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Assessing Engineering Global Competencies – Importance and Preparation

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Abstract

In the last decade and a half, there has been particular interest and action towards globalization and preparation of undergraduate engineers for the practice of engineering in a global context. To support program change decisions, a study with the goals of 1) determine the relative importance of a defined set of eight competencies related to the practice of engineering in a global context, 2) determine the perceived level of preparation of recent engineering graduates related to the competencies, 3) collect suggestions for improvement from selected constituencies, and 4) gather both information about current company practices and employment conditions for recent graduates, was undertaken. By seeking ratings of both importance and preparation, both importance and a gap analysis can be used to set priorities for curriculum change. Eight competencies were arrived at by review of competencies from recent studies reported in the literature for engineering and those defined for all students of the University by the Office of International Affairs at Ohio State University. The eight are:

1. Understanding of global cultural diversities and their impact on engineering decisions.
2. Ability to deal with ethical issues arising from cultural or national differences.
3. Proficiency in a second language.
4. Ability to communicate across cultural and linguistic boundaries.
5. Proficiency in working in an ethnically and culturally diverse team.
6. Understanding of the connectedness of the world and the workings of the global economy.
7. Understanding of the international aspects of engineering topics such as supply chain management, intellectual property, liability and risk, market and product design considerations, and business practices.
8. Familiarity with the history, government, and economic system of several target countries.

Surveys were conducted using three populations: 1) 2 and 3 year engineering alumni, 2) 10 and 15 year engineering alumni, and 3) members of the departmental and college advisory committees. Respondents were asked to rank, using a Likert type scale, the eight competencies for both importance and preparation. From this a gap or difference was calculated.

Summary observations include:

- Sequence of **importance** ratings shows some difference of opinion between groups. However all three highly rated both: 7. *Understanding of the international aspects of engineering.…* and 5. *Proficiency in working in … diverse team.* Two of the three groups highly rated 6. *Understanding of the connectedness.…*. The lowest two for all three groups were: 3. *Proficiency in a foreign language* and 8. *Familiarity with the history.…*.
- Sequence for gap or **difference** (Importance-Preparation) ratings also shows some similarities and some differences. All three groups showed the largest gap, by some margin, for: 7. *Understanding of the international aspects of engineering.…*. Across groups the next largest gaps would be 6. *Understanding of the connectedness of the world*… and 4. *Ability to communicate across cultural and linguistic boundaries*.

Project teams (both within classes and extra-curricular activities) were by far the most frequently mentioned item in open-ended responses regarding what impacts global competency in engineering-related fields. When combined with design courses, it is clear that the experiential learning components of the engineering curriculum play a major role in global competency. The formal curriculum, general education and specific major and minor courses, also play a significant role in attainment of global competency.

Background

In the last decade and a half, there has been an increase in interest of globalization topics by universities. In 2006, the Association of American Colleges and Universities (AAC&U) conducted a study where results show that only "18 percent of employers rated graduates as very well prepared in global knowledge; 46 percent felt that graduates were not well prepared." [1] Based on this research, Hovland concludes that "college and university students will benefit from a careful and intentional alignment of global learning goals with the essential learning outcomes of a liberal education – what it means to be a well-educated citizen for the twenty-first century." Similarly, Downey, et al. [2] state that global competency in engineering "[shows] that the often-stated goal of working effectively with different cultures is fundamentally about learning to work effectively with people who define problems differently." Warnick, et al. [3] summarized the approaches of Universities to developing global competence. They note that study abroad programs continue to be the most prevalent method to provide global educational experiences for engineering students. They also addressed the five areas that Brigham Young University is focusing on to promote competence, which include technical excellence, character/ethics, innovation, leadership, and global competence. They also state the in order to update their curriculum for global teachings, they set out to create a set of high level competencies, as well as promote technically-oriented international programs and experiences.

As Jesick [7] points out, there are two main questions which need to be answered. One is the definition of what it means to be globally competent, and the other is what dimensions of global competency are the most important. Although no consensuses has been reached in defining global competency, areas that tend to be looked at more prominently include foreign language capacity, awareness and knowledge of different cultures, awareness and knowledge of other technology, education and business practices, ability to work effectively in a multicultural work team, and global citizenship self-efficacy [4]. A study by Clarke et al. [5] yields similar results stating that study abroad programs tend to focus on global mindedness, skills with intercultural communications, openness to diverse people and intercultural sensitivity. Williams [6] suggests that the three most important areas under 'Intercultural Competency' include a Cognitive dimension where students gain knowledge about the culture they are encountering; an Affective dimension where students must become flexible to new situations and learn how to adapt and be open minded; and finally a Behavioral dimension where students learn about critical skills such as resourcefulness, problem-solving, and culturally-appropriate social skills.

Looking at the current curriculum and why it is important to adapt to the changing world as King [8] noted "the economic realities of global competition and the arrival of ubiquitous broadband communications are driving entry-level and more routine engineering jobs overseas… American

engineers need additional dimensions of knowledge in order to compete for the United States to retain its role as world leader in technological innovation."

Study Development

As a part of a continuous quality improvement program, the College of Engineering periodically sets up study groups around specific issues. In this case the Core Curriculum and College Services Committee authorized a study group around the preparation of undergraduates for the practice of engineering in a global environment. The study group included engineering faculty, graduate and undergraduate students as well as representatives from the Office of International Affairs. The initial charge to the group included to identify and define important dimensions/competencies, and their relative importance, that could or should be addressed in our engineering curriculum in some way. Once developed, these were used as the basis for the three surveys evaluated in the study. Three primary sources were relied upon for identification of specific competencies. The first was developed by the Ohio State University Office of International Affairs as competencies for all students [9]. The second and third directed specifically toward engineering student competencies and were presented in recent ASEE papers [4] [10]. Table 1 shows the competencies from the original sources

The Klein-Gardner and Walker [4] survey found a range of 2.8 to 4.3 (5 point scale) for importance of their categories with the five highest being; 1) ability to communicate across cultures, 2) the ability to appreciate other cultures, 3) a proficiency working in or directing a team of ethnic and cultural diversity, 4) the ability to effectively deal with ethical issues, and 5) possessing understanding of cultural differences in engineering work. Based on 38 responses (not intended to be statistically significant) to a survey of a variety of engineering alumni and fewer than 10 senior faculty members who had engineering experiences on a global basis, Waggenspack, et al. [10] found their top three items to be "understanding of global cultural diversity", "oral, written, and visual communication skills", and "ability to work harmoniously and efficiently in diverse group settings".

The College of Engineering study group, by a consensus building process, consolidated the three lists into the eight statements shown in Table 2. The group reached these eight global competencies by combining similar statements and eliminating some that were deemed to be an experience rather than a competency. However, while having reached consensus that these are desirable competencies for the practice of engineering in a global context, two important questions remained as to their relative importance and how well prepared our current students are in these particular competencies. These two of questions have been addressed in previous surveys by the College for areas such as ethics [11], general education [12] and communication [13] by use of alumni surveys. The surveys generally asked the respondent to rate both the importance of the item and the level of preparation for recent graduates. They also gave opportunity for suggestions and collected some potentially relevant demographics.

Table 1. Global Competencies for Engineering from the Literature

	International Affairs 5 Competencies [9]	Dimensions of Global Competence [4]	To succeed in today's global workforce, an engineer must [10]
1	Ability to work effectively in international settings.	Can appreciate other cultures.	Show mastery of at least on foreign language for native English speakers.
2	Awareness of and adaptability to diverse cultures, perceptions and approaches.	Are able to communicate across cultures.	Complete a study abroad experience (either summer or semester).
3	Familiarity with the major currents of global change and the issues they raise.	Are familiar with the histories, governments, and economic systems of several target countries.	Have profound understanding of global cultural diversities and their impacts on engineering decisions.
4	Capacity for effective communication across cultural and linguistic boundaries.	Can speak a second language at a conversational level.	Have well developed oral, written, and visual communication skills.
5	The ability to comprehend the international dimension of one's field of study.	Can speak a second language at a professional (i.e. technical) level.	Demonstrate an ability to work harmoniously and efficiently in diverse group settings.
6		Are proficient working in or directing a team of ethnic and cultural diversity.	Achieve professional licensure/registration.
7		Can effectively deal with ethical issues arising from cultural or national differences.	
8		Have an understanding of the connectedness of the world and the workings of the global economy.	
9		Understand implications of cultural differences on how engineering tasks might be approached.	
10		Have some exposure to international aspects of topics such as supply chain management, intellectual property, liability and risk, and business practices.	
11		Have a chance to practice engineering in a global context, whether through an international internship, a service-learning opportunity, a virtual global engineering project or some other form of experience.	

Table 2. Consolidated Global Competences for Engineers

1. Understanding of global cultural diversities and their impact on engineering decisions.
2. Ability to deal with ethical issues arising from cultural or national differences.
3. Proficiency in a second language.
4. Ability to communicate across cultural and linguistic boundaries.
5. Proficiency in working in an ethnically and culturally diverse team.
6. Understanding of the connectedness of the world and the workings of the global economy.
7. Understanding of the international aspects of engineering topics such as supply chain management, intellectual property, liability and risk, market and product design considerations, and business practices.
8. Familiarity with the history, government, and economic system of several target countries.

The study group developed and pre-tested surveys on students in our ASEE student chapter, study group members, and two members of College Advisory Committee. IRB approval was received for three populations; 2 and 3Year Engineering Alumni, 10 and 15Year Engineering Alumni, and members of the various Departmental and College Advisory Committees. Two web-based survey versions were developed and distributed with the use of Qualtrics software package. The first focused on 2 and 3 Yr Alumni. The second focused on 10 and 15Year Alumni and Advisory Committees. For both surveys and for each of the eight identified competencies, participants were first asked to rate A) the Importance – How important do you think this topic is to engineering education? (1= Not Important 5= extremely important, or No Opinion) and B) Preparation – How well have you [recent undergraduates for alumni and advisor] been prepared in these areas? (1 = Not prepared; 5 = Well Prepared; or No Opinion). Each group received one email reminder/repeat request to complete the survey.

Results and Discussion

The three populations surveyed, response numbers and response rates are summarized in Table 3.

Table 3. Populations Surveyed, Response Numbers and Response Rates

Group	Total	No. Respondents	Response Rate
2 & 3Year Alumni	1379	315 (80% M; 20% F)	22.8%
10 & 15Year Alumni	770	31	4%
Advisory Committees	176 (1 College, 9 Departments)	22	12.5%

Comparison of Rating of Competencies – Importance, Preparation, and Difference

Rating of importance, preparation, and the calculated gap for the eight competencies is displayed the three groups in Figures 1-3. Numeric values are also given in Table 4. Means across the competencies, last line of Table 4, shows a pattern where that the Advisory group members rated importance higher than 10 and 15 Year alumni and 10 and 15 year alumni higher than 2 and 3 Year alumni. However, preparation level was rated much more consistently across the three groups. The rating of importance also correlated very highly with the frequency of travel abroad for business (collected in demographic data).

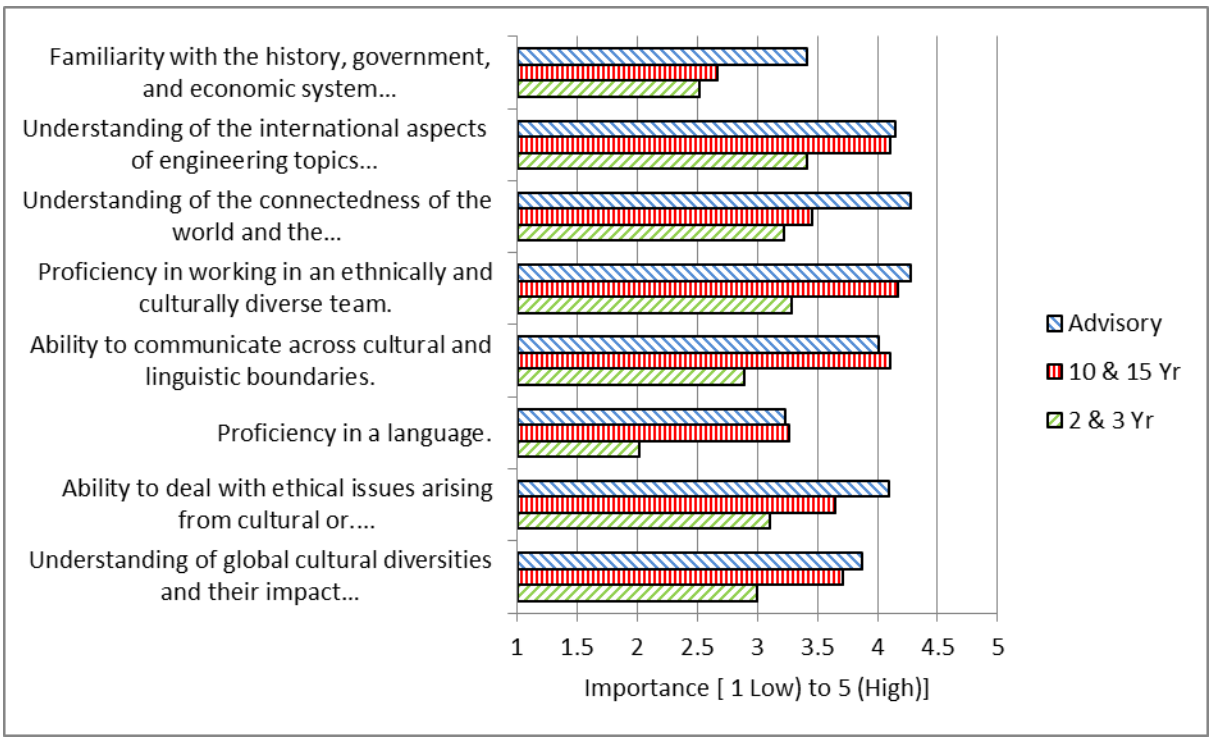

Figure 1. Importance Rating for Global Competencies

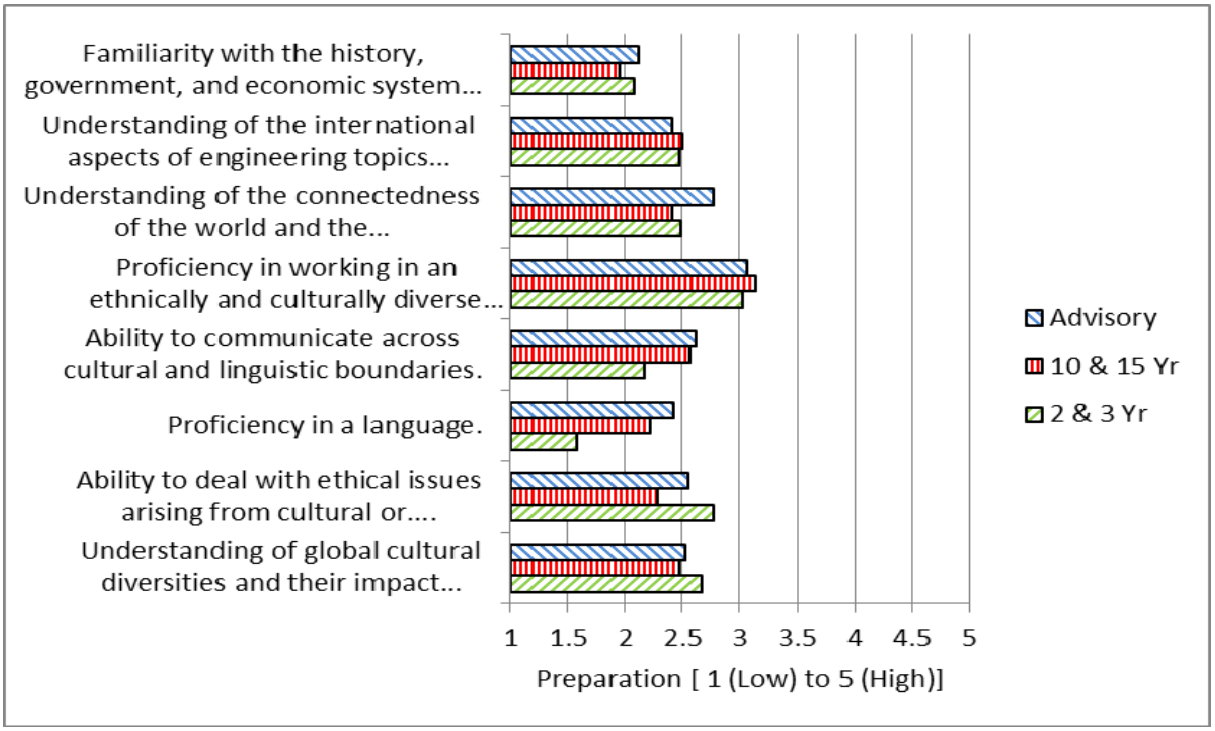

Figure 2. Preparation Rating for Global Competences

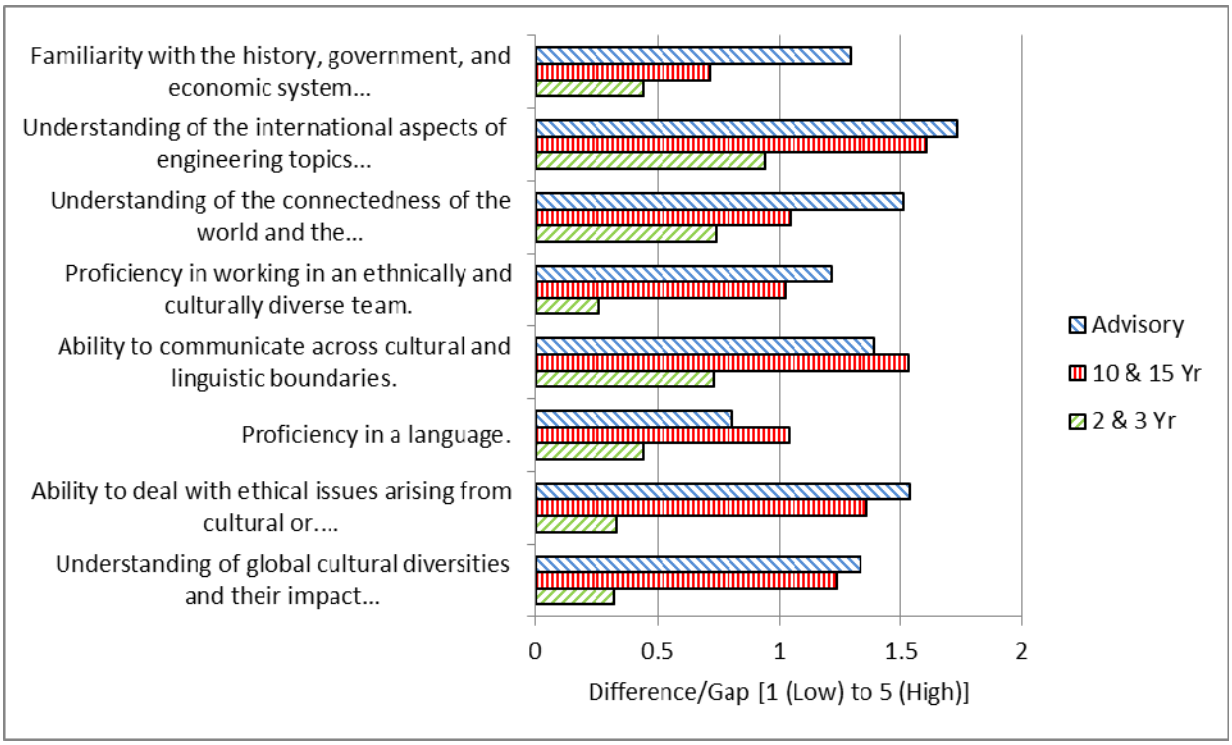

Figure 3. Gap/Difference in Ratings For Global Competencies (Importance – Preparation)

Table 4. Competency Ratings - 2 and 3 Yr Alumni, 10 and 15 Yr Alumni, and Advisory Committee Members [Scale 1 (Low) to 5 (High)]

	2 & 3 Yr Alumni			10 &15 Yr Alumni			Advisory Committee		
Competency	Import	Prep	Diff	Import	Prep	Diff	Import	Prep	Diff
Understanding of global cultural diversities and their impact on engineering decisions.	2.99	2.67	0.32	3.71	2.48	1.23	3.86	2.53	1.33
Ability to deal with ethical issues arising from cultural or national differences.	3.10	2.77	0.33	3.65	2.29	1.36	4.09	2.56	1.54
Proficiency in a language.	2.01	1.57	0.44	3.26	2.22	1.04	3.23	2.42	0.81
Ability to communicate across cultural and linguistic boundaries.	2.89	2.16	0.73	4.10	2.57	1.53	4.00	2.61	1.39
Proficiency in working in an ethnically and culturally diverse team.	3.28	3.02	0.26	4.16	3.14	1.02	4.27	3.06	1.21
Understanding of the connectedness of the world and the workings of the global economy.	3.22	2.48	.74	3.45	2.41	1.04	4.27	2.76	1.51
Understanding of the international aspects of engineering topics…..	3.41	2.47	0.94	4.10	2.50	1.60	4.14	2.41	1.73
Familiarity with the history, government, and economic system of several target countries.	2.51	2.07	0.44	2.67	1.95	0.71	3.41	2.12	1.29
Means	2.93	2.40	0.53	3.64	2.44	1.19	3.91	2.56	1.35

An additional question "Overall, how would you evaluate the importance of global competencies for your employment and the preparation you received as an undergraduate?" was asked of only 2 and 3 Yr alumni. They gave it an Importance rating of 2.97 out of a possible 5, and Preparation Rating of 2.40 out of a possible 5 for a Difference of 0.48. For 2 and 3 Yr Alumni only, these numbers can be compared to those collected for some similar questions on the general college survey. For eighteen questions related to ABET defined educational outcomes (often referred to as A-K), the means were 3.99 for Importance and 3.57 for Preparation. Table 5 displays results for three questions from the general survey that can be most directly compared to the globalization survey. Clearly these questions and importance at large for globalization competencies were not ranked as highly as the average of others although similar questions had similar means for importance.

Table 5. Selected Responses from the General 2 and 3Yr Alumni Survey

Question	Importance	Preparation	Difference
Ability to: Function in culturally and ethnically diverse environments	3.67	3.92	-0.24
Understanding of: Impact of engineering solutions in a global and societal context	3.32	3.22	0.1
Understanding of: Contemporary issues	3.25	2.99	0.26

The following two tables allow quick comparison order of **importance** ranking across all three groups (Table 6) and the **gap/difference** between importance and preparation (Table 7). The Tables are in order by the highest to lowest Importance/Gap as determined by the 2 and 3year alumni group. Sequence of **importance** ratings shows some difference of opinion between groups. However all three rated highly both: 7. *Understanding of the international aspects of engineering…* and 5. *Proficiency in working in … diverse team.* Two of the three groups highly rated 6. *Understanding of the connectedness….* The lowest two for all three were: 3. *Proficiency in a foreign language* and 8. *Familiarity with the history….* Sequence for **gap/difference** (Importance-Preparation) ratings also shows some similarities and some differences. All three groups showed the largest gap, by some margin, for: 7. *Understanding of the international aspects of engineering….* Across groups the next largest gaps would be 6. *Understanding of the connectedness of the world…* and 4. *Ability to communicate across cultural and linguistic boundaries*. Although it cannot be confirmed by the survey directly as cause and effect, an explanatory observation for the lower value for the GAP/DIFFERENCE regarding "Ability to deal with ethical issues arising from cultural or national differences" of the 2 and 3 Yr Alumni may be that they were the first group to have experienced a specific requirement of an applied ethics course within the general education curriculum for engineering.

Additional single answer and open-ended questions followed on each survey. For 2 and 3 Yr Alumni these focused on their student experience, activities as a student, and current employment experience. For the 10 and 15 Yr Alumni and Advisory Groups, questions focused on support and expectations of employees in their first years of work after undergraduate study, characteristics of the company, and the global experience of respondent.

Table 6. Comparison of **Importance** Ranking Across Survey Groups

	2 & 3 Yr Alumni	**10 & 15 Yr Alumni**	**Advisory Comm**
Understanding of the international aspects of engineering topics such as supply chain management, intellectual property, liability and risk, market and product design considerations and business practices	1	2	3
Proficiency in working in an ethnically and culturally diverse team	2	1	2
Understanding of the connectedness of the world and the workings of the global economy	3	6	1
Ability to deal with ethical issues arising from cultural or national differences	4	5	4
Understanding of global cultural diversities and their impact on engineering decisions	5	4	6
Ability to communicate across cultural and linguistic boundaries	6	3	5
Familiarity with the history, government, and economic system of several target countries	7	8	7
Proficiency in a foreign language	8	7	8

Table 7. Comparison of **Gap/Difference** Ranking Across Survey Groups (1 = Largest Gap)

	2 & 3 Yr Alumni	**10 & 15 Yr Alumni**	**Advisory Comm**
Understanding of the international aspects of engineering topics such as supply chain management, intellectual property, liability and risk, market and product design considerations and business practices	1	1	1
Understanding of the connectedness of the world and the workings of the global economy	2	5	3
Ability to communicate across cultural and linguistic boundaries	3	2	4
Familiarity with the history, government, and economic system of several target countries	4	8	6
Proficiency in a foreign language	5	6	8
Ability to deal with ethical issues arising from cultural or national differences	6	3	2
Understanding of global cultural diversities and their impact on engineering decisions	7	4	5
Proficiency in working in an ethnically and culturally diverse team	8	7	7

The following sections gives more detailed information for 2 and 3 Yr Alumni and then 10 and 15 Yr alumni combined with Advisory Group responses. Questions are shown in *italics.*

Additional Questions 2 and 3 Year Alumni Survey

At the beginning of the survey, respondents were asked "*Do you have any clarifying comments to your answers to the questions above?"* Almost all of the comments (45) contributed by this open-ended question are encompassed in following survey questions. However two that could be considered unique were:

- While global competency is important, it should not be the focus of an engineering education.
- Domestic competency should not be overlooked either...it's important to compare and contrast and help foreign engineering students understand the United States as well.

The recent alumni were asked "*What parts of curriculum, other activities, or other parts of the* Ohio State University *experience do you think contributed most towards your global competency? (Gen Ed, Design Classes, Project Teams, Organizations, Other)?"*. Items noted by the respondents to this question were placed in to the ten (10) categories as noted in Table 8. Project teams (both within classes and from extra-curricular) were by far the most frequently item mentioned as impacting global competency (27% of all responses). When combined with design course responses, it is clear that the experiential learning components of the engineering curriculum play a major role in global competency. The category of Other Classes (27 responses) included a very wide array of specific courses within the majors, minors, and electives with no consistent pattern. When combined with general education (25 responses) and language courses (3 responses), it is clear that the formal curriculum also plays a significant role in attainment of global competency. It is also worthy to note that student organizations (14 responses) and the diverse nature of our student body, faculty and staff (18 responses) were also noted with significant frequency. Given the small percentage of engineering students studying language or studying abroad, the small numbers in these categories would not be unexpected.

Table 8. Contributing Most Towards Global Competencies (166 completions, resulted in 205 items)

Experience Noted	**No.**
Project Teams	55
Classes	
Design	27
Other	27
General Ed	25
Language	3
Work Experience (Intern)	10
Study Abroad	6
Student Organizations	14
Diversity of Population	18
Unclassified	20
Sum =	205

Recommendations for improvement were sought by asking "*What changes would you recommend for our undergraduate engineering education to improve the preparation for the*

global practice of engineering (e.g. language courses, education abroad, service learning, cultural courses, new specific courses, embedded in current courses, global design courses, other)?". Individual recommendations were placed into nine (9) categories shown in Table 9 with a small number of representative comments for each. Expanding study aboard and international internships was recommended by 27% of the respondents. Advantages in both educational experience and competitiveness for employment were noted along with the need to make engineering students more aware of the opportunities. Use of language courses were highlighted positively by 23% of respondents and negatively by 2.5%. Challenges in curriculum space and choice of language were noted, while benefits for cultural understanding were frequent.

Table 9. Summary of Recommended Changes and Representative Comments (163 completions, resulted in 192 recommendations)

Part a.

Category for Recommended Change	**No.**	
Expand Study Abroad, Intl Internships	44	
Increase Language Course Enrollment	42	4 negative
Global Focus in Design Courses	25	1 negative
Courses in Culture, Intl Issues, Politics	22	1 negative
Utilize Business Courses	12	
Change Not Necessary	11	
Embed Topics in Curriculum	7	2 negative
Support More Teamwork	5	
Not responsive to question or did not fit a category	25	
Sum=	193	

Part b. Representative Comments by Category

Expanding Study Abroad, International Internships

- More opportunities (or better publicizing) for engineering-related study abroad. Perception is that study abroad is for students in other majors.
- Highlight international internships and offer a minor in international engineering with classes designed for it.
- Integrate a study abroad program into the required curriculum and make it affordable.
- Study abroad opportunities encouraged/simplified/facilitated by the College of Engineering would make Ohio State grads markedly more attractive to employers.

Increase Language Course Enrollment

- I wanted to take a foreign language, but it would not have counted toward graduation.
- Introduce a language/culture course pertaining to the topics listed above (not so much an actual course to learn a language but rather how to diminish borders, per say.)
- We are in a career where it can be very important to come across well to other nations. I always thought it was strange that this requirement was waived for engineers
- I feel as though most engineering jobs now do not require much knowledge of a foreign language.

Global Focus in Design Courses

- A project focusing on designing a product or system to address a market need in a global/developing economy.
- Have a course that involves engineering design for an issue in a very different country than the U.S.
- I think the global competency is achieved through having the design practices that are used globally in the classroom.
- A global design course could be extremely interesting because it could touch on cultural differences and how they affect design requirements.

Courses in Culture, International Affairs, and Politics

- Special course or courses for worldwide culture/laws/politics specifically how it relates to engineering
- More courses on the current cultural aspects of the world...many comparative studies and reading/writing focus on the past vs what is currently happening.
- I think embedding more cultural awareness into current courses would help.
- Service learning, cultural exploration highlighting differences between how cultures interact and communicate

Utilize Business Courses

- Maybe adding a course about specific business types on a global level would be helpful.
- Engineering course on the global economy/manufacturing world
- I also think it would be very beneficial to offer an Intro to Legal Issues in Engineering.
- More classes dealing with how politics and the economy affect engineering.

The Ohio State University Office of International Affairs has proposed a framework for Colleges to develop a "Global Option" [9]. The goal being "Providing an enrichment program resulting in an institutional certificate for students who wish to acquire a meaningful international experience and global perspective as part of their major without adding time to graduation". With only a very brief description of the concept, the following question was presented to the 2 and 3 year alumni "*If a global curriculum option (An Enrichment program that permits students to acquire a documented international expertise integrated into any major.) was available, would you have chosen this option?"*. Of the 177 respondents, 38.4% indicated yes they would be interested in such a program with another 16.9% indicated they may be interested. With only 44.6% indicating they would not be interested.

Results of seven questions directed at international experience and demographics, for 2 and 3 Yr Alumni only, are summarized in Table 10. The table compares male and female responses as well as the overall response rates. Numbers for ethnicity categories were too small for meaningful comparisons. Highlights that can be gleaned from the table would include:

- A much higher percentage of students traveled abroad for vacation (36.7%) than for study or work abroad (7.7%) or other academic reasons (5.3%).
- A high percent of the employers of the graduates (77%) do business outside the US; with 39% of graduates working on international projects, 26% have already traveled abroad for professional reasons and a higher percent expect to in the next five years.
- Consistent with other studies, higher percentage of women than men participated in travel as a student. This appear to also carry forward to travel for and expect travel for professional

reasons, and is likely as a correlation for them being more likely to work for firms doing work internationally and specifically being assigned to international projects.

Table 10. International Experience and Demographics (2 and 3 Yr Alumni)

	Percentage Yes		
	All (N=315)	**Male (N=251)**	**Female (N=64)**
While you were a student, did you...?			
Study or work abroad	7.7%	4.1%	21.2%
Travel abroad for other academic reasons (meetings)? [3 (23.1%) overlap with study or work abroad]	5.3%	3.6%	11.3%
Travel abroad for vacation?	36.7%	33.8%	47.2%
When did you get your first passport?			
Before College	41.0%	38.6%	49.1%
During College	28.0%	28.4%	28.3%
Since College	14.0%	15.2%	7.5%
Do not have passport	17.0%	17.8%	15.1%
How often do you travel abroad for professional reasons?			
Never	74.0%	76.6%	62.3%
One or twice per year	20.0%	17.8%	30.2%
More frequently	6.0%	5.6%	7.5%
Do you expect to travel abroad for professional reasons in the next five years?			
Do not	16.0%	17.9%	11.3%
Not sure	37.0%	35.7%	41.5%
Once or twice	27.0%	26.5%	26.4%
More frequently	20.0%	19.9%	20.8%
Does your employer do business outside the US?			
	77.0%	74.9%	82.7%
Have you or do you work on international engineering projects?			
	39.0%	37.6%	44.2%
If you are a native English speaker, do you consider yourself proficient in a second language?			
	15.0%	14.7%	20.8%

Additional Questions for 10 and 15 Yr Alumni and Advisory Committee

Additional questions asked of the 10 and 15 Year Alumni and Advisory Committee members were intended to identify program of support for new employees, priorities for educational experiences of job candidates, their own experience with international engagement and some demographics about the person and company. Demographics of the companies represented a range by number of employees (1-100 23%; 101-500 21%; 500+ 57%) and primary market (Domestic 45%; Multinational 55%). In the following discussion, specific questions asked on the survey are again *italicized*.

Given that many companies have ongoing educational opportunities, the question was asked "*Does your employer support employees in gaining any of the following competencies?"* Responses shown in Table 10 demonstrate a range with the highest percentage being in the competency of "working on an ethnically and culturally diverse team" and the lowest "proficiency in a language". Participants mentioned that many of these areas are addressed in courses provided by the company mostly per request of the employee. If the company itself did not have direct support for the employee, they would receive monetary compensation to take a course elsewhere.

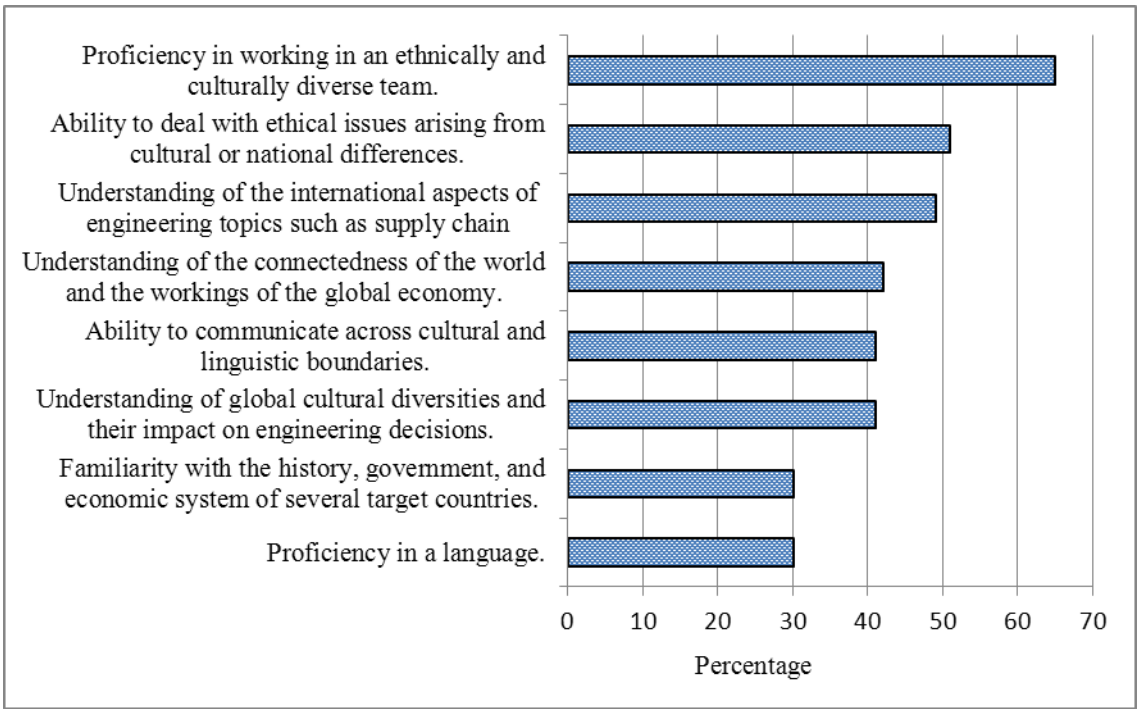

Figure 6. Employers with a program to assist with competencies (%) (Combined 10 and 15 Yr Alumni and Advisory Committees)

To gage how employers valued various experiences and competencies, they were asked "*As an employer, what value would you place on the following skills if they were listed on a job candidate's resume? (1 = Low Value, 5 = High Value)".* Responses shown in Table 11 indicate employers would value students having "completed an engineering study abroad" over "having

fluency in another language", "completing a non-technical study abroad", or "having a cultural awareness course or experience".

Table 11. Value of College Experiences Towards Employment

	Importance (1(low) – 5 (high))	
What value would you place on:	**10 & 15 Yr Alumni**	**Advisory**
Completed an engineering study abroad experience	3.59	3.91
Having fluency in another language	3.56	3.45
Completed a non-technical study abroad experience	2.63	3.41
Having a cultural awareness course or experience	2.78	3.36

A series of questions were asked in order to understand the international experience of the survey respondents and their employers. Table 12 demonstrates that a high percentage of their firms do business outside the U.S. and work on international engineering projects, and that greater than one-third of employees will be traveling abroad in their first two years of employment.

Table 12. International Travel and Work

	Answered Yes	
While you were a student did you:	**10 & 15 Yr Alumni**	**Advisory**
Study or work abroad?	22%	23%
Travel abroad for other academic reasons?	7%	23%
Travel abroad for vacation?	59%	36%
International Work:		
Does your employer do business outside of the US?	89%	95%
Do new employees travel abroad in the first 1 or 2 years of work?	33%	43%
Have you, or do you work on international engineering projects?	74%	77%

Respondents were asked questions regarding their own international travel and language skills (Table 13). Members of the advisory committees clearly travel abroad more frequently than the 10 and 15 Yr Alumni. A small percentage of participants in both groups also responded yes to the need to learn a new language for work reasons.

Table 13. International Travel and Language Skills of Survey Respondents

	Do Not		Once or Twice a Year		More Frequently	
	10 & 15 Yr	**Advisory**	**10 & 15 Yr**	**Advisory**	**10 & 15 Yr**	**Advisory**
Travel						
How often do you travel abroad for professional reasons?	37%	9%	59%	68%	4%	23%
Do you expect to travel abroad for professional reasons in the next five years?	26%	9%	63%	77%	11%	14%
Language	**Percent Yes**					
	10 & 15 Yr		**Advisory**			
Are you a native English speaker?	92%		86%			
If you are a native English speaker, do you use one or more other languages for work?	24%		14%			
If yes, which language?	Japanese (3), Arabic (2), Spanish, German		German			
Did you have to learn a new language for professional reasons?	4%		10%			
If yes, which language?	Japanese		Italian, German, Japanese			

When giving open responses to the question "*If you would like to give us further comments for consideration regarding preparing undergraduate engineers for the practice of engineering in a global context, please use the follow comment box."* A condensed version of two comments not included in early observations were:

- Based on your questions - I think you still do not get it - if you work in software/IT technology it is not an option - all large projects involve multi-cultural teams from several countries and many American companies are struggling getting the task done because of that; we are not able to deliver the cost savings through outsourcing because of this reason.
- Having grown up in Europe's education system I have a slightly different perspective. …One could summarize that employers today don't want someone who can do the job; they want someone who has already done the exact job.... Obviously colleges can never teach to the specifics of each job but progress can be made.

Concluding Remarks

Based on its study, including the survey reported here, the study group developed an overriding recommendation that the College of Engineering pursue a college-wide approach to integrating global competency for undergraduate engineers including to:

- Encourage discipline-focused study abroad, internships and coop opportunities.
- Develop a broad set of international experiences with enough variety to meet the needs in all the college's programs.

- Support faculty development for international opportunities.

The eight competencies identified by the Study Group were recommended as desired outcomes in this area.

The following specific actions are recommended:
1) Support interested faculty to develop and integrate curriculum elements within their current courses that address "Understanding of the international aspects of engineering topics such as supply chain management, intellectual property, liability and risk, market and product design considerations, and business practices."
2) Develop a "Global Option" as envisioned by Office of International Affairs specifically for engineering students. Core curriculum and College Services Committee should establish a work group for this purpose.
3) Make specific curriculum changes:
    - Change General Education requirement for diversity from U.S. diversity to World diversity.
    - Encourage our general education ethics course providers to include an element of international ethics within the approved courses.
    - Determine ways in which General Education options that develop the global competencies can be further encouraged.
    - Encourage inclusion of international aspects of engineering in the first-year course sequences.
4) Consistent with the College's strategic plan, establish a College of Engineering Globalization Studies Office with specific responsibilities and funding for study abroad opportunities and coordination of curriculum globalization activities within the curriculum.

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