AC 2011-350: GLOBAL COMPETENCE: ITS IMPORTANCE FOR ENGINEERS WORKING IN A GLOBAL ENVIRONMENT

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GLOBAL COMPETENCE: ITS IMPORTANCE FOR ENGINEERS WORKING IN A GLOBAL ENVIRONMENT

Abstract

We live and work in a world that is even more interconnected and interdependent than ever before. Engineers must now not only develop technical engineering competence, but must also develop additional skills and competencies including global competence, to obtain success within a global engineering environment.

A study was conducted to determine whether multinational companies considered global competence an important skill in mechanical engineering graduates when making hiring decisions as well as the implications for higher education engineering programs. This paper summarizes an exploratory study that utilized an extensive literature review to identify eight global competencies for engineering success within a global environment and also included a survey instrument completed by Brigham Young University (BYU) mechanical engineering alumni in 48 states and 17 countries.

The study focused on an evaluation of standard hiring technical engineering competencies with eight global competencies identified in an extensive literature review. The study established that standard engineering technical competencies were the most important consideration when hiring mechanical engineers, but global competence was also considered important by a majority of all survey respondents with six of the eight global competencies rated important by at least 80% of respondents with an ability to communicate cross-culturally, the highest-rated global competence. The importance of global competence in engineers when making hiring decisions, as considered by large companies who employed more than 10,000 employees or who had annual revenue exceeding $1 billion (US$) per year, was particularly strong. The majority of respondents (70%) indicated that companies were willing to provide training and experience to help engineers obtain success in a global engineering environment. In addition, a majority of respondents (59.9%) indicated that companies valued the efforts of higher educational engineering institutions to prepare engineers for success in a global environment with only 4.8% of respondents indicating that they did not value this effort of higher education engineering institutions. However, only 27% of respondents agreed that colleges and universities were successful in this endeavor.

Globalization is not a passing phenomenon, it is here to stay. Colleges and universities throughout the world need to recognize the importance of globalization and the interdependence and interconnectedness among the world's population. Therefore, it is important to identify, develop, and provide opportunities for international collaboration and interaction among students and faculty throughout the world and to focus on developing global competence as an important outcome for engineering graduates.

Introduction and Background

This paper begins with a brief explanation of how engineering education and the practice of engineering have been effected throughout history. An overview of globalization is then presented including a summary of detailed efforts to categorize global competence and the limitations of current academic efforts to prepare engineers to be globally competent. The remainder of the paper provides a summary of a detailed study and results to determine if multinational companies considered global competence an important skill in mechanical engineering graduates when making hiring decisions**.** The study included an evaluation of standard technical engineering competencies in addition to a list of global competencies for engineering. Finally, recommendations for improving global competence among engineering graduates are presented, as well as recommendations for future research.

The nature of engineering education and the practice of engineering have been affected dramatically throughout history. While it may be common practice in other academic disciplines for higher education to define and guide future curriculum areas, engineering education is often guided by the needs of industry. Many engineering departments and programs utilize industry advisory committees[1, 2] that include representatives from industry to help provide feedback and suggestions on how to better prepare engineering students to be successful within the work environment, including recommendations for curriculum modification. In fact, colleges and universities have adapted programs, research interests, and curricula to satisfy the needs of private business and industry, ensuring continued funding and the marketability of their graduates and programs. The response of satisfying the needs of business and industry has been evident in both public and private higher education institutions. Companies will look elsewhere for needed engineering talent if engineering education does not strive to meet the needs of industry, thus creating a challenging job market for future engineering graduates. The American Society for Engineering Education indicated that[1]:

> "While U.S. engineering education has served the nation well, there is broad recognition that it must change to meet new challenges. This is fully in keeping with its history of changing to be consistent with national needs. Today, engineering colleges must not only provide their graduates with intellectual development and superb technical capabilities, but following industry's lead, those colleges must educate their students to work as part of teams, communicate well, and understand economic, social, environmental and international context of their professional activities".

Rapid changes in technology and the opening of additional trade markets throughout the world have created a need for engineers who not only possess core technical skills, but who also demonstrate broader professional capabilities, including "global" competence. Educational institutions are responding by implementing changes to improve and enhance the educational outcomes for engineers and others to meet the needs of industry created through innovation. It is essential for graduating engineers and people with technical skills to be prepared to work in a rapidly changing world.

Today we are experiencing an increasing rate of significant change in parts of society in which, it used to be common for companies to manufacture and sell everything locally or within a region;

it is now not only common but necessary to participate and compete on a global scale. Companies of all sizes are involved in many different regions throughout the world, and it is now common for small companies to have manufacturing operations in China, India, Mexico, or other developing areas. Multinational companies continue to grow and expand throughout the world[3]. While it was once sufficient for an engineer to develop technical knowledge and skills, engineers must now also adequately prepare to live and work in a global environment. Engineers in almost any company will have interaction with people who live or work in many parts of the world. The ability to communicate, understand cultural differences, and collaborate across time zones is now necessary for engineers to be successful.

Developing and integrating global competence skills into a compacted curriculum is a challenge facing many higher educational institutions; however, past experience demonstrates that engineering departments and programs within the United States can adapt to such challenges. The launch of *Sputnik* in 1957 created an educational shift from merely teaching applied technical courses to focusing on engineering research. In the 1980s, industry began to convey the need for professional skills such as leadership, communication, and team experience. There was a concern that a focus on professional skills would reduce the effectiveness of technical skills among engineering graduates, but research indicated that incorporating professional skills into the curriculum increased students' technical proficiency[4]. Engineering educators now have an opportunity to define and develop global competence as part of engineering education to better prepare its graduates to be successful in a global environment.

We live and work in a global environment that presents many new and interesting challenges for engineers and many other professionals. As engineering educators, it is no longer sufficient to merely prepare students to understand the fundamentals of math, science, and engineering; we must also prepare them to work effectively in international environments and across different cultures[5]. It has become much more common for mechanical engineering graduates to work at global or multinational companies; they may work with international suppliers, provide services or outsourcing to international product markets, or be involved in developing products that will be used internationally.

Understanding the global environment will become increasingly vital for higher educational institutions to adequately prepare mechanical engineering graduates for success in a global environment. Globalization is forcing colleges and universities to evaluate and change their educational approach. Sam Zamrik (2007-2008 American Society of Mechanical Engineering president) commented in his 2007 keynote address at the Middle East Mechanical Expo Conference and Exhibit that[6]:

> "While the requirement to master the fundamentals of engineering – that is, thermodynamics, Newton's laws, or heat transfer – will never change, some additional skill sets will need to be developed. In order to prepare engineering students to work abroad and function effectively on international design teams, educators must refocus curricula, augmenting technical course work with the study of foreign languages and project management. Beyond this, colleges and universities must develop academic programs in such nontraditional areas as intercultural teaming, distance learning, and cross-cultural communication" (The Best Engineers section, para. 3-5).

A further illustration of the importance of global competence among engineers comes from Ken Kohrs[7], former vice president of the Ford Motor Company, who said:

> "What's the relevance of globalization to you personally, and to your future in engineering? I can answer that in one word: Everything. No matter what area of engineering you enter, your ability to remain on the leading edge, and to progress in our organization, will depend largely on your capacity to connect and communicate globally" (p. 5).

To understand where adjustments or improvements are needed in curriculum, it is vital that areas of deficiency, as assessed by global companies, are addressed in order to provide feedback to colleges and universities to help their administrators and faculty to determine what, if any, curriculum modifications are necessary to better prepare their graduates. Higher educational institutions will need to adapt and respond to global changes to ensure that their graduates are adequately prepared to be successful to live and work in a global environment.

Globalization:

There are powerful globalization forces, such as rapidly changing technologies and economic and geopolitical changes that affect the practice of engineering throughout the world. The effects of globalization have led to an increase in the frequency of interactions among people of different cultural and ethnic backgrounds. The ability of individuals to interact in a global environment is due in part to their ability to understand cultural differences[8]. The American Society of Mechanical Engineering's Committee on Issues Identification report identified the need for engineers to operate in complex and dynamic multidisciplinary and transnational environments[9]:

> "The economics of nations are becoming increasingly interconnected. Information technology and knowledge cross borders through international telecommunications and on-line services. Computer-based engineering work is handed off around the world. Business, R&D, design, manufacturing, marketing and distribution are going global and engineering and engineering standards must go with them".

The rapid development of technology and information exchange has created new challenges for engineering education and industry to prepare engineers to operate not only within a complex and multidisciplinary environment, but also within a global environment dealing with many different contextual issues[9]. The world's economy is becoming vastly more interdependent, with exports accounting for an increasing percentage of economic activity. It is common for manufacturing activity, capital, and jobs to move rapidly from one continent to another[10]. As a result, engineering graduates are likely to work on internationally distributed teams with people of varying cultural and linguistic backgrounds[11].

Multinational companies indicate they prefer engineers with international mobility in order to provide diversity in engineering and R&D skills in locations throughout the world[12]. The need for international mobility has created challenges, and engineers may not be adequately prepared

to live and work in different countries without developing global competence. To make progress engineers will need to not only navigate these barriers, but also possess an understanding of the technologies involved and provide the leadership necessary to implement solutions[13].

The Accreditation Board for Engineering and Technology (ABET) states that engineering programs must demonstrate that their baccalaureate students attain certain outcomes for graduation. A set of 11 outcomes are described in Criterion 3 that can be divided into two categories: five "hard" technical skills and a second set of six "professional" skills. The ABET outcomes clearly demonstrate a focus on core technical skills as well as other skills including global elements[14, 15]. The fact that ABET is focused on the importance of providing not only core technical skills but also a broad "professional" education including global elements underscores the importance for engineering programs within higher education to assess their current approach and make appropriate adjustments to better prepare their graduates to be successful living and working in a global environment.

Engineering now includes work that involves interaction in a transnational environment. It is not uncommon for engineers to be involved in large, complex, and multinational projects. These projects include working in teams with members distributed throughout the world. Diversity within teams is common with many different cultural and language characteristics[16, 17]. Many engineers will live and work in different countries during part of their career and many others interact on a regular basis with people of different languages and cultures. These interactions increase the need for improved language and communication skills and the ability to interact with people of different cultures[18].

Recent trends within the United States indicate an ongoing effort to outsource high-technology jobs to other countries which is creating an uncertainty about the long term future of engineering employment within the United States. What seems apparent is that global career competition is likely to continue, and therefore engineering graduates must develop a greater awareness of and familiarity with the global world in which we live to remain competitive[19].

Globalization is not a passing phenomenon it is here to stay. Colleges and universities throughout the world need to recognize the importance of globalization and the interdependence and interconnectedness of the world's population[20]. Therefore, it is important to identify, develop and provide opportunities for international collaboration and interaction among students and faculty throughout the world and to focus on developing global competence as an important outcome for engineering graduates.

Global Competence

In recent years there has been an increasing awareness that the practice of engineering now transcends cultural and national boundaries and that to remain competitive engineers must develop professional skills beyond the core technical skills including development of global competence. Although the term "*global competence*" is becoming widely used in industry and education, its meaning is still ambiguous. Downey et al.[21] described global competence as the development of "knowledge, ability, and predisposition to work effectively with people who define problems different than they do." The challenge to define global competence is occurring

at the same time that colleges and universities are working to internationalize their curricula and provide more global opportunities for their students.

Global competence or a strong interest in becoming globally competent has become a clear differentiator in an engineering graduate's ability to obtain employment, to progress in a career, and to remain viable in the future[9]. Globalization has created challenges for academia to produce engineering graduates who can perform effectively and comfortably in different international engineering scenarios[22]. The Commission on International Education said that[23]:

> "America's future depends upon our ability to develop a citizen base that is globally competent…The United States needs more people who understand how other people think, how other cultures work, and how other societies are likely to respond to American action" (p. 272).

In addition, Patricia Galloway, former president of the American Society of Civil Engineers, discussed globalization issues in her book, the 21st-century engineer: A proposal for engineering reform, and indicated that[13]:

> "A solid understanding of globalization is key to an engineer's success in today's global society. [Development of global competence] will enable 21st-century engineers to develop into professionals capable of working successfully both domestically and globally, highly respected by the general public and regarded…the world over as professionals of the highest order" (p. 3).

Hunter et al.[23] acknowledged that in comparing definitions of global competence either proposed or assumed, there was little commonality among many of the definitions and most were American derived. As a result, Hunter and his associates pursued efforts to advance the intellectual core. A Delphi technique was utilized to further define global competence that included participants from human resources at top transnational companies, senior international educators, United Nations officials, intercultural trainers, and foreign government officers. Three rounds of debate led to the Delphi panel concluding that global competence was "having an open mind while actively seeking to understand cultural norms and expectations of others, leveraging this gained knowledge to interact, communicate and work effectively outside one's environment"[23]. In general, global competence can be referred to as "the ability to work knowledgeably and live comfortably in a transnational engineering environment and global society"[16]. Many researchers have worked to further the body of knowledge concerning global competence and its importance for engineers in the future. Development of global competence is now becoming essential for engineers to be effective in a multinational environment.

An extensive literature review was conducted by the author to identify common categories for global competence. Table 1 summarizes the eight common categories identified for engineers to be successful in a global environment[24].

Table 1. *Common Categories for Global Competence Engineers Should Develop to be Successful in a Global Environment*

#	**Global Competency Attribute**
1.	Exhibit a global mindset
2.	Appreciate and understand different cultures
3.	Demonstrate world and local knowledge
4.	Communicate cross-culturally
5.	Speak more than one language including English
6.	Understand international business, law, and technical elements
7.	Live and work in a transnational engineering environment
8.	Work in international teams

A brief description of each identified global competency attribute is provided with appropriate supporting evidence from the literature.

1. *Exhibit a global mindset:* The ability of individuals to establish self awareness, understand cultural norms and expectations, and realize that they are part of a global world, or in other words that they are citizens of the world as well as citizens of a particular country. An ability to exhibit a global mindset includes an understanding and avoidance of ethnocentrism, the idea that one's own culture is superior to all other cultures. An ability to exhibit a global mindset is a state of mind that provides a positive disposition to be successful in a global environment[8, 17, 25, 26, 27].

   Engineers who exhibit a global mindset are "able to place technology in a global context, recognize the multidisciplinary and multicultural approaches to problem solving…and achieve a greater understanding of diversity"[6]. Each engineer should also comprehend the international dimensions of his/her major field of study[28]. Hunter developed and administered a survey instrument entitled "Determining Global Competence". The survey indicated that the most critical step to becoming globally competent is developing a clear understanding of one's own cultural norms and expectations[29].

2. *Appreciate and understand different cultures:* A developed awareness, appreciation, and understanding of, as well as adaptability to diverse cultures, perceptions, and approaches with an ability to interact with people from other cultures and countries[17, 26, 30, 31, 32, 33].

   It is essential to be open to new and different cultures. Daniel Bates and Fred Plog (as cited in Zhao, 2009) described culture as "the system of shared beliefs, values, customs, behaviors, and artifacts that the members of society use to cope with their world and with one another, and that are transmitted from generation to generation through learning"[34]. Curran indicated that one must have the ability to become familiar with an environment without causing a rift when experiencing something new, which includes cross-cultural sensitivity and adaptability[27]. Cross-cultural awareness includes the ability to understand how another culture feels from the perspective of an insider[35]. From an engineering perspective cross-cultural awareness also includes a realization that culture affects how decisions are made and how tasks are completed[17].

3. *Demonstrate world and local knowledge:* An ability to understand the major currents of global change and its implications and demonstrate knowledge within a global and comparative context. Demonstration of world and local knowledge includes familiarity with history, geography, government, market, and public policy issues around the world and in several target countries along with an understanding of the workings and close linkages of the global economy to promote critical and creative thinking concerning the current global challenges[6, 8, 17, 26, 28, 30, 31].

   Demonstration of world and local knowledge also includes a broad knowledge of the world coupled with specific knowledge of target countries, which provides improved understanding of local customs and strategies. A broad knowledge of the world and local areas also improves each engineer's ability to better understand the implications of their work[14, 31, 33].

4. *Communicate cross-culturally:* An ability to interact with and understand people from different cultures and recognize the importance of both appropriate verbal and nonverbal communication including the ability to communicate and interact in a globally interdependent world. An ability to communicate cross-culturally also includes the ability to communicate across time and space since we live in a technological world where it is common for individuals to interact across many different time zones[9, 11, 17, 30, 32, 35, 36].

   Multicultural environments within organizations are more common than ever and the need to communicate both internally and externally in an organization is constantly increasing as engineers encounter people who define and solve problems differently[21, 32]. Communication in general is difficult; when communicating across cultures, miscommunication may occur that could lead to conflict. For example, in some cultures just because someone says yes does not mean they agree with what you are saying; it only indicates that they are listening to you. Nonverbal behavior arises from our common culture, and interpetation of these behaviors is also often misunderstood across cultures. What is considered normal or effective in one culture may be considered inappropriate in another. Time also means different things in different cultures; one culture may perceive completing tasks in a timely manner as important, while other cultures may see time as a variable that is secondary to developing relationships. The ability to understand these implications and communicate effectively will enable engineers to be more successful in a global environment.

5. *Speak more than one language including English:* An ability to communicate in the international business language of English both orally and in writing, and the ability to speak another language[6, 8, 9, 16, 17, 26, 28, 31, 32, 33, 34, 36]. Across many countries in Europe and Asia, English has been and continues to be taught as a second language. English has fast become a common language for engineering and science throughout the world and many universities now provide instruction in English. The ability to speak another language even at a basic level helps foster goodwill relationships, breaks down cultural barriers, and facilitates an appreciation for others who have learned a different language. An ability to communicate at a technical or professional level in a second language also helps to reduce any misunderstandings that may occur due to language and cultural barriers[17].

Proficiency in English and the ability to speak another language, especially that of a host country, provide engineers access to additional information, experiences, and understanding within their profession[26, 32]. The development of foreign language proficiency also provides insight into and increases understanding of the values, beliefs, behaviors, practices, customs, and artifacts of other cultures[34].

6. *Understand international business, law, and technical elements:* An ability to understand the different cultural contexts of how business, law, engineering and technology might be approached and applied and the implications of each within an international environment, including an appreciation of ethics and its application in different countries and cultures[17, 29, 32, 33]. Engineers involved in conducting business in other countries or cultures are often confronted with different laws, methods of conducting business, and engineering practices. An understanding of the business culture and customs within each country, together with a respect for different worldviews, helps improve one's ability to conduct business in an efficient manner. It is also important to understand the law in the country of operation and the differences between countries in order to avoid legal implications[32].

   An appreciation for new and developing markets provides unique engineering opportunities for engineers to design and implement appropriate engineering solutions. For example, an engineering solution that may work for the United States would potentially not work in certain parts of Africa due to the lack of accessibility to electricity, clean water, telephone and the Internet. Engineering solutions and product use may also be affected by customs, cultural practices, or the availability of materials and supplies. Therefore, it is important that engineers deliver product development and engineering systems that are culturally appropriate and meet the needs of a diverse global community[9].

   Variances in laws, the conduct of business, and the practice of engineering vary across countries and cultures; what is considered ethical in one country may not be considered ethical in another country. For example, it is common in some countries for companies to provide bribes or kickbacks to conduct business, while in other countries this practice would be considered unethical or illegal[17]. Therefore, as engineers interact with individuals from diverse backgrounds, it is important that they show ethical behavior in all aspects of their behavior, both personally and professionally[9].

7. *Live and work in a transnational engineering environment:* An ability and awareness to live and work effectively in international settings. This also includes the ability to transact business in different countries and cultures, to practice engineering in a global context, and to think critically and solve problems within the context of at least one other country or culture[16, 17, 25, 26, 30, 36]. Authentic international experiences provide unique opportunities to learn about the world and the practice of engineering. These experiences may be provided through interaction and collaboration with people who think or act differently, through virtual collaboration with people in different countries, international internships, study abroad programs, service and humanitarian efforts, and through other opportunities where individuals interact with people from different cultures and countries.

8. *Work in international teams:* An ability to collaborate and contribute professionally in multicultural work environments either in person or in geographically distributed teams with persons of different cultures and linguistic backgrounds where diverse ways of thinking, being, and doing are the basis of practice[9, 11, 17, 31, 32]. In essence the ability to work in international teams focuses on the ability of the engineer to get along with other people and work with a team in a multicultural, multilingual and multicontextual business environment[6, 32, 34].

As part of the study, these eight common global competence categories for engineers to be successful in a global environment were compared with standard technical engineering competencies. The purpose was to determine if multinational companies considered global competence an important skill in mechanical engineering graduates when making hiring decisions of new engineers.

Limitations of Current Academic Efforts to Prepare Engineers to be Globally Competent

In recent years there have been many credible sources citing the need to better prepare engineers to live and work in a global environment. Duane Abata[37], 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".

James Duderstadt[38], former president and dean of engineering at the University of Michigan, indicated that engineering education needs to respond to changes associated with globalization. He also indicated that it is important to stress the importance of global perspective for engineering practice and for engineers to develop a deep understanding of global markets and organizations. The capacity to work in multidisciplinary teams is important; characterized by high cultural diversity while exhibiting the nimbleness and mobility to address rapidly changing global challenges and opportunities.

One of the greater challenges facing engineering departments and programs in universities and colleges is how to incorporate international preparation into an already content-full and highly-sequenced curriculum[16]. Many programs are including ways to incorporate globalization in the curriculum: international internships, study-abroad programs, faculty-led courses while on international travel, international design projects, research experiences, and language study, among other programs. However, much of what is occurring is an add-on approach made up of short summer programs, minors, and certificates[26]. Many of these efforts provide limited cultural immersion and do not typically provide significant opportunities to gain second-language proficiency. These programs are often expensive and have other constraints that make it difficult for students to participate.

It is estimated that less than 20% of students participate in global experiences like study abroad programs[32], and given the relatively low percentage of participation of students in international experiences, what can be done to provide global experiences for all engineering students? It is anticipated that a more comprehensive and integrated approach that helps all students develop

global competence is needed. As mentioned previously, the cultural and economic effects of globalization have created a need for fundamental changes in engineering education. Although internationalization and the development of global competence may originally have begun in the social sciences and humanities, engineering programs now recognize the importance of developing international skills within its graduates to succeed in today's global society[39].

What seems apparent in the literature is that many institutions have focused on trying to improve global outcomes for their engineering students[24]. While international efforts to improve global competence among graduates of engineering programs continue to increase, the percentage of students who have participated is still relatively small. Real success is likely to be achieved as colleges and universities focus on their own curricula to make global competency an essential part of a student's education[40].

Many challenges must be overcome, including how to incorporate global elements into an already packed curriculum, develop foreign language capabilities, and deal with timing differences in semesters of international schools. Improvement of global outcomes will require commitment from higher educational institutions to produce globally competent engineers. Faculties need to not only focus on helping students acquire technical skills, but also set the example themselves and provide opportunities for their students to gain international experience[33]. The incorporation of global elements will likely require a review and modification of existing curricula to make sure that it is comprehensive, coherent and accessible to all students[30].

Study Overview

The primary purpose of this study was to determine if multinational companies considered global competence an important skill in mechanical engineering graduates when making hiring decisions. The following research questions were utilized to address this purpose:

1. Is global competence considered by hiring managers at multinational firms in their hiring practices of mechanical engineering graduates?
   a. Is global competence an important consideration for employment in multinational companies?
   b. To what extent are multinational companies willing to train engineers in global competence?
   c. To what extent do multinational companies expect higher education engineering departments and programs to prepare engineers for working in a global environment?

Each research question was addressed individually. The study included an evaluation of standard technical engineering competencies as well as a list of global competencies for engineering developed from the literature. Global competence has become a topic often cited in literature and is an area of focus for many engineering programs.

To facilitate a more foundational comparative approach an exploratory study method was utilized. The study used a survey instrument that evaluated both quantitative and qualitative elements. A Likert scale approach was utilized and survey participants were asked to provide

responses to open-ended questions that offered qualitative insights into the importance of global competence for mechanical engineers.

The study identified the relative importance of global competence as compared to standard engineering competencies within companies that conduct business or have operations in more than one country. The study population was limited to alumni from BYU who graduated from the mechanical engineering department from the early 1950s through 2010. An invitation to participate in the survey was sent via e-mail to BYU alumni who had e-mail addresses registered with the BYU alumni group, which included 2,816 of the 5,149 (54.7%) mechanical engineering alumni from 48 different states and 17 countries [41]. Of the 2,816 alumni that had e-mail addresses registered with the BYU alumni group, only 106 kickbacks (invalid e-mails errors) were received, for a delivery rate of 96.2% (2,710). The response to the survey invitation was generally good, with 561 (20.7% total response rate) participating. Survey respondents were given a voluntary opportunity to provide personal contact information, and of the 561 respondents that participated in the survey, 461 (82.2%) provided their contact information representing 26 states and 3 countries and more than 80 different companies, including many large, multinational firms such as: Hewlett-Packard, Boeing, 3M, ATK, United Parcel Service, Browning, Intel, Honeywell, Exxon Mobil, Ford Motor Company, ConocoPhillips, Cessna, Adobe Systems, Northrop Grumman, Monsanto, Siemens, Bard Access Systems, and Stryker.

Profile of the Respondents

The accessibility of alumni data including the fact that alumni were distributed throughout different industries and locations and many were employed by multinational firms led to the identification of BYU mechanical engineering alumni for the study's purpose.

There were 558 BYU mechanical engineering alumni who participated in the study comprised of 95% male and 5% female. The low percentage of females in mechanical engineering and subsequently the survey participation is not atypical. For many years, the average percentage of graduating seniors in mechanical engineering at BYU who were female was less than 4%, compared to the 2008 national average of 11.9%[42]. However, efforts made in recent years have increased the approximate percentage of female mechanical engineering students at BYU to nearly 12% in 2010. Study participants were asked to indicate if they spoke a foreign language, and of the 540 that responded to this question, 381 (70.6%) said yes and 159 (29.4%) said no. The percentage of respondents who indicated that they spoke a foreign language (70.6%) corresponds with the percentage (more than 70%) of BYU students who speak a foreign language. These results verify that the study population within mechanical engineering is representative of the typical foreign language capabilities of BYU students in general[43]. Of the participants 85% were employed at least part time, 84% worked for companies with international operations and 39% were involved in making hiring decisions for new engineers.

The majority (68%) of study participants worked for larger companies that employ more than 1,000 employees with nearly half (45%) who worked for companies with more than 10,000 employees. Figure 1 provides a histogram of the number of employees (worldwide) of the respondents' companies.

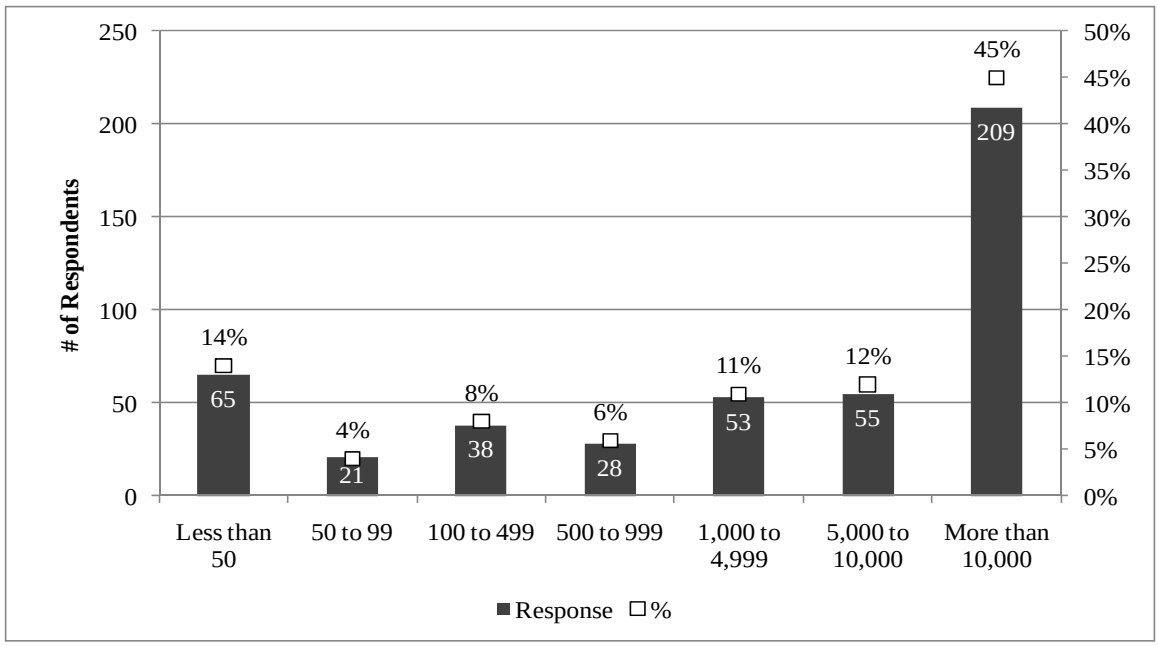

Figure 1. Number and percentage of employees (worldwide) as categorized by survey respondents according to different employee size groups (i.e., less than 50).

Similar to the results shown previously, Figure 2 illustrates that the majority of survey respondents were employed by larger companies, with 55% of respondents employed by companies with annual revenue exceeding US$1 billion. Both the size of company by total employees and by annual revenue indicated that the majority of respondents worked for large companies, and it is probable that many of these companies are global in nature.

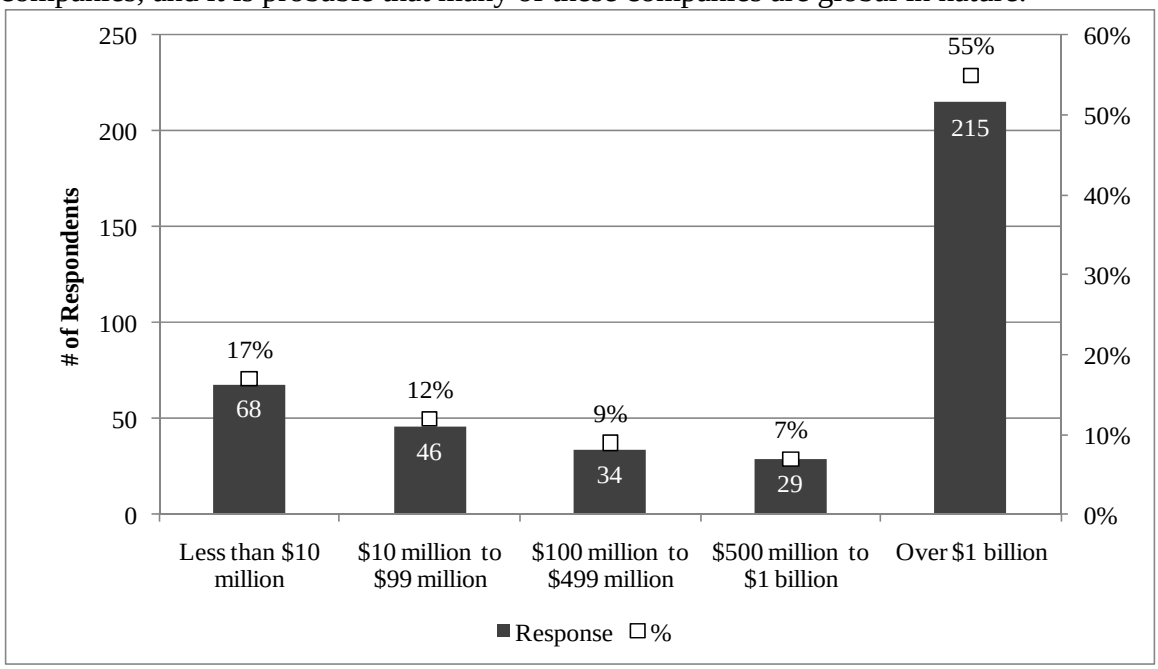

Figure 2. Approximate annual revenue (US $) of respondent companies.

Study Results and Conclusions

Survey results of BYU mechanical engineering alumni were utilized to address the research questions for this study. To complete the entire survey including the competency comparison section, a participant needed to be employed at least part-time, work for a company that conducted business internationally or had at least one operation in a different country, and be involved in the hiring process of new engineers with their company. Of the 558 alumni who took the survey, only 149 (26.7%) qualified to answer the competency section of the survey.

Fifteen different competencies were evaluated by survey respondents including the eight global competencies identified in the literature review section of this study. Survey respondents rated each competency on a five-point Likert scale for importance ranging from 1 (unimportant) to 5 (very important) according to the following question "How important is it for mechanical engineers hired by your company who will either work immediately or eventually in a global environment to have?" followed by each stated competency. A mode analysis, which is one of the most appropriate methods for analysis of a Likert scale response, was conducted to determine the most frequently cited response. According to the Likert scale rating, each of the five standard engineering technical competencies as shown below were rated a 5 (very important).

- An ability to apply knowledge of mathematics, science, and engineering.
- An ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- An ability to identify, formulate, and solve engineering problems
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Four of the eight global competencies using a mode analysis were identified according to the five-point Likert scale response as 4 (important) along with pertinent applicable work experience as shown below.

- An ability to exhibit a global mindset
- An ability to appreciate and understand different cultures
- An ability to communicate cross-culturally
- An ability to work in international teams
- Pertinent applicable work experience

Survey respondents considered each of the remaining global competencies and a high GPA moderately important (rank of 3). Possessing and demonstrating standard engineering technical competencies is essential if one is to be employed as an engineer, regardless of whether the engineer is working in a international environment or not. However, global competence is also an important consideration for employment, and engineers should focus particularly on developing the ability to exhibit a global mindset, an ability to appreciate and understand different cultures, an ability to communicate cross-culturally, and an ability to work in international teams.

These results indicated that not only are standard engineering technical competencies important, but global competence is an important consideration when making hiring decisions for mechanical engineers who will work immediately or eventually in a global environment. In particular the ability to exhibit a global mindset, an ability to appreciate and understand different cultures, an ability to communicate cross-culturally, and an ability to work in international teams are important competencies for engineers to develop.

As indicated previously, 4 of the identified global competencies were considered important according to mode analysis (most frequent response) for employment in multinational companies. To further understand the importance and significance of these results and since the majority of the survey data was ordinal level data, a cross-tab analysis was conducted. The cross-tab analysis was conducted on various independent variables to determine the statistical significance and correlation on each of the 15 competencies considered when making hiring decisions for mechanical engineers. When conducting cross-tab analysis it is important to remember that there are three main parameters of correlation[44].

1. The sign of the correlation. The correlation can be either positive or negative. Theoretically, the correlation may be 0 or have no sign at all. The sign is positive if an increase in the value of variable X is accompanied by an increase in the value of variable Y. The sign is negative if an increase in the value of variable X is accompanied by a decrease in the value of variable Y[44].
2. The strength of the correlation. Strength is measured with different correlation coefficients, such as *Pearsons' r*, *Kendall's tau-b*, *Gamma*, and *Somer's d*. Most values range from -1 to +1. If the absolute value is closer to 1, then the association is high, either with a positive (+1) or negative association (-1). But as the value approaches zero, even if the *p*-value is considered statistically significant, then the association is weak at best[44].
3. The significance of the correlation. The significance is measured by the p-value. If the p-value is low (generally less than 0.05) it is considered statistically significant; if it is less than 0.10 but higher than 0.05, it is considered marginally significant; and if it is higher than 0.10, no statement of association can be made. This last point does not mean that there is not an association; it means simply that the data does not provide evidence of the association[44].

An important consideration in reviewing the survey data was to determine the influence different variables had on the relative importance of competencies when hiring mechanical engineers to work in a global environment. In other words, did things like job title, company size, and total revenue impact how survey respondents felt about the importance of different competencies? For example, does a CEO rate the importance of communicating cross-culturally differently than an engineer, and if so, is the difference statistically significant?

A cross-tab analysis was conducted to determine which variables had a correlation to the importance of different competencies. Table 2 summarizes the results of the cross-tab analysis. Cross-tab comparisons that were statistically significant (p-value less than 0.05) are identified in the shaded cells. Cross-tab comparisons that were marginally significant (p-value between 0.05 and 0.10) are identified in the bold and italicized cells.

Table 2. *Cross-tab Analysis Summary of Different Variables and Each Competency*

	Inferential Correlation Statistic					
	Job Title * Global Competence		# of Employees Worldwide * Global Competence		Annual Revenue (US $) of Company? * Global Competence	
Competency	*p*	Gamma	*p*	Gamma	*p*	Somer's d
High GPA	0.011	0.319	0.011	0.305	***0.098***	***0.121***
Exhibit a global mindset	0.322	-0.111	0.009	0.288	0.128	0.112
Apply knowledge of mathematics, science, and engineering	0.716	0.102	0.715	-0.103	0.665	-0.025
Appreciate and understand different Cultures	0.559	0.073	0.000	0.476	0.020	0.181
Design and conduct experiments	0.490	-0.120	0.939	-0.014	0.254	-0.084
Demonstrate world and local knowledge	0.642	-0.052	0.272	0.120	0.309	0.072
Design a system, component, or process	0.730	-0.063	0.254	0.202	0.730	0.024
Communicate cross-culturally	0.507	-0.090	0.381	0.112	1.000	0.000
Speak more than one language	0.023	-0.252	0.630	0.053	0.604	-0.035
Identify, formulate and solve engineering problems	0.610	-0.147	0.267	0.322	0.389	0.047
Understand international business, law, and technical elements	0.710	-0.043	***0.072***	***0.196***	0.814	0.017
Use techniques, skills and modern engineering tools	0.646	-0.108	0.326	0.217	0.995	0.000
Live and work in transnational engineering environment	0.809	-0.029	0.000	0.505	0.050	0.153
Work in international teams	0.339	-0.128	0.002	0.358	***0.058***	***0.149***
Applicable work experience	0.881	0.022	0.533	-0.090	0.540	-0.044

Note. ***p*** = significance; shaded cells = statistically significant ($p < 0.05$); bold italic cells = marginally significant (p 0.05 – 0.10)

Two-proportion z-tests were conducted on items identified as statistically significant in Table 2. A one-tailed z-test was utilized for all comparisons, since this is the method utilized to determine if one proportion is greater (or lower) than another[45]. A p-value of 0.05 or a 95% confidence level was utilized to determine if proportion results were statistically significant. A p-value of 0.05 "means that there is one chance in twenty that the two proportions are not really different"[45]. These tests were conducted to determine whether a statistically significant proportional difference existed between variable categories.

Categorical comparisons were completed for importance, by company size (annual revenue in US$) and Table 3 provides summary results including the corresponding p-value and z-test statistic for each comparison.

Table 3. Results of Z-Test for Two Proportions Comparing Annual Revenue Categories for Importance (Important and Very Important)

Competency	Value	Over $1 billion vs. $100 million to $1 billion	Over $1 billion vs. less than $100 million	$100 million to $1 billion vs. less than $100 million
Appreciate and understand different cultures	Z-value	2.264	3.592	0.427
	p-value	.012	.000	.335
Live and work in transnational engineering environment	Z-value	0.751	3.054	1.408
	p-value	.226	.001	.080

Categorical comparisons were completed for importance, by company size (number of employees) and Table 4 provides summary results including the corresponding p-value and z-test statistic for each comparison.

Table 4. Results of Z-Test for Two Proportions Comparing Total Number of Employee Categories for Importance (Important and Very Important)

		# of Employees Worldwide		
Competency	Value	More than 10,000 vs. 1,000 to 10,000	More than 10,000 vs. Less than 1,000	1,000 to 10,000 vs. Less than 1,000
High GPA	Z-value	0.659	2.093	0.864
	p-value	.255	.018	.194
Exhibit a global mindset	Z-value	1.695	2.730	0.412
	p-value	.045	.003	.340
Appreciate and understand different cultures	Z-value	2.276	3.967	0.959
	p-value	.011	.000	.169
Live and work in transnational engineering environment	Z-value	.823	4.274	2.667
	p-value	.205	.000	.004
Work in international teams	Z-value	-0.012	3.026	2.243
	p-value	.505	.001	.012

An important consideration in reviewing the survey data was to determine the influence that different variables had on the relative importance of competencies when hiring mechanical engineers to work in a global environment. A cross-tab analysis was conducted to determine which variables had a correlation or association to the importance of different competencies. The cross-tab analysis identified the following items as statistically significant (p-value < 0.05):

A positive correlation exists between:

1. Job title and the importance of a high GPA.
2. The number of employees worldwide per company and the importance of a high GPA.
3. The number of employees worldwide per company and the importance of an ability to exhibit a global mindset.
4. The number of employees worldwide per company and the importance of an ability to appreciate and understand different cultures.
5. The number of employees worldwide per company and the importance of an ability to live and work in a transnational engineering environment.
6. The number of employees worldwide per company and the importance of an ability to work in international teams.
7. The annual revenue (US$) per company and the importance of an ability to appreciate and understand different cultures.
8. The annual revenue (US$) per company and the importance of an ability to live and work in a transnational engineering environment.

A negative correlation exists between:

1. Job title and the importance of an ability to speak more than one language including English.

The cross-tab analysis also identified the following items as marginally significant (p-value between 0.05 to 0.10):

1. A positive correlation exists between the number of employees worldwide per company and the importance of an ability to understand international business, law, and technical elements.
2. A positive correlation exists between the annual revenue (US$) per company and the importance of a high GPA.
3. A positive correlation exists between the annual revenue (US$) per company and the importance of an ability to work in international teams.

Survey results indicate that companies with a large employee base (greater than 10,000 employees) or companies that have high annual revenues (over US$1 billion) placed a higher importance on global competencies when making hiring decisions for new engineers than smaller companies. A summary of the data indicated that a majority (68%) of respondents worked for larger companies who employed more than 1,000 employees and 55% of respondents were employed by companies with annual revenue (US$) exceeding $1 billion. In general, survey respondents who worked for larger companies placed a higher importance on global competence than did those who worked for smaller companies. It is not unreasonable to conclude from these results that larger companies recognized and valued the importance of engineers who

were not only technically competent, but who also possessed global competencies applicable to work within a global environment.

Additional evidence of the importance placed on global competence by larger companies comes from the researcher's own experience of working more than 12 years for a multinational medical technology company with over US$6 billion in annual revenue and approximately 25,000 employees worldwide. Communication with colleagues throughout the world on different projects and programs occurred daily, and global competence among engineers was considered an important capability for success. In addition, at a recent engineering education conference, the researcher encountered a manager from a multinational aerospace company with more than 120,000 employees worldwide who indicated that global competence was essential for engineers within their company.

These results are likely to be important for higher education engineering programs, because it is probable that graduates of other engineering institutions are similarly employed in larger companies. Large companies indicated that the following global competencies were important for the success of engineers in a global environment: an ability to exhibit a global mindset, an ability to appreciate and understand different cultures, an ability to live and work in a transnational engineering environment, and an ability to work in international teams.

To further understand whether global competence was an important consideration for employment in multinational companies, the survey responses were consolidated into two categories the first being unimportant or of little importance and the second including moderately important, important, and very important. The competencies were rank ordered from most important to least important based on survey respondent responses as shown in Table 5.

All 15 competencies were considered at least moderately important (3 or higher on a scale of 1 to 5) by a majority of respondents, with the least important competency being an ability to speak more than one language including English, with only 62% who indicated it was moderately important to very important. An ability to understand international business, law, and technical elements was also viewed as less important than other competencies, with 67% of respondents who perceived it was moderately important to very important when making hiring decisions for new engineers. Even though these two competencies were rated lower by respondents for importance, nearly 21% of respondents indicated they wished they had been better prepared to conduct business and engineering in an international environment and nearly 11% felt that better foreign language experience would have helped them within their career when asked "What do you wish you would have known upon completion of college to better prepare you to work successfully in a global engineering environment?"

The remaining 13 competencies were considered moderately important to very important by more than 79% of respondents. The 6 remaining global competencies were considered moderately important to very important by 79% to 91% of respondents. Given these results, one may conclude that, for BYU mechanical engineering alumni involved in hiring decisions for their company, global competence is an important consideration when hiring new engineers who will work either immediately or eventually in a global environment.

Table 5. Rank Order of Each Competency by Importance

Rank	Competency	Unimportant / Of Little Importance		Moderately Important to Very Important	
		#	%	#	%
1	an ability to identify, formulate, and solve engineering problems	2	1%	147	99%
2	an ability to apply knowledge of mathematics, science and engineering.	4	3%	145	97%
3	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	5	3%	144	97%
4	an ability to design and conduct experiments, as well as to analyze and interpret data	6	4%	143	96%
5	an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	7	5%	142	95%
6	pertinent applicable work experience	10	7%	139	93%
7	an ability to communicate cross-culturally	14	9%	135	91%
8	a high GPA	15	10%	134	90%
9	an ability to appreciate and understand different cultures	15	10%	134	90%
10	an ability to work in international teams	23	15%	126	85%
11	an ability to exhibit a global mindset	25	17%	124	83%
12	an ability to live and work in a transnational engineering environment	30	20%	119	80%
13	an ability to demonstrate world and local knowledge	32	21%	117	79%
14	an ability to understand international business, law, and technical elements	49	33%	100	67%
15	an ability to speak more than one language including English	57	38%	92	62%

Given these results, one may conclude that for BYU mechanical engineering alumni involved in hiring decisions for their companies, global competence is an important consideration when hiring new engineers who will work either immediately or eventually in a global environment. These results provide a basic prioritization in competency development. Assuming that higher educational engineering institutions are currently proficient in developing technical competence

among engineering graduates, efforts should be made to evaluate current practices and to improve global competence for engineers with ability to:

1. Communicate cross-culturally
2. Appreciate and understand different cultures
3. Work in international teams
4. Exhibit a global mindset
5. Live and work in a transnational engineering environment
6. Demonstrate world and local knowledge
7. Understand international business, law, and technical elements
8. Speak more than one language including English

Survey participants were also provided an opportunity to recommend what college and university engineering departments can do to better prepare engineers for success in a global engineering environment and 66 of 147 (44.9%) survey respondents for this section provided suggestions for improvement. Each of the qualitative responses was categorized into common themes and a histogram was developed that illustrates each category by percentage of respondents as seen in Figure 3.

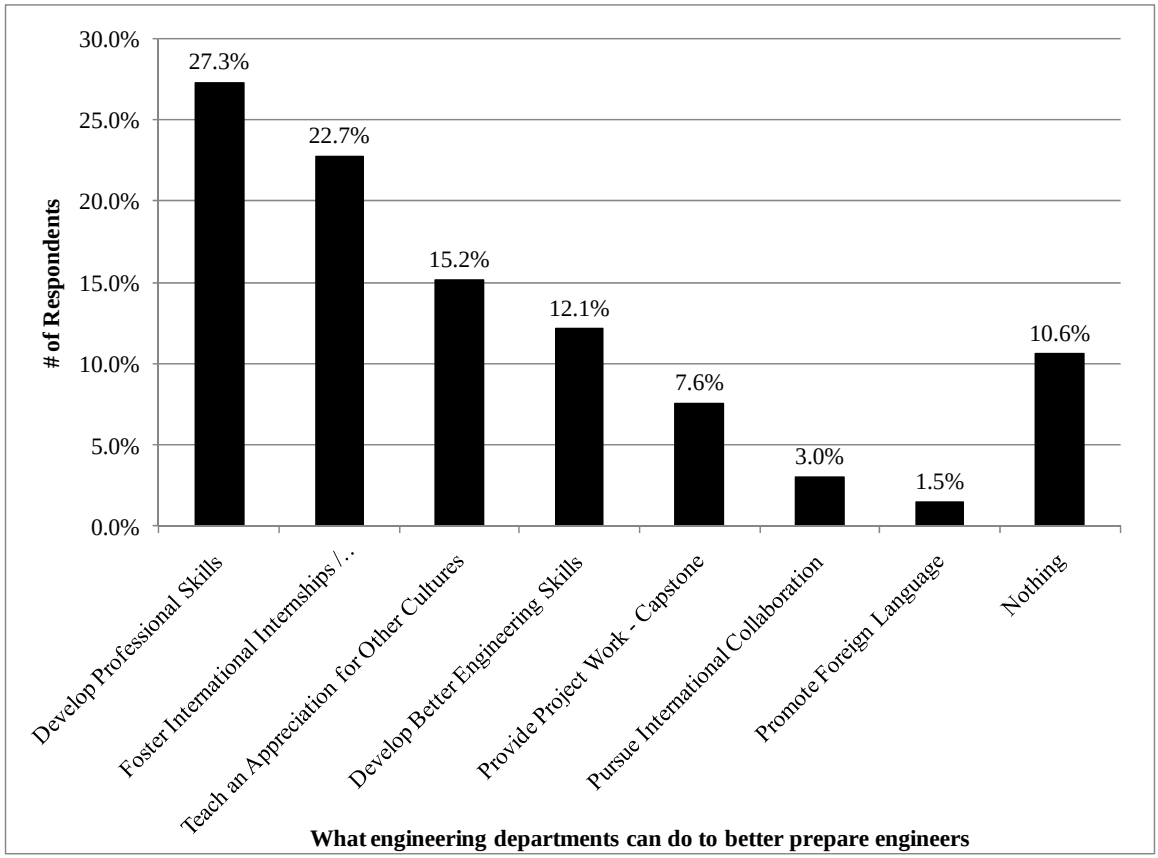

Figure 3. What college engineering departments and programs can do to better prepare engineers for success in a global engineering environment.

Although professional skills were purposely excluded from the survey because the focus of the study was to compare the importance of global competencies with standard technical

competencies, 27% of survey respondents indicated that professional skill development—including communication, presentation, and writing skills—is an important focus area for college engineering programs. This result supports what was already a commonly agreed upon competency requirement for engineers as identified by ABET and many scholars throughout the literature. Respondents' remaining suggestions for college and university engineering programs to improve their preparation of engineers for a global environment can be broken into two primary categories: the development of standard engineering technical competence and the development of global competence[24].

Survey participants who had worked in a global environment during part of their career were also given the opportunity to provide qualitative comments. Survey participants were asked, "What do you wish you would have known upon completion of college to better prepare you to work successfully in a global engineering environment?" All responses were categorized into common themes, as shown in Figure 4.

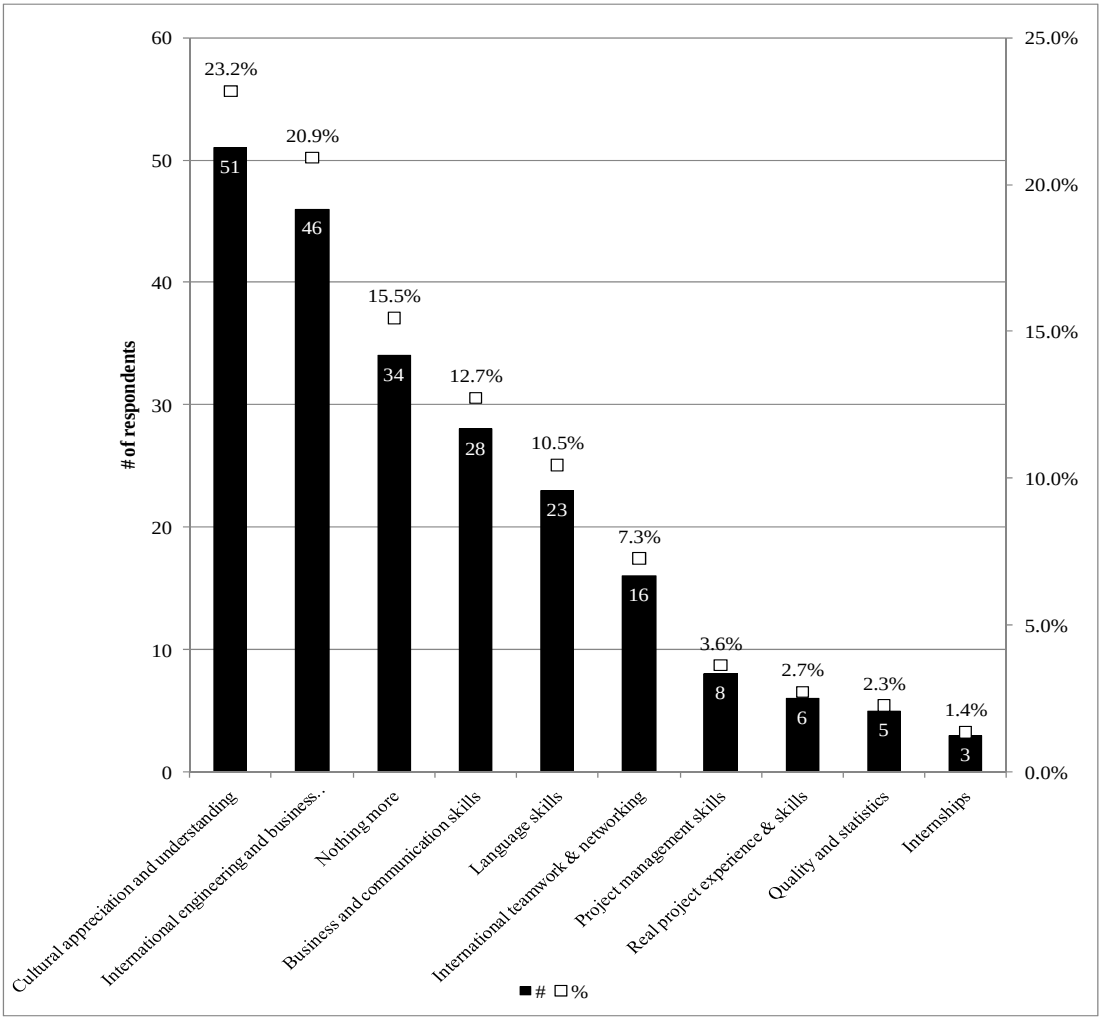

Figure 4. What do you wish you would have known upon completion of college to better prepare you to work successfully in a global engineering environment?

Of 220 respondents 51 (23.2%) indicated that they wished they would have had better cultural appreciation and understanding. This result supported the evidence presented previously concerning the importance of engineers developing an appreciation and understanding of different cultures. Thus, both the quantitative and the qualitative data support the importance of an ability to appreciate and understand cultures. In addition, 46 (20.9%) indicated a desire to have been better prepared to conduct business and engineering in an international environment. The competency to understand international business, law, and technical elements was not considered as important as other competencies based upon the competency portion of the study. However, with more than 20% of survey respondents indicating that they wished they would have had a better understanding of international business, law, and technical elements, it seems apparent that an ability to understand these elements was an important competency for engineers to obtain success in a global engineering environment.

Thirty-four (34) out of 220 (15.5%) respondents felt that they were adequately prepared for success in a global engineering environment. A few commented that previous international experience was helpful in preparing them for the future. Language skills were identified by 23 of 220 (10.5%) survey respondents as something that could have helped them in their career. This gives some validity to the global competence of an ability to speak more than one language including English. Many of the qualitative comments provided by survey participants supported the validity of the identified global competencies developed in the literature review. International teamwork was also mentioned by 16 of 220 (7.3%) participants which also supports the importance of the global competency of working in international teams. Eight (8) of 220 (3.6%) survey participants wished they would have had better project management skills, with others indicating a desire for real project experience, quality and statistics, and also internships.

Study results also indicated that 70% of companies, as rated by survey respondents were willing to provide training and experience for engineers to be successful in a global environment. However, the rated success of survey respondent companies was lower with only 59.9% of respondents indicating their company was successful at providing the appropriate training and experience for success in a global environment[24].

The data from this study indicates that most companies are willing to provide training and experience to help engineers succeed in a global engineering environment. However, the success of companies to develop global competence among engineers is lower than their willingness and therefore leaves room for improvement. Companies who conduct business in more than one country or who have operations in multiple countries should evaluate their current efforts and training procedures to determine how to improve global competence among employees.

On a similar note, survey respondents indicated that their companies valued the efforts of higher educational engineering programs in preparing engineers to work within a global environment, with 59.9% in agreement on its importance. The success of colleges and universities in preparing engineering graduates for a global engineering environment was perceived by survey respondents to be much lower than the success of the company's own efforts. Only 40 of 147 (27.2%) survey respondents agreed or strongly agreed that colleges and universities were successful at preparing engineers to work in a global environment[24].

An overall conclusion that can be drawn from these results is that companies generally consider higher education institutions an important component in preparing engineers for success in a global environment. However, the perceived success of higher education institutions in preparing engineers to work in a global environment is significantly lacking. As indicated previously, some higher educational institutions are involved in efforts to develop global competence among engineers. The majority of institutions employ an add-on approach to develop global competence, which includes instruction, study-abroad, and international certificate options. Based on the results of this study, with only 27.2% of respondents who consider engineering colleges and programs successful at preparing engineers for work in a global environment, current practices are just not sufficient.

Although this study was limited to mechanical engineering graduates from BYU, it is likely that the study findings are relevant to mechanical engineers from other institutions, as well as other disciplines within engineering and technology. Global competence is a topic that is far reaching and not only effects engineering and technology, but also has implications across many other industries. Additional research in this area is recommended.

Recommendations for Implementation

The study data clearly indicates an opportunity for higher education engineering programs to assess their educational efforts and identify ways to improve global competence among their engineering graduates. Higher education engineering institutions need to evaluate current efforts to prepare engineers for success in a global environment and to identify the changes that are necessary to increase global competence among their graduates.

What seems apparent is that many institutions have focused on trying to improve the global outcomes for their engineering students. While international efforts to improve global competence among graduates of engineering programs continue to increase, the percentage of students who have participated is still relatively small. Real success is likely to be achieved as colleges and universities focus on their own curricula to make global competency an essential part of a student's education[40].

Many challenges must be overcome, including incorporating global elements into an already packed curriculum, developing foreign language capabilities among engineering students, and dealing with timing differences in academic schedules of international schools. Improvement of global outcomes will require commitment from higher education institutions in producing globally competent engineers. Faculty will need to not only focus on helping students acquire technical skills but also on providing opportunities for students to gain international experience as well[33]. The incorporation of global elements will likely require a review and modification of existing curriculum to make sure that it is comprehensive, coherent, and accessible to all students[30].

Faculty members in engineering institutions throughout the world are encouraged to identify opportunities within each course they teach to facilitate interaction of engineers within a global environment. Efforts to develop global competence among engineering students may include

team-based projects, work-focused projects in different countries, interaction of engineers in a multicultural environment, international educational partnerships among colleges and universities throughout the world, and the use of technology to develop cross-cultural competence through virtual teams.

Students' involvement in a global environment throughout their education versus a single study abroad experience will greatly enhance the capabilities of engineering graduates to succeed in a global environment. Based on this study, particular focus should be placed on incorporating each of the following global competencies into the curriculum with ability to:

1. Communicate cross-culturally
2. Appreciate and understand different cultures
3. Work in international teams
4. Exhibit a global mindset
5. Live and work in a transnational engineering environment
6. Demonstrate world and local knowledge
7. Understand international business, law and technical elements
8. Speak more than one language including English

Based on the results of this study, it is the opinion of the author that success in developing global competence among engineering students will require a deviation from the current practices of providing a few add-on international courses or experiences. Improving global outcomes in engineering will require a total integration of global competence across the curriculum. It is the opinion of the researcher, based on this study, that higher education engineering institutions should consider the following to improve global competence among their students:

1. Utilize the list of eight global competencies developed as part of this study and assess current student proficiencies for global competence. This would help establish a baseline of current performance and could serve as a benchmark to assess efforts to improve global competence among graduates. A five-point Likert scale assessment could be utilized to determine agreement for each competency using the agreement scale shown here:
    - 1 = Strongly disagree (SD)
    - 2 = Disagree (D)
    - 3 = Neutral (N)
    - 4 = Agree (A)
    - 5 = Strongly agree (SA)

Each student or graduate could be asked to rate their agreement with the following statements, "I consider myself proficient in":

Global Competency	SD	D	N	A	SA
Communicating cross-culturally	O	O	O	O	O
Appreciating and understanding different cultures	O	O	O	O	O
Working in international teams	O	O	O	O	O
Exhibiting a global mindset	O	O	O	O	O
Living and working in a transnational engineering environment	O	O	O	O	O
Demonstrating world and local knowledge	O	O	O	O	O
Understanding international business, law and technical elements	O	O	O	O	O
Speaking more than one language including English	O	O	O	O	O

2. Evaluate current curricular offerings to determine which courses include global elements and to what degree and incorporate global elements into all curricular offerings.
    a. For example, an engineering design course that previously had students gain experience in designing engine parts for General Motors could modify the assignment to design a non-electric water-pump for a village in Mozambique.

3. Identify global partner institutions and establish working relationships with these institutions to provide opportunities for students to interact with people from different cultural backgrounds and countries. These partnerships could include:
    a. Cross-cultural virtual teams: Utilization of technology to facilitate team interaction on different assignments or projects for a given course.
    b. Study-abroad: Students travel internationally to gain exposure to different cultures and countries.
    c. Senior design or Capstone projects: Student teams from different universities and countries collaborating to complete an industry sponsored project.
    d. Collaborative international research: Faculty and students from different international locations collectively conduct research utilizing the strengths and capabilities of each individual and institution.
    e. Student exchange: Students from partner institutions are exchanged to experience a semester or more at the host institution.

4. Encourage students to complete a foreign language minor.

5. Add a requirement for all juniors and seniors to attend a weekly one-hour seminar focused on globalization.
    a. This seminar would be a 1/2 credit hour course each semester and would count towards graduation requirements.
    b. Faculty and guest speakers would provide instruction on different topics pertinent to globalization including: awareness of the cultural environment, ethnocentrism, linguistic diversity, communicating across cultures (verbal and nonverbal),

international business, international law, cross-cultural negotiation, implications of international teams, and other global elements.

6. Encourage faculty to model the importance of globalization. Faculty should be involved in globalization activities, express its importance, and provide opportunities for students to gain global experience.

Recommendations for Future Research

The purpose of this study was to determine whether multinational companies consider global competence an important skill in mechanical engineering graduates when making hiring decisions. The study established that standard engineering technical competencies were the most important consideration when hiring mechanical engineers, but global competence was also an important consideration when hiring new engineers to work in a global environment.

The analysis of the data presented in this study generated the following topics and considerations for further research:

1. Do the findings of this study apply to an engineering population larger than BYU mechanical engineering graduates?
2. Do the findings of this study apply to other academic disciplines when considering the importance of global competence in engineering graduates?
3. Does global competence predict actual outcomes in engineers?
4. Is it possible to identify the antecedents of global competence and if so, what are they?
5. What are the effects of faculty being involved in globalization activities on students?
6. Conduct a comparison of leading engineering institutions to determine the importance placed on preparing engineers for success in a global environment.
7. Identify and assess outcomes and metrics to measure the effectiveness of global competence instruction in higher education engineering institutions.

Globalization is not a passing phenomenon, it is here to stay. Colleges and universities throughout the world need to recognize the importance of globalization and the interdependence and interconnectedness among the world's population[20]. Therefore, based on this study, it is important to identify, develop and provide opportunities for international collaboration and interaction among students and faculty throughout the world and to focus on developing global competence as an important outcome for engineering graduates.

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