AC 2008-1230: GLOBALIZATION: A NEW FRONTIER FOR CAPSTONE COURSES

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Gregg Warnick came to Brigham Young University (BYU) in May 2006 as the External Relations Coordinator for the Department of Mechanical Engineering. He actively works to recruit approximately thirty industrially-sponsored projects each year for the Engineering and Technology capstone course. He is currently working to increase international project opportunities for students and faculty. He is also the internship coordinator and helps students develop and improve their resumes and interviewing skills and to help identify potential job opportunities. In addition, he is responsible for publicity and media relations for the department. He holds a B.S. in Manufacturing Engineering Technology and a Masters Degree in Technology Management from Brigham Young University and is currently pursuing a Ph.D in Educational Leadership from the University of Nebraska-Lincoln. His dissertation research is focused on how to help engineers become leaders in a global environment utilizing capstone courses and other project-based curriculum. He worked for BD Medical for nearly 13 years including work as a project/program manager, business leader, technical services leader, product development engineer, and quality engineer. In addition, he provided project management and ethics training to many facilities throughout the world. He has lived and worked in many different locations throughout the world including extensive experience working on global projects. His research and teaching interests include global technology issues, project management, ethics, and manufacturing processes. He also currently provides project management and leadership consulting/training to fortune 500 companies with IP Solutions, LLC. He is a Certified Manufacturing Technologist (CMfgT).

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Robert H. Todd is a professor of Mechanical Engineering at Brigham Young University and the founding director of BYU’s Capstone program. During the 2007-2008 academic year BYU completed its 487th industrially sponsored project with cross-functional teams of Sr. engineering and technology students through the Capstone course. Dr. Todd received his PhD from Stanford University in Mechanical Engineering Design, taught engineering courses and served in department and college administration at BYU-Idaho (then Ricks College) before spending 10 years in industry in senior level engineering and management positions with both the General Motors Corporation and the Michelin Tire Corporation in both the U.S. and Europe. His research and teaching interests include manufacturing process machine design and development and the development and improvement of engineering education in a global setting. Since coming to BYU in 1989, he has been the Sr. author of two manufacturing processes books; one a best seller used thought out the world, and numerous technical articles. He has served as a department chair and undergraduate coordinator, a member of the Engineering Accreditation Commission (EAC) of ABET (the Accreditation Board for Engineering and Technology). He is a recipient of BYU’s Karl G. Maser Excellence in Teaching award, the Mechanical Engineering Department’s
Outstanding Teacher and Rudy Awards, the Department’s Outstanding Achievement Award, and BYU’s Blue Key College of Engineering and Technology Outstanding Faculty award. He is a Fellow of the American Society for Engineering Education.

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GLOBALIZATION: A NEW FRONTIER FOR CAPSTONE COURSES

Abstract

The world we live in is constantly changing. Engineers must not only understand the fundamentals of math, science and engineering, but must also be prepared to work within a global environment. Engineers commonly work in multinational corporations or are involved in work that requires communication and collaboration across international boundaries.

Over the last twenty years, capstone courses have become widespread as major contributors to better prepare engineering students for their leadership roles in industry. As educators we need to ask ourselves how capstone courses can contribute to a new frontier of globalization needed in engineering education.

This paper will explore:

- The reality of globalization
- The history and evolution of capstone courses
- Several learning activities currently pursued by engineering programs throughout the country aimed at preparing students for globalization.
- A sampling of globalization activities currently occurring in some capstone courses in the United States
- A summary of the experiences that Brigham Young University is pursuing to provide international opportunities for engineering and technology students
- A building block model to improve and evaluate the likelihood of achieving international learning outcomes in engineering education

Introduction:

Students, educators, government agencies, global enterprises, local firms and entrepreneurs are all affected by globalization. As educators we must not only prepare students to understand the fundamentals of math, science and engineering, but must also prepare students to work within a global environment. Duane Abata, former president of the American Society for Engineering Education (ASEE), indicated that there needs to be a “major revolution in engineering education. We must internationalize our curriculum; to include … intercultural interaction … We must mold our students to be entrepreneurs, and spirited international adventures as well.” We need to ask ourselves how capstone courses can contribute to the new frontier of globalization needed in engineering and technology education. What can we learn from other globalization efforts for engineering students that will help us modify capstone courses to better prepare engineering students for leadership roles in a global environment?

Engineering education’s charge is to develop engineers who, “must design under—and so understand at a deep level—constraints that include global, technical, cultural, and business contexts.” This charge challenges engineering programs to prepare engineers with sufficient knowledge to function and communicate cross-culturally.
Preparing engineering graduates to contribute within the context of a global workplace is no small task given that engineering programs are already overloaded with credits, content, and other demands. The design and applied learning experiences in most capstone courses are intended to foster cohesion and synergy between the various aspects of the engineering curriculum including the engineering sciences, modeling, mathematics, technology, manufacturing, design and business. The nature of capstone courses potentially provides an opportunity to achieve globally-oriented educational outcomes within existing curriculums.

This paper will discuss the reality of globalization and the need to prepare students to contribute in the global workplace. A brief review of the history and evolution of capstone courses in the United States will also be presented. In addition, a brief review of the literature concerning what engineering and technology programs are currently doing to address globalization will be shared. Finally, a building block model will be presented to assist capstone courses to evaluate and increase the likelihood of achieving global outcomes in engineering education.

The Reality of Globalization

The case for preparing engineering graduates and others for globalization continues to be strengthened. Noted below, Ferraro cites several examples of how interdependent we have become with other industrialized nations and how much this interdependence is increasing. Clearly this has strong implications for engineering education:

- The United States remains highly reliant on other countries for a number of important minerals. For example, the United States imports 100 percent of its graphite, manganese, mica, columbium, and strontium and more than 90 percent of its bauxite and diamonds.
- In the past quarter of a century, the percentage of the U.S. population that is foreign born has grown from 4.8 percent in 1970, to 6.2 percent in 1980, to 7.9 percent in 1990, and to more than 9 percent at the turn of the last century.
- A significant number of corporations make more than half their total sales in foreign markets. To illustrate, Coca-Cola sells more of its product in Japan than it sells in the United States.
- Foreign-owned firms operating in the United States employ more than 5 million workers, approximately one in ten manufacturing jobs.
- Internet users worldwide have increased dramatically in the last decade. It is estimated that 143 million Americans used the Internet in 2001, up from just 20 million six years earlier. During that same six-year period the percentage of the population using the Internet rose from 7 percent to 51 percent in the United States, 6 percent to 60 percent in Norway, and less than 1 percent to 41 percent in Korea.
- Direct foreign investments in the United States have increased from $141 billion in 1990 to $895 billion in 2001, an increase of 630 percent. And, in the opposite direction, U.S. investment abroad has grown from $81 billion in 1990 to $439 billion in 2001, an increase of 540 percent. (Statistical Abstract of the United States: 2002, p.782)
- The number of telephone calls made in the United States to other countries in the world doubled between 1995 and 2001.
In order to remain competitive, many U.S. corporations are outsourcing both manufacturing and service jobs to countries with cheaper labor.

In 2003, according to a survey of the International Franchise Association, 56 percent of U.S. franchise operators (e.g., Dunkin’ Donuts or Kentucky Friend Chicken) were in markets outside the United States as compared to only 46 percent in 2000 (Tahmicioglu 2004).

These examples, and many others, provide ample evidence that engineering graduates will be integrally involved with the globalization of engineering during the course of their careers. This may occur through working at global or multinational companies, working with international suppliers, outsourcing, providing services to international product markets, or simply developing products that will be used internationally. Current trends strongly indicate that multinational companies will continue to develop along with China and other developing nations and outsourcing of manufacturing and design services will continue to grow.

There are numerous drivers for the continued integration of a global economic system. Developed countries are constantly demanding improved and diverse products while expecting improved quality at a lower cost. These drivers have forced companies to invest in low cost labor markets to reduce the cost of producing their products. As a result, low cost labor markets are flooded with capital, intellectual property, and other opportunities for growth. As these areas develop rapidly, improving the standard of living of their inhabitants, they in turn become larger consumers of new products. For multinational companies the investment into developing countries and markets represents their opportunity for not only growth but survival. Developing countries are eager to find a place on the global stage and these same countries represent relatively large untapped markets. In order for multinational companies to be successful in developing these markets, expanded engineering skills are needed.

Educational leaders and industry are pressing engineering and technology programs to move forward and better prepare students for leadership roles in the globalization of engineering. This includes a call for a major revolution in engineering education to provide more international elements within the curriculum and more intercultural opportunities. This will enable students and faculty to develop an entrepreneurial and international adventurous spirit to better succeed in the new frontier of a globalized environment.

History and Evolution of Capstone Courses

In the early 1990’s there was mounting pressure from industrial and educational leaders to make significant changes to the engineering curriculum to better prepare engineers for leadership while providing real-world experience. This was a result of industry feeling that engineering graduates were inadequately prepared for the practice of engineering. Response from these pioneers developed what has become known as capstone courses or programs. These programs brought open ended design problems and often industrially sponsored design projects into the engineering and technology curriculum. Over the last twenty years, capstone courses have evolved and become widespread as major contributors to better prepare engineering and technology students for leadership roles in industry, government and academia.
The Accreditation Board for Engineering and Technology (ABET) also became a major catalyst for fostering the development of capstone courses. Industry became more heavily involved in ABET and helped foster the development of ABET 2000 which requires all accredited engineering programs to have a capstone course. The National Academy of Engineering has also called for better preparation of engineering graduates for the practice of engineering exemplified in capstone courses\textsuperscript{18,19}. These courses have improved and expanded to better prepare students for the practice of engineering through the involvement and support of accreditation agencies, the National Academy of Engineering, industry, and educational leaders along with professional organizations’ research into the technical and pedagogical content, assessment, and execution of engineering curriculum\textsuperscript{15,16}.

Design and manufacturing of products and services is already a major focus of many capstone courses, it seems that these courses are ideally situated to include elements of globalization without compromising their current learning outcomes. Rather, the opportunity to connect capstone courses with what needs to happen in engineering globalization will only enhance the educational experience of our students.

**Current Efforts to Address Globalization in Engineering Education**

There are numerous efforts among pioneering technical institutions to provide students with international and multi-cultural opportunities independent of capstone courses. Parkinson, et al. recently reviewed what many forward-thinking engineering education institutions are doing to add a global and multi-cultural component to their curriculums\textsuperscript{20}. A review of the literature shows that study abroad programs are currently the most prevalent method to provide global educational experiences for engineering students and others\textsuperscript{7,20}. Understanding these programs may enable engineering and technology programs to leverage these current activities to improve global opportunities and outcomes for capstone courses.

Given the impact of globalization upon engineering, it can be expected that increasingly more engineering programs will be sponsoring study abroad programs. The most recent data indicate that in the 2003-2004 school year, 5,548 engineering students participated in some form of study abroad program\textsuperscript{21}. This would represent about 7.5\% of the graduating class, based on the most recent ASEE graduation data\textsuperscript{22}.

In Parkinson’s previous research he identified eight different kinds of program formats for engineering study abroad efforts. These eight are listed in Table 1 along with two additional formats that the authors have since indentified: Dual Degree and International Capstone Projects. A description of these various formats is provided in Table 1 below.
**Table 1: Categories of formats commonly used for engineering Study Abroad Programs**

<table>
<thead>
<tr>
<th>Format</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual degree</td>
<td>Students obtain two degrees—one from the home university and one from the abroad university. Students follow an integrated program which includes substantial study at the abroad university in the abroad language. This format often is employed for graduate-level work.</td>
</tr>
<tr>
<td>Exchange</td>
<td>Students from the home and abroad university are exchanged and take regular courses in the abroad language. A parity of exchange is maintained so there is no net expense to either institution.</td>
</tr>
<tr>
<td>Extended Field Trip</td>
<td>Students take a 1-3 week tour visiting several countries, companies, and/or universities. Students obtain a “snapshot” of the world via a broad exposure to numerous places.</td>
</tr>
<tr>
<td>Extension</td>
<td>The home university operates a pseudo-extension campus in the abroad country at some sort of permanent facility. Courses are usually taught in English by faculty from the home university.</td>
</tr>
<tr>
<td>International design/Capstone Projects</td>
<td>International experiences are integrated with departmental senior design/capstone courses. In this model groups of students are assigned projects that have international content.</td>
</tr>
<tr>
<td>Internship or Co-op</td>
<td>Students work abroad at a foreign company or at an international branch of a U.S. company. Often less structured than coursework, an internship can include a lot of informal learning regarding business issues, teamwork, communication, design, manufacturing, etc.</td>
</tr>
<tr>
<td>Mentored Travel</td>
<td>Under the guidance of a faculty member, students travel to the abroad country and study and/or tour for four or more weeks. Students stay together as a group. Many traditional study abroad programs would be of this type.</td>
</tr>
<tr>
<td>Partner Sub-contract</td>
<td>The home university partners with an abroad university and contracts for courses to be taught to students of the home university (usually in English). Students may live on-campus. Unlike an exchange program, parity of exchange does not have to be maintained.</td>
</tr>
<tr>
<td>Project Based Learning/Service Learning</td>
<td>Students travel abroad and are immersed in another culture via a project that connects technology with the abroad society. There has also been growing interest in programs such as Engineers Without Borders, which provide service learning via humanitarian projects</td>
</tr>
<tr>
<td>Research Abroad</td>
<td>Students travel to an abroad laboratory and conduct research under the guidance of a faculty member or post doc, etc.</td>
</tr>
</tbody>
</table>

A number of exemplary programs were studied as part of Parkinson’s survey. A few are mentioned here. Iowa State runs a broad suite of programs, with 170 engineering college participants in 2005. The college has summer programs for students in London, Germany and Spain, and also has approximately 30 exchange agreements with universities around the world.

MIT runs the International Science and Technology Initiative (MISTI) program, with locations in France, Germany, India, Italy, Japan, and Singapore. Since 1983, more than 1400 students have been placed in internships in laboratories and offices with partner companies.

Georgia Tech has had its own facility in France since 1990. They have also recently announced an “International Plan” where students from any discipline spend two terms abroad and take courses in international relations and cultural issues. A capstone course is then completed in which their international skills are implemented. Michigan has a similar program in Global Engineering that involves completing 24 credit hours of course work along with a study abroad experience. Georgia Tech and Michigan both run programs at Shanghai Jiao Tong University.
University in China. The models are similar: they use facilities at the university and teach courses with their own faculty in English.

The Fulton College of Engineering and Technology at Brigham Young University (BYU) has experimented with many different approaches to provide global educational opportunities for its faculty and students. Among their efforts have been a Global Product Development course; semester abroad programs to Asia, Latin America and Europe; International Internship programs with companies; faculty sabbaticals in foreign nations; and participation in multi-university projects such as the Partners for the Advancement of Collaborative Engineering Education (PACE) programs\textsuperscript{12,31}. One of the major drawbacks of these programs is that they tend to impact a relatively small percentage of our students. At the same time, however, global engineering experiences at BYU and other institutions have shown that these programs have a significant impact on the students involved by strengthening their confidence in being able to contribute in the global engineering workplace. At BYU, we are searching for ways to have a greater number of our students participate in globally-oriented engineering learning activities. We believe capstone courses offer the potential to do this.

**Globalization Experiences and Capstone Courses in the U.S.:**

A number of capstone courses around the U.S. have pursued or are pursuing projects and/or coursework that are international or global in nature\textsuperscript{32,33,34}. Growth of these project types has in some ways mirrored the development of the more general global programs reviewed in the previous section. The observations and interactions of the authors with other programs show a few trends in this area:

- Industrially-sponsored programs have increasing opportunities to work with international companies that may involve students with other engineers throughout the world.
- Improved communication capabilities have allowed some programs to collaborate with other students in foreign locations.
- International service opportunities (such as Engineers without Borders) are increasing.
- Materials to support classroom discussions related to globalization are more accessible.

There is an increasing body of literature describing capstone-like course experiences that have an international component. A sampling of this literature is reviewed below.

Vaz and Pedersen describe Worcester Polytechnic Institute’s long standing program of having at least 50 percent of their students complete one of three projects overseas at one of WPI’s residential Project centers located around the globe\textsuperscript{35}. These international capstone projects are intended to help students gain the attributes necessary for successful involvement in team-based projects in a real-world setting and to “demonstrate an understanding of how engineering relates to the broader contexts of society and the world.” Each year more than half the junior class is sent abroad. Projects involve a team of three to four students that have the opportunity to spend about ten weeks on site dealing with technical problems from definition to completion. WPI has more than twenty project centers on five continents, including Hungary, Ireland, France, Thailand, Denmark, Hong Kong, England, Australia, Germany, Mexico and Canada\textsuperscript{36,37}. 


In a paper entitled, Problems and Solutions in Internationalizing Capstone Design, Lin et al.\textsuperscript{34}, attempt to compare and contrast the strengths of engineering curriculums in different countries in teaching capstone design. They hypothesize that analyzing these differences and learning from each other’s strengths, will enable engineering programs to do a better job in internationalizing the teaching of capstone design and preparing students from different countries to be more adaptable to working in a global working environment. They state that “For the common goal of improving teaching in a global environment, there are opportunities for collaboration and learning from each other.”

The Rose-Hulman Institute of Technology has begun pursuing international capstone projects as part of their belief that international outsourcing should not be feared but embraced, and that international projects would be especially beneficial to students. They considered three different types of project model including joint projects, staying home projects and traveling overseas projects.

- Joint Projects - students partner with other students in a different country. Advantages include increased technical skills, teamwork over international borders, international experiences for students who cannot afford to travel, and an increased reality that products are often designed in one country and manufactured in another. Disadvantages include the issue that partner schools must acquire computers, workstations, and communication tools and that it is difficult to coordinate the design effort.
- Staying Home Projects - students work directly from Rose-Hulman Institute of Technology. Advantages are clearly associated with cost and convenience, but of course the international experience is diminished.
- Traveling Overseas Projects - students travel abroad to work in host countries. Advantages include the opportunity to pursue a hands-on international experience that includes a real design problem. Project quality is high due to hands-on experience and face-to-face interaction. Disadvantages include the expense, constraints of curriculum, potential for loss of faculty control over the educational process and more preparation than using other models.

The authors conclude that an international project was undoubtedly the most popular choice among students. They also advocate that a program considering an international project should carefully evaluate what benefits the project will provide as learning outcomes and compare them with the anticipated costs and risks.

The BYU Capstone Course and Global Experiences

BYU started its capstone course in 1990 as a result of a need for improving the relevance of engineering education in the U.S. A survey of companies that hired new engineering graduates was conducted. This survey identified a list of weaknesses in new engineering graduates resulting in a two-semester capstone course with specific outcomes intended to help overcome these weaknesses.\textsuperscript{38}

As of the end of the winter semester 2008, BYU has completed 487 industrially sponsored projects involving a design and build paradigm. Students are divided into cross-functional teams using results from the Herrmann Brain Dominance instrument and other data. Each team has a
faculty coach which is selected either from full-time faculty or local practicing engineers or engineering managers. The structure of the course is to involve all student teams in one hour of lecture each week and to interact in a lab learning environment with a smaller number of project teams. The lectures and labs are designed to help students learn a structured design process. The industrially sponsored projects are used as a means for the students to learn and apply a structured design process. An educational grant ($20,000 for the 2007-2008 school year) is provided by the industrial sponsor to help defray the cost of the hardware that students build for each project and to cover the salaries of faculty coaches, administrators, and staff that help with the course.

Alumni feedback through the years has been very positive. Although between 75 and 80 percent of our students go on to seek a graduate degree, most end up working in industry either as a project engineer or engineering manager. Many of our projects come from companies who employ our alumni, who have previously taken the course, and these past students are one of our best sources for new projects.

Approximately 75 percent of BYU’s students speak a second language many due in part to serving a two-year mission for the Church of Jesus Christ of Latter-day Saints. As a result, students are often eager to be involved in projects with companies that may be global in nature. This interest and experience often leads to BYU’s alumni working for companies that are global in nature.

Recognizing this situation, we have begun to recruit capstone projects from sponsors that are located overseas or that have global engineering content. During the 2007-2008 academic year we had three industrially sponsored projects that involved sponsors from countries other than the U.S. or involved project hardware that will eventually be located outside of the United States as well as many other projects that have global connections. We continue to search for ways to have a greater number of our students participate in global-oriented learning activities and we believe our capstone course offers great potential to help us do this.

**International Learning Outcomes for Engineering Students**

In a comprehensive paper on learning outcomes, Downey et al., offer an approach to conceptualizing the global competency of engineers. They hypothesize that the often-stated goal of working effectively with different cultures is “fundamentally about learning to work effectively with people who define [and solve] problems differently.” In their paper, they also establish a “topology of methods” to support ways to develop global learning competencies in engineering students. They conclude that the “ultimate success of methods for achieving global competency will depend upon their integration across the full range of the engineering curriculum, including engineering science courses, and upon widespread acceptance among engineering educators of the importance of giving as much weight and time to problem definition as is given to problem solving.” Their work could easily form a basis for establishing learning outcomes appropriate to capstone courses.
Building Blocks to Achieve International Learning Outcomes for Engineering Students via Capstone

As previously mentioned, BYU has completed 487 capstone projects since 1990. In recent years efforts have been made to increase the span of the course to include sponsored projects in over twenty different states and five countries. The course continues to develop and evaluate options for expansion internationally. To assist capstone instructors and administrators in developing and assessing international learning opportunities the authors developed a building block approach to evaluate the likelihood of achieving international learning outcomes for engineering students.

Figure 1 illustrates BYU’s model to design and implement a project-based capstone course that maximizes the potential to improve international learning outcomes for engineering students via capstone. The model is divided into four columns: project source, project interaction, implementation location, and funding. Project source indicates how the project is initiated including an indication of the sponsor type. Project interaction describes the type of interactions within the project from none to multinational interactions. Implementation location indicates where the project will be implemented or utilized upon completion. Funding indicates whether the project is funded including the source of funding.

<table>
<thead>
<tr>
<th>Project Source</th>
<th>Project Interactions</th>
<th>Implementation Location</th>
<th>Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Sponsor</td>
<td>Multinational</td>
<td>Multinational</td>
<td>Full External</td>
</tr>
<tr>
<td>Competitions</td>
<td>Foreign</td>
<td>Foreign</td>
<td>Part External</td>
</tr>
<tr>
<td>Entrepreneur</td>
<td>Domestic</td>
<td>Domestic</td>
<td>Internal (Dept.)</td>
</tr>
<tr>
<td>Internal (Dept.)</td>
<td>Individual/Team</td>
<td>Individual/Team</td>
<td>Individual/Team</td>
</tr>
<tr>
<td>Individual/Team</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

Figure 1: Building Blocks to Achieve International Learning Outcomes for Engineering Students via Capstone. The dotted line represents a cutoff for a high likelihood of achieving international student learning outcomes.
The model is used by selecting a building block from each column that best represents (classifies) the proposed project. A scale from low to high indicates the potential for each building block to improve international learning outcomes for engineering students and a classification above the dotted line improves this likelihood. Figures 2 and 3 illustrate how the model can be used to evaluate projects for increased learning outcomes for engineering students via capstone. Both examples are from projects from the 2007-2008 academic year.

Figure 2 is an example of a project that included designing, building and testing playground equipment to generate electricity in public schools in Ghana, Africa. The project was sponsored by a non-profit organization that included multiple multinational interactions with implementation in Ghana. The project was fully funded. Since all shaded building blocks within the model were above the dotted line and high on the scale, this project shows a high probability of creating an environment where the course can achieve international student learning that would better enable BYU students to be leaders in a global environment.

Figure 2: Industrial Sponsored Humanitarian Project in Africa. Shaded blocks show the approach chosen for this project.
Figure 3 is an example of a project that included the design of a workstation capable of producing custom foot orthotics in less than 30 minutes compared to existing methods that could take weeks to complete. The sponsor was a local entrepreneur who provided full funding, but the project interactions and implementation were within the United States (domestic). Despite the interest of the sponsor in international markets, the probability of achieving international learning outcomes using this project is low.

<table>
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</tr>
<tr>
<td>Competitions</td>
<td>Foreign</td>
<td>Foreign</td>
<td>Part External</td>
</tr>
<tr>
<td>Entrepreneur</td>
<td>Domestic</td>
<td>Domestic</td>
<td>Internal (Dept)</td>
</tr>
<tr>
<td>Internal (Dept.)</td>
<td>Individual/Team</td>
<td>Individual/Team</td>
<td>Individual/Team</td>
</tr>
<tr>
<td>Individual/Team</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

Figure 3: Entrepreneurial Project focused on Developing New Orthotic Product in the USA

The model provides opportunities for capstone faculty to evaluate their current course and projects and determine opportunities to improve international learning outcomes for their students. It is intended to be flexible in its application and can be customized to meet the needs of the user.

**Conclusion:**

We all live in a rapidly changing world. We have an opportunity to improve the preparation of students to work in and be leaders in a global engineering environment. Capstone and its focus on applied learning via projects is a natural vehicle to achieve this outcome. Many colleges and universities are actively involved in providing and exploring global opportunities for students. However, many students are not currently provided this opportunity. A new frontier for capstone courses is globalization and it rests upon us as engineering educators to collaboratively identify methods to improve the scope and involvement of our courses to meet this challenge. The authors anticipate that the ideas and models presented in this paper will generate additional ideas and thoughts that will foster collaboration for finding ways to enhance the contribution of capstone courses in preparing students to be leaders in globalization and not victims of it.
Since 1990, Brigham Young University has enjoyed the benefits associated with its capstone course to better prepare engineering graduates to be more successful in their careers. Collaborative association over the years with alumni, industry, advisory boards, and other colleges/universities has improved our capstone course and improved student learning outcomes for our engineering and technology programs. The authors anticipate that this new global opportunity for capstone courses will help us better prepare our students to be leaders in a global environment. We invite additional collaboration from any college/university, industry, or individual to help define and develop success in this new frontier in engineering education.

Acknowledgements

The authors would like to recognize the continuing efforts of Brigham Young University and its donors to support development of international programs. We also recognize the efforts of Emily Sanders in editing the text.

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