was reoriented to embrace the full six sigma methodology breaking the projects into six reporting phases of Define, Measure, Analyze, Improve, and Control (DMAIC), with a gate review at the end of each phase. In the Define phase, the students must demonstrate a thorough understanding of pertinent customer needs by translating the voice of the customer (VoC), to determine what the customer considers critical to quality. In the Measure phase, the students collect, measure, and interpret customer data to support all alternatives and prioritize solutions supported by statistical reasoning. They utilize the cause and effect diagrams, FMEA and other relevant tools to accomplish this phase. In the spring semester, the Analyze, Improve, and Control phases are accomplished. Implementation of the six sigma methodology has been guided by Black belts from Caterpillar, Trane and GE who have volunteered their time to the class. This gives the students the much needed industry perspective.

Over the years, the IE department has aimed at providing all students with industry sponsored projects. As such, we continue to collaborate with industry sponsors who provide projects that have the potential for implementation, and participate in multidisciplinary projects with other departments such as ME and ECE, while providing solutions to pertinent issues in their organizations. Table 2 shows a sample of current and previous project sponsors.

Expansion into Competition-Based and Multidisciplinary Design Projects

Competitions have been a part of the senior design for many years. For the past 10 years at the ME has included completion based project that were sponsored by engineering societies such as the ASME, AIAA and SAE. Starting in 2003, the ECE senior design projects have included teams designing autonomous vehicles or robots to compete in the annual IEEE SoutheastCon student hardware competition. The use of competition provides excitement to the design process and encourages the teams to excel in the design rather than simply meet the requirements. The goals and rules of the competitions require significant technical depth, but the scale of the projects works well for teams of 4-6 with a moderate budget.

In addition to the IEEE SoutheastCon hardware competition, multiple senior design projects have been based on industrially-sponsored challenges, and other national and international competitions. In the 2006-2007 academic year an ECE senior design team competed in the Freescale HBCU Student Design competition for the best project featuring the Freescale ZigBee Student Learning Kit. This team won the competition by designing a wirelessly (ZigBee) controlled generator control system to provide efficient on-demand power for refrigeration. Starting in 2009-2010 the ECE and ME senior design projects included teams designing entries into national and international competitions including the North American Solar Challenge and SAE/Dartmouth Formula Hybrid Competition. The formula hybrid car designed and constructed by a multidisciplinary senior design team won first place in the Hybrid-in-Progress category (for first year entries) in the 2010 SAE/Dartmouth Formula Hybrid Competition. In 2010-2011 multidisciplinary senior design teams were formed to design a "RoboSub" for the Autonomous Underwater Vehicle Competition sponsored by the Office of Naval Research (ONR), and the AUVSI, a Lunar Regolith Excavator sponsored by NASA and an unmanned, electric powered, radio controlled aircraft sponsored by AIAA and the wii for health care sponsored by Harris.

The inclusion of larger design projects for competitions and other projects requiring multidisciplinary design teams has required the ME, ECE and IE departments to work cooperatively with the senior design courses.

Organization of Multidisciplinary Projects

Beginning in 2009, the ECE and ME departments began a collaborative effort to define a better process to foster more cross-disciplinary projects. It started with the concept by exchanging senior design students to form multidisciplinary design teams in either department. Since the structure of the ECE and ME senior design courses are fairly compatible after ECE's restructuring, this allows the students to follow the respective design process without significant disruption. The design coordinators from each department work together to establish guidelines for the students working outside their departments. They also developed a grading rubric for how individuals and groups are to be evaluated which made the grading more objective and consistent, and provides the student with an in-depth feedback on every graded assignment. For effective assessments and to make sure all the curricular requirements are met the design coordinators from each department works closely with each other throughout the year. The design coordinator responsible for the lead department also meets with each team at least every other week to address any issues or challenges that the student or team are facing. The design coordinator will meet with the faculty advisor as needed during the year to address issues or challenges that the team is facing. The faculty advisor and the design coordinator from the other department that has students on the team will also attend the team presentations to provide feedback to the design coordinator which will be utilized as part of the grading.

Those students working on projects sponsored outside their home department are followed closely by the design coordinator from the department leading the project. The students' home department senior design coordinator will provide the oversight for these students by participating in major design review presentations throughout both semesters to ensure that the students follow the proper design techniques and methodologies. Additionally, two faculty advisors, one each from the home department and the leading department, will be assigned to assist the students for technical issues from respective disciplines.

Starting in the 2010-2011 academic year, both ECE and ME departments have included Industrial Engineering students in their multidisciplinary senior design teams. Based on the initial agreement, the industrial engineering students for these projects are operating as subcontractors on the design projects rather than as members of the design teams. The IE students provide design, construction and integration support for the design projects to aid the teams in meeting the requirements for the project. However, the IE subcontracting team reports directly to the Department of Industrial and Manufacturing Engineering's senior design class. For the 2010-2011 design cycle there is one IE subcontracting group providing support for the North American Solar Challenge design team. Other two IE groups are assigned to work on two industry-sponsored projects (Harris and AFRL) with the special focus on the development of manufacturing process using composite materials. The IE senior projects are run using the six sigma methodology enabling the determination of what the customers perceive to be critical to quality (CTQ), addressing the necessary issues, and placing controls to ensure that the proffered solutions are implemented correctly.

When most ECE and ME Engineering students start their professional engineering career they have relatively little knowledge of the Quality functional deployment (QFD) process and other six sigma tools. Therefore, the involvement of IE students in our multidisciplinary projects could provide the project team with a more complete perspective using industry relevant tools that ensure the optimization of quality in design and product delivery. By working together on the QFD process such as the employment of "The House of Quality" methodologies the team can better define the customer requirements and clarify the deliverables and expectations of the project outcome.[9] Based on our experience, other quality system methodology that has been learned by the Mechanical Engineering capstone senior design students is the Fishbone diagrams (a.k.a. the cause-and-effect diagrams). The use of the diagram forces the project team to think of all possible causes of the potential design issues during the project development by helping to identify all factors which can lead to design failure in a more structured and controlled way. We have found out that although not all of the projects are multidisciplinary or uses QFD process, yet most students are exposed to these concepts during the project presentations.

In recent years, a greater emphasis has been placed into selecting and assigning multidisciplinary teams from Mechanical Engineering, Electrical and Computer Engineering and Industrial Engineering. Forty-seven percent of the Mechanical Engineering capstone projects are multidisciplinary, and twenty five percent of our total number of students (20 out of 78 students) is ECE and IE students working with the ME students. Fifty-seven percent of the Electrical and Computer Engineering capstone projects are multidisciplinary, thirty-nine percent of our total number of students (14 out of 36) are ME and IE students working with the ECE students.

Academic Year	**Project (lead department)**	**# ECE**	**# ME**	**# IE**
2009-2010	Solar Car (ECE)	4	3	
	Formula Hybrid Car (ECE)	4	4	
	NASA Regolith (ME)	3	4	
	Maple Seed Sensor (ME)	2	3	
	LabView Advanced Controller Unit (ME)	2	3	
2010-2011	Solar Car (ECE)	3	3	3
	Formula Hybrid Car (ECE)	3	3	
	NASA Lunar Regolith Excavator (ME)	2	3	
	Bridge Scour Detection (ECE)	3	2	
	AIAA Unmanned Elec. Aircraft, Design/Build/Fly Competition (ME)	2	3	
	Wii Controller for Health Care (ME)	2	3	
	Experimental Propulsion System in Micro Air Vehicles (ME)		3	3
	Carbon Nanotubes Based Antenna (ME)		2	3
	AUVSI - RoboSub (ECE)	3	3	

Table 3: Multidisciplinary Projects and Number of Students from Each Department

Capstone Design Course Assessments

To insure the capstone senior design course objectives and outcomes are met, the senior design teams and each student is evaluated by course instructor, faculty advisor(s), two or more in the case of the multidisciplinary teams, peer evaluation, external sponsors, Mechanical Engineering Advisory Council (MEAC) and by senior exit interviews. These evaluations are conducted through presentations, reports, staff meeting and Peer self evaluations. Grading rubrics were developed for assessment during the course. It was established to assess the students on the course objectives and student outcomes as set forth in the course syllabus.

During the two semesters the teams present their project a total seven times. During the 1st semester the team has three presentations, design concept, interim design review and final design review. During the 2nd Semester the team has four presentations, three progress review presentations and final project presentation. All students attend all the presentations to learn from the lessons learned of the other teams, and exposing the non international and non multidisciplinary teams to those projects. The final design presentations during the 1st semester are attended by the class and ME Faculty advisor and for the multidisciplinary projects the ECE and IE faculty advisors. The final presentation where the course concluded with a one day review “Open House” where all the teams presents their projects and outcomes to the senior students, project sponsors, faculty advisor(s) and MEAC members. MEAC, Faculty advisors and sponsors serve as panel judges during the presentations where they use the grading rubrics to evaluate the teams. During the course of the projects the teams are asked to develop four reports, needs and assessment report, Project plan, final design, and project final report. The teams are encouraged to discuss their reports during the development phase with their faculty advisors and industrial project sponsors prior to submitting the final version, this encourages collaboration between faculty advisors and industry advisors throughout the project development phase and avoids any surprises and/or false expectations at the end of the semester or even worst at the end of the project . The reports are evaluated using the grading rubric by the course instructor and the Faculty advisor(s)

Eight staff meetings between the team members and course instructor are scheduled throughout the two semesters. Additional staff meetings are encouraged if the teams are facing challenges and road blocks throughout the course. During the staff meeting the team’s progress is evaluated and each team members contribution and progression is monitored and logged, which not only insures equal contribution by all the team members but helps guide the individual member where needed. Team members are also asked to conduct team self assessments, four throughout the project, where it will give each team member the opportunity to comment of the other team members contribution. This was found to be a good way of establishing a more cohesive working team.

MEAC also meets twice a year where they provide feedback and evaluation of the capstone senior design from the industry point of view. Senior students give feedback through senior exist interviews which further provides the students perspective of what was retained and how to improve the course. Using these feedbacks and working with MEAC a plan for enhancement to the course is developed and its implementation is discussed. This will continually improve and update our capstone senior design course and insure we attain the student outcomes and keep the graduating engineers entering the workforce prepared for the industries’ need s for well rounded engineers.

International Design Projects

One of the authors had experience working with colleagues from U.S., Romania and Brazil to coordinate a total of four international senior design projects in 2005 and 2006. The results of those international project experiences including lessons learned regarding the team selection process, the selection of effective communication channels, the funding, and positive and negative elements associated with the experience, were reported[3,4].

Leveraging on this collaborative experience, a consortium co-sponsored by the U.S. Department of Education and the Brazil's Ministry of Education was established in 2010 to integrate the participation of four universities (two from U.S. and two from Brazil) to expand the educational and research experience of U.S. and Brazilian students beyond our respective national borders. One of the most important components of the program is centered on the international capstone design project course. Under this arrangement, select U.S. students will travel to Brazil in Fall, actually the Brazilian "Spring" term. They will participate in one of the international capstone design projects developed during the summer before their departure. They will join a group of non-FIPSE Brazilian students to undertake the design and planning of the projects in Brazil.

Concurrently, Brazilian exchange students at one of the U.S. universities will be involved in corresponding international capstone design projects with a group of non-FIPSE US students. The involvement of non-FIPSE students from both institutions guarantees project continuity when the FIPSE students return to their home institutions. At the conclusion of the Fall semester (the Brazilian Spring semester), US exchange students will return to US to complete the design projects. Currently, students from all four institutions are being recruited to participate in the program. Special Portuguese language classes have been arranged to prepare U.S. students for them to transition smoothly to study at one of the Brazilian universities. We expect the first cohort of students will start their exchange programs in the U.S. Fall semester, 2011.

In preparation for the initiation of the exchange program and the senior capstone design collaboration, we organize one international design project in this school year with the participation of five students (3 from U.S. and 2 from Brazil). Although these students in the current project will not participate in the international exchange, yet their experience, both positive and negative, can be learned to assist the transition when we expand the collaborations later this year.

The objective of this project is the design and fabrication of a prototype unit for monitoring and controlling CO_2 and other greenhouse gases for the photo-bio-reactor system designed for the promotion of algae growth. This will contribute for the future construction of a full-scaled, High Density Microalgae Biodiesel Production Plant (HIDENBIOPRO). The selection of the project is critical since it has a long-term perspective to be relevant due to the ongoing research activities of one of the Brazilian participants and potentially the project could be pursued throughout the duration of the FIPSE-CAPES program. As learned from our previous experience, dedication of a faculty mentor is critical in order to the successful implementation of a capstone project, especially one involved international collaboration, student exchange and many other complications. In the final paper, we will report more concrete results from the current project.

We expect the current project will be extended by adding different design component for the optimization of the HIDEBIOPRO system for the FIPSE-CAPSE international exchange program.

At the same time, we are working with the other Brazilian partner to develop a second international collaborative project with the focus on aeronautical engineering, the other aspect of the international program. The preliminary decision is the participation of the Society of Automotive Engineer (SAE) Collegial Aero Design competition [see SAE site: http://students.sae.org/competitions/aerodesign/about.htm] There are several advantages we can take advantage of the design competition, such as (1) It is an international event with competition in U.S. and Brazil; (2) the Brazilian university has several years of design and competition experience already; (3) the U.S. university also has ongoing experience in similar model aircraft design competition such as the American Institute of Aeronautics and Astronautics (AIAA) Design/Build/Fly competition [see AIAA web site: http://www.aiaadbf.org/]; (4) it aligns with local research interest to develop stronger aeronautical-related activities which guarantee the involvement of faculty mentors and resource allocation.

We expect two teams will be formed with a mix of U.S. and Brazilian students to build two aircrafts to compete in events at their respective countries. FIPSE-CAPSE exchange students will serve as liaisons between two groups for establishing effective communication and technical interface. They will spend the first semester (U.S. Fall/Brazil Spring) as exchange students in host campus working with non-FIPSE/CAPSE students during the project planning/concept generation phases. They will return to their home department the second semester to join their home team for the implementation and optimization phases of the project. We expect both teams to communicate regularly through video-conference for information exchange and progress report and, hopefully, learn from their counterpart of all pros and cons to optimize the project.

The inclusion of international design project collaboration and its integration with the FIPSE/CAPSE exchange program is certainly an exciting component added to our senior capstone design course. It brings additional complications such cultural and language barriers, curricular disparity, long-distance communication and resource allocation into perspective. However, we believe that these challenges could be overcome and all students (FIPSE/CAPSE and others) will benefit greatly from this experience. We will report more details about our progress in the final paper.

Conclusion

Our capstone senior design course has long been proven as an exceptional conduit to educate our students in team-based strategies, and the use of the fundamentals of engineering to real industrial problems. Now we have taken it to the next level, where our students must find a way to work with other engineering disciplines within our College of Engineering, as well as international university students, and the “customer”, our industry sponsor. This multidisciplinary approach to solving a project benefits the industry by the team providing them a comprehensive solution, and with a group of students ready to enter the work force with experience. The experience gained by our students far outweighs the challenges, we as educators face with the multidisciplinary approach.

As this capstone course has matured, it created a firm foundation for attracting and fostering our industrial partners that provide the project ideas, funding, mentoring, and support of our students. We expect these industrial sponsored design projects to lend an atmosphere of real world, and the students to feel a sense of competition between the teams working on them, which should motivate them to strive for their personal best.

The multidisciplinary approach has its challenges, but the success for the past two years proves it is well worth the extra effort. We look forward to the future growth of this course, and the addition of more multidisciplinary projects.

Acknowledgments

The authors wish to thank all the industrial sponsors that have supported this capstone experience with their projects, time, and funding; of special note are those organizations that have repeatedly sponsored our project: Lockheed-Martin, Harris, Air Force Research Laboratory-Munitions Directorate (Eglin AFB), Cummins, Seven Hills Engineering, Keuka Wind, Center for Advanced Power Systems, and Danfoss-Turbocor. Their involvement has been the key to the continued success of our program.

Also would like to thanks the chair of all three engineering departments, for their vision and leadership which is also a key to making the multidisciplinary projects a reality. Finally, we would like to thank the College for financial sponsorship of several multidisciplinary engineering design competition projects.

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