TO: Lafayette College Study Abroad Office  
FROM: Caroline Goss and Perry Schiff  
DATE: May 2013  
SUBJECT: Study Abroad Workshop

With the increase in the presence of globalization in the engineering field, the U.S. has begun to face strong competition with other countries. Not only are other countries outperforming us in their engineering developments and projects, but they can provide services at a lower cost. This problem of outsourcing to other countries for engineering services will become more significant as years progress and will affect the nature of engineering in America. Students will be less likely to pursue engineering degrees, as trends in the job market will prove that companies are more willing to hire international candidates. Acknowledging this problem is the first step in determining a solution to improve U.S. engineering in relation to other countries.

For our Senior Engineering Studies Capstone Final Project, our group has attempted to create one method to help solve this problem. Becoming what is referred to as a ‘global engineer’ is a key quality in understanding how you can compete in the global job market with other engineers. Our group determined that the most effective way of building an international awareness is to study abroad, an opportunity that not many engineers typically seize. By studying abroad, engineering students can better understand the U.S.’s position in the international engineering community. However, after studying the patterns of how Lafayette students study abroad, our group has realized that the programs could be better integrated in the remainder of the engineering curriculums. That way, the students would have a better understanding of how valuable their abroad experiences are to their studies and careers later in life.

In order to better integrate the study abroad programs with the engineering curriculum at Lafayette, our group has proposed a workshop to be given to the sophomore B.S. engineers prior to their departures abroad. As part of the Senior Capstone Class syllabus, students are required to lead a discussion group. Therefore, we propose that one discussion leading option be to host this workshop. The reason why we want the senior EGRS students to hold the workshop is because A.B. students are exposed and trained to evaluate the various contexts that influence engineering problems. Therefore, many of the key concepts that EGRS students learn could be passed along to sophomore B.S. students looking to study abroad to open their minds to alternative ways of thinking. Ultimately, we want to educate the Bachelor of Science students on how to think like an Engineering Studies major while they are abroad.

Attached to this letter you will find a sample lesson plan that we propose the seniors use as a template as they plan the logistics for the workshop. As you will notice, the first few sections propose providing information specific to the effects of globalization on engineering, the various contexts of Spain and Germany, and the nature of engineering in the two countries. In order to save the seniors time and effort, we have provided a hefty packet of information in note form (also attached) as well. It is up to them to go through the packet to fully understand the material yourselves, and then choose what they think is most important to teach.

In the second part of the lesson plan you will notice that we suggest a number of discussion questions after the main presentation of the material. We have included in the lesson plan a number of sample questions that the seniors could use, but they should also be able to create new ones on their own using their knowledge from their EGRS experiences. Finally, they will go through a case study with the students to give meaning to the material they have just presented. This will reinforce the concepts for the sophomores and give them an interactive
opportunity to assess how much they have learned during the workshop. We suggest that they choose a case study from the Lucena textbook which the Capstone class reads during the semester, but if they have a strong desire to analyze another one, that would be acceptable as well.

In order to create a successful workshop, they will need to be in contact with your department, the Study Abroad Office. We worked closely with Ms. Gisolo during the course of our project, so she is well aware of the purpose and logistics of the program. Unfortunately our group was not able to actually host this workshop for a number of reasons, but we hope that you understand our goals and ambitions and continue to support this program. If the workshop goes well, there is potential for it to become a project for Capstone Seniors for many years to come. These types of projects are not perfect the first time around, so the final part of the assignment for the seniors will be to provide feedback in memo form to you and the Capstone professor describing what went well and what they could have changed so that next year the discussion leaders can continue to improve this project.
Sample Lesson Plan

I. Introduction to Study Abroad for Engineers
   i. Globalization in the engineering world
   ii. U.S. position in the world
   iii. What can you do?

II. While abroad, learn to listen

III. Introduction to Contexts
   i. What are the different contexts in the U.S., Germany, and Spain?
      a. Political
      b. Economic
      c. Cultural
      d. Technical
      e. Historical
      f. Geographic

IV. Introduction to Engineering Education
   i. Educational Systems/Certification Processes
   ii. Facts about Engineering Education
   iii. Engineering Identity

V. Discussion Questions (examples below)
   i. How is community involvement important in the problem I am trying to solve?
   ii. Will this project be sustainable in the community which it is being implemented?
   iii. As an engineer, do I have a social responsibility to help a community in need?
   iv. How do I better ‘listen’ to what a community needs so that I can find a solution that will match their needs and constraints?
   v. How are those constraints different in a foreign environment as opposed to in the U.S.? For example, certain communities are not willing to take as much risk or hold differing values than we in the US do?
   vi. If I am a Japanese engineer working for IBM Japan, am I working on behalf of Japan or of IBM’s host country, the USA? Or both? Or neither?
   vii. How and why has a given national emphasis in engineering changed over time?

VI. How to give significance to your study abroad experience
   i. Engineers Without Borders
   ii. Potential future projects
      a. Oeschle Global Studies Program
      b. Curriculum for international engineering class

VII. Case Study- El Cajon Dam in Argentina
   i. Divide class into small groups and have them fill out chart below
<table>
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<tr>
<th>Context</th>
<th>What are they?</th>
<th>How they influenced the project?</th>
<th>What could have been done differently?</th>
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INTRODUCTION TO STUDY ABROAD FOR ENGINEERS

“Rather than thinking of engineers as passively sharing cultures or grammatical styles, or simply manifesting structural interests or factors, it may be helpful to construe engineers as actively responding to the cultures, styles, interests, or factors that confront them; engineers may do so differently from one another and illustrates the separation between the shared historical experience of influences as challenges, expectations, or pressures and the diversity that emerges in events of affirmation, resistance, and transformation” (Downey & Lucena, 2004).

Globalization in the Engineering World
- Definition the increasing interaction of regional cultures and commerce. This includes the fields of engineering and its development into a global enterprise with numerous entities and business ventures around the world. Outsourcing is a major component of global impact, as establishing business on a global scale entails conducting business with countries possessing various levels of manpower and widely varying costs for labor and contracts (ASME, 2013).

- The whole world has become a market for the economies of many countries, and globalization is transforming not only the location and organization of production and services, but also social and economic patterns (Kenny & Dossani, 2005).

- Coming generations of engineers will inevitably be working in far different ways than their predecessors (Grandin, 2006).

- To stay in business, companies must be prepared to go to the market wherever it is- to remain innovative and competitive, they must seek out and cultivate the best talent worldwide to develop and manufacture the best products at the most efficient cost, regardless of location (Grandin, 2006).

- As a result of sophisticated telecommunications and the digitization of engineering work processes, increasing portions of engineering work can be done without close proximity to particular persons, places, or other processes (Kenny & Dossani, 2005).

- To thrive, engineers will have to be able to work productively with radically different cultures (Downey, Lucena, Moskal, Parkhurst, Bigley, Hays, & Nichols-Belo, 2006).

U.S. Position in the World
- US higher education continues to face many challenges including growing competition for international students, shrinking federal investment in basic research, rising infrastructure costs, and concerns about the employability of today’s graduates (Blumenthal & Grothus, 2008).

- American engineering students lack the cross cultural skills compared to their counterparts in Europe (Blumenthal & Grothus, 2008).
- In our country, there are growing concerns about the impact of globalization on our technological prowess, the long-term maintenance of our manufacturing capability as critical technological skills migrate abroad, our energy supplies, our research capacity, and our ability to stay on the cutting edge of engineering and science, which is essential to preserving our strength and freedom (Kenny & Dossani, 2005).

- It is worrisome that less than 5 percent of U.S. college students go into engineering, far fewer than the 12 percent in Europe and the 40 percent in China (Kenny & Dossani, 2005).

- In short, globalization can weaken us, or it can offer us, and the world, hope that we can find ways to avoid global conflicts and improve human welfare. But we must act now to ensure that the United States continues to prosper and has the strength and talent to contribute to improvements in the security and quality of life for people everywhere (Kenny & Dossani, 2005).

- Undergraduate engineering students in relatively advanced developing nations, such as India and China, follow a curriculum roughly comparable to the one taught in developed nations. Thus, even as barriers to performing conventional engineering work remotely are eroding, a global pool of conventionally trained engineers is growing. This means that U.S. engineers are now in global competition with engineers in developing nations whose wages are 40 to 80 percent lower than ours (Kenny & Dossani, 2005).

- If engineering education only provides them with the same skills as others in the global economy, many are likely to pursue other fields of learning. This would be unfortunate, however, because enormous opportunities are being created for technically skilled graduates capable of understanding and operating in global networks or with the entrepreneurial skills to discover new opportunities and pull together the resources and teams capable of actualizing them (Kenny & Dossani, 2005).

- Engineering is too important a contributor to our economy to entrust its future solely to market forces in the belief that a positive outcome will result. A more rational, positive response is to try to determine the skills future U.S. engineers will need and then make changes to provide them. Only then will U.S. engineers be capable of creating a new reality (Kenny & Dossani, 2005).

What can you personally do to help? Study Abroad!

- Attention is increasingly turning to the vehicle of short term study abroad as a way to infuse American undergraduate education with the global competencies; the opportunity stimulates interest in international education, language study, and global careers, while also providing students with skills that will better prepare them to be competitive in global market place (Blumenthal & Grothus, 2008).

- You will find yourself in a position of leadership because you are able to pull people together from different cultures and different disciplines to achieve the necessary goals (Grandin, 2011).
- You will develop cross-cultural communication skills (Grandin, 2011).

- You will gain an ability to work productively on teams involving those with very different cultural values, attitudes, and abilities (Grandin, 2011).

- You will appreciate a sensitivity to the opportunities and challenges presented to engineering endeavors in other regions of the world (Grandin, 2011).

- You will develop an appreciation of the limitations of the US-centric view of the world including the international perceptions of US strengths and weaknesses (Grandin, 2011).

- You will learn to work effectively with different cultures is fundamentally about learning to work effectively with people who define problems differently (Downey, Lucena, Moskal, Parkhurst, Bigley, Hays, & Nichols-Belo, 2006).

- You will be able to engage ways of thinking and understanding that differ from your own can refer either to ways of solving or of defining problems (Downey, Lucena, Moskal, Parkhurst, Bigley, Hays, & Nichols-Belo, 2006).
WHILE ABROAD: LISTEN!

- There are several common problems that make projects fail because they do not listen to the community

- Basic listening: necessary in any human communication, hearing or paying attention to messages, information is specific and quantifiable

- Contextual listening: necessary for SCD, multidimensional integrated understanding that facilitates meaning, quantifiable info only makes sense when context is understood
  - Integrating history and culture: communities shaped by international, national, regional, and local socio-cultural/ historical contexts
  - Being open to cultural differences and ambiguity: not only listening but accepting
  - Building relationships: get a clear understanding of shared struggles (takes time) then trust can grow
  - Minimize deficiencies and recognize capacities: see more value in things this way
  - Foregrounding self determination: the ability of the community to determine its own destiny without excessive external pressures
    - Ownership: if a community thinks they own a project, they are more likely to take responsibility of the upkeep
    - Achieving shared accountability: how the “ours vs theirs” becomes ours, projects should be shared missions

- Contextual listening problems come from EPS method that does not give a chance to listen because it’s such a regimen, and design problems that inhibit expansion

- Benefits of contextual listening
  - Counters biases
    - Documentation bias: since a lot of documentation is done orally, doing this type of listening allows engineers to see what may not be written
    - The dominant voices bias: official documents usually only get opinion of important people, it is important to overcome that and get all opinions
    - Hidden voice bias: important people like the elders get a voice
  - Fosters a community-centric approach to problem solving: makes community the center of any project
  - Integrates multiple groups of people

- PDS: Project, Definition, Solution
  - Method proposed to help problems of lack of contextual listening
  - Illuminates location (position or physical), knowledge (different views), and desires (basic and wanted needs)
  - Analysis and assessment done for each option
  - Mediation done to tweak
  - Shift in perspective
  - Can European methods be compared to this one? Think about incorporating several approaches to create new ones (Lucena, Schneider & Leydens, 2010).
INTRODUCTION TO CONTEXTS
- Engineers must think about their motivations, approaches, and relationships to the communities. Communities must be the focal point of projects (Lucena, Schneider & Leydens, 2010).

- Sustainability is usually thought of as technical reliability or environmental impact. (Lucena, Schneider & Leydens, 2010).

- When designing a project, the engineers need to think of the local context of its implementation (Lucena, Schneider & Leydens, 2010).

- The relationship between engineers and communities is problematic because engineers often think that technological development and modernization solves all problems, that this happens independently to society, culture, and politics, and that there is a universality of technology and its effectiveness (Lucena, Schneider & Leydens, 2010).

- Countries want to make their engineers maximally appropriate for time and place (Downey & Lucena, 2004).

- The cultural and historical specificity of such efforts illustrate the extent to which the questions of what counts as engineering knowledge and what counts as an engineer are linked tightly together, and also suggest that both may be tied in some way to what counts as a nation (Downey & Lucena, 2004).

- Understand the differences between the way Germans and Americans behave and function in their daily lives and understanding the German engineering culture (Grandin, 2011).

- Post-Humanism: Engineering projects are not affected by a single context solely, but all contexts play a role in shaping a given engineering scenario.

- Is vs. Ought: A social responsibility stating that simply because engineers have the ability to create a technology does not imply that that technology should be created. Alternatively, engineers have the responsibility to generate projects or technologies to create positive change that may not necessarily have been conceived yet.
U.S. CONTEXTS

Political
- In our country, there are growing concerns about the impact of globalization on our technological prowess, the long-term maintenance of our manufacturing capacity as critical technological skills migrate abroad, our energy supplies, our research capacity, and our ability to stay on the cutting edge of engineering and science, which is essential to preserving our strength and freedom (Kenny & Dossani 2005).

- Globalization has put even greater pressure on lawmakers to ease restrictions for H1-B visas, which allow U.S. companies to hire foreign tech workers. The cap on such hires annually is 65,000, with another 20,000 for H-1Bs with advanced degrees (Swartz, 2011).

- Half of Silicon Valley CEOs came from outside the U.S. And 40% of founders of the Fortune 500 are immigrants or the children of immigrants (Swartz, 2011).

- Congress blocked a plan to offer more permanent-residency visas (green cards) to foreign doctorate and master’s-degree students in science and technology fields. Republicans deliberately set up the bill to fail -- a bill which they ostensibly supported -- hoping to score political points and elicit campaign contributions from the technology industry, a Democratic-leaning constituency (Soltas, 2012).

- The federal government's support for R&D, as a share of the U.S. economy, has plummeted by nearly two-thirds since the 1960s, says Rep. Rush Holt, D-N.J., who has a doctoral degree in physics. The Congressional Research Service estimates the federal government provided $147 billion for R&D in 2010 (Swartz, 2011).

- Global markets will be fought over who has the best technology and who is driving innovation the fastest and the hardest (Swartz, 2011).

- U.S. engineers are now in global competition with engineers in developing nations whose wages are 40 to 80 percent lower than ours (Kenny & Dossani, 2005).

- The federal stimulus program is hastening the rebuilding of America's highways, bridges and tunnels, and the refitting of buildings to be more sustainable, which is making the demand for engineers soar. Also, the demand for new sustainable energy sources such as wind farms is increasing too (Weiss, 2009).

- Almost no engineers or scientists are engaged in high-level politics, and there is a virtual absence of engineers in our public policy debates (Weiss, 2009).

Economic
- A much-quoted estimate is that technical progress has been responsible for as much as 80 percent of the rise in personal incomes, capital investment for no more than 20. Technical skill has been hailed as “human capital” (Engineers in the United States: An Overview of the Profession, 2004).
- Patent wars have stifled innovation for some tech firms, and a gasping economy has led to cutbacks in research and development at cash-strapped tech companies (Swartz, 2011).

- A wheezing economy, a dearth of college engineering students, sagging high school math and science scores, and sinking research-and-development investments have heightened concerns about the USA's ability to compete with rising powers China and India (Swartz, 2011).

- Giving citizenship or permanent residency to more high-skilled immigrants is perhaps the single-easiest way to grow the American economy (Soltas, 2012).

- The best economic research on high-skilled immigration, recently assembled by [Bloomberg] by the Kauffman Foundation, suggests extensive economic gains from growing America’s stock of human capital. For just one example, a disproportionate fraction of American startups and patents -- and that means jobs, too -- come from the entrepreneurship and ingenuity of our immigrants (Soltas, 2012).

- The main industries include petroleum, steel, motor vehicles, aerospace, telecommunications, chemicals, electronics, food processing, consumer goods, lumber and mining. Agricultural production, though only a small part of the economy, includes: wheat, corn, other grains, fruits, vegetables, cotton, beef, pork, poultry, dairy products, fish and forest products (CIA the world factbook, 2013).

Cultural
- American culture includes both conservative and liberal elements, scientific and religious competitiveness, political structures, risk taking and free expression, materialist and moral elements. Despite certain consistent ideological principles (e.g. individualism, egalitarianism, democracy etc), the culture has a variety of expressions due to its geographic scale and demographic diversity (McDonald, 2010).

- Engineering is part of Forbes’ Top 10 Hardest Jobs to Fill list. This means that there is a high demand for engineers but not enough qualified candidates (Weiss, 2009).

- Companies are looking to replace more than half of their engineers over the next eight years because baby boomers are retiring (Weiss, 2009).

- Of course, you have to be a stellar math and science student. To get admitted to a top-tier school, you need to take pre-calculus by your junior year in high school--not an easy feat for most teenagers (Weiss, 2009).

- Americans tend to highlight similarities across cultures while minimizing differences (Downey, Lucena, Moskal, Parkhurst, Bigley, Hays, & Nichols-Belo, 2006).

Technical
- As of March 2013, the report card given by the American Society of Civil Engineers shoed the national infrastructure a single grade above failure, a step from declining to the
point where everyday things simply stop working the way people expect them to. Some of the greatest problem areas were aviation, drinking water supply, roads, transit and sewage treatment (Halsey, 2013).

- Restoring it all to good working order will require an investment of $3.6 trillion by 2020 (Halsey, 2013).

**Historical**

- The creative individuals who transformed the American economy in the 19th century Industrial Revolution learned their skills mostly in the shop. They called themselves mechanics or “mechanicians” rather than engineers. As late as the 1890s, the pioneers of the electrical power industry similarly called themselves “electricians” (Engineers in the United States: An Overview of the Profession, 2004).

- The title of “engineer,” originally applied exclusively to the builders of such military and civilian structures as forts, bridges, canals, and railroads, was adopted haltingly in other technical fields (Engineers in the United States: An Overview of the Profession, 2004).

- Engineers during the 19th century had three options for education. There was on the job training, which recruited workers as apprentices especially in mechanized factories. There were military academies whose graduates started not only going into the military but also into civilian professions. There was an emergence of civil engineering schools that did not study the typical subjects of universities at the time (classics, theology etc) (Reynolds, 1991).

- Before the Morrill Act of 1862, which provided support for education “in agriculture and the mechanic arts,” only six schools in the country offered degrees in engineering. In the next few decades, engineering schools proliferated. It was not until the first decades of this century, however, that a majority of engineers—which was now the commonly accepted term—had college degrees (Engineers in the United States: An Overview of the Profession, 2004).

- Since 1900, the engineering workforce including graduates in engineering, graduates from other disciplines, and individuals without a college degree whose occupation is engineering—has mushroomed from less than 40,000 to close to 2 million. Between 1900 and 1930, it increased in size nearly six fold. This workforce grew more slowly during the Depression but picked up speed again after World War II, more than doubling between 1950 and 1970. In the last 30 years it has continued to grow but at a more moderate rate, a little under 2 percent a year (Engineers in the United States: An Overview of the Profession, 2004).

- In the 20th century, there was a shift in the nature of the engineering profession from independent consultant/ proprietor-engineers to corporate hierarchies because big corporations needed large numbers of lower management that understood technology, the costs of new technology was too high for individuals, and managers wanted internal
control. Engineering positions became a stepping stone to managerial careers, leaving behind the notion of bench-engineers (Reynolds, 1991).

- In 1900, engineers still formed a tiny group among the Nation’s professional workers (scientists, engineers, lawyers, doctors, teachers, etc.)—scarcely more than 3 percent. By 1960, they accounted for over 12 percent. Today, with other and newer professions like computer science growing faster, engineers account for roughly 10 percent. Engineering has become an established profession, like law and medicine, against which other professions measure themselves (Engineers in the United States: An Overview of the Profession, 2004).

- The second half of the 20th century was marked by the Cold War tensions between the U.S. and the Soviet. Universities became military-industrial academic, and engineering was the most common professional job of the time. The development of intercontinental ballistic missiles and space exploration required skilled engineers and scientists. The 1950’s had a surge in investment in STEM programs spiked by the Sputnik (Wisnioski, 2012).

- Transnational relations were classified as political and military competition between communism and capitalism. In the 1980’s a new image emerged as international struggle shifted to an economic idiom (Downey & Lucena, 2005).

Geographical

- The generation of innovation usually occurs in self-contained geographical areas that rely on their own R&D inputs, on favorable local socio-economic environments, and on the training and attraction of highly skilled individuals (Crescenzi, Rodriguez-Pose & Storper, 2007).

- During the 1990s, 92% of all patents were granted to residents of metropolitan areas, although these areas account for only about three-quarters of the US population (Crescenzi, Rodriguez-Pose & Storper, 2007).

- The US is surrounded by non-predatory neighbors to its north and south, and fish to its east and west. This has given the country an unprecedented degree of security, a huge margin for error in international affairs, and the luxury of largely unfettered development. The Americans were given the space and time to work on their union largely freed from constant external threats and crises (Miller, 2013).

- The U.S. borders both the North Atlantic and North Pacific Oceans and is bordered by Canada and Mexico. It is the third largest country in the world by area and has a varied topography. The eastern regions consist of hills and low mountains while the central interior is a vast plain (called the Great Plains region) and the west has high rugged mountain ranges (some of which are volcanic in the Pacific Northwest). Alaska also features rugged mountains as well as river valleys. Hawaii's landscape varies but is dominated by volcanic topography (CIA the world factbook, 2013).
GERMANY CONTEXTS

Political

- Strong political and governmental pressures were imposed on the universities and Fachhochschulen to improve the global competitiveness of the system by structural and curricular changes and by internationally accepted measures of quality assurance like quality assessment and accreditation (Heitmann, 2000).

- The political system of the Federal Republic of Germany represents the second democratic system in German history. At the Parliamentary Council when designing the new constitution, the Basic Law, the founders of the Federal Republic took into account the lessons that had been learned from the failure of the first democracy, namely the Weimar Republic, and the Nazi dictatorship (Hintereder, 2013).

- The Basic Law determines that Germany is a constitutional state: All state authorities are subject to judicial control (Hintereder, 2013).

- Germany is a parliamentary democracy. The government policy is determined by the head of government and the ministers, and not by the head of state (Hintereder, 2013).

- At the beginning of the 21st century, two basic trends are setting science and research considerable challenges: globalization and the transition to a society based on knowledge. A highly efficient and competitive system of science is necessary if Germany is to maintain its leading position in the international competition for research locations (R&D in Germany, 2013).

- In 1999 gross domestic expenditure on R&D by the Federal Republic of Germany totaled DM € 67 88,8 billion, or 2.84% of the gross domestic product. Within the German research scene economic activity in the field of R&D plays the largest role. In 2009, R&D expenditure by German business exceeded the € 45 billion €. The state was represented with 19,9 billion € in R&D expenditure, the inward investment in R&D was close to 2,6 billion € (R&D in Germany, 2013).

Economic

- The German economy is the fifth largest economy in the world in PPP terms and Europe's largest is a leading exporter of machinery, vehicles, chemicals, and household equipment and benefits from a highly skilled labor force. Like its Western European neighbors, Germany faces significant demographic challenges to sustained long-term growth (CIA the world factbook, 2013).

- Among the world's largest and most technologically advanced producers of iron, steel, coal, cement, chemicals, machinery, vehicles, machine tools, electronics, food and beverages, shipbuilding, textiles (CIA the world factbook, 2013).

- With a population of 82 million Germany is furthermore the largest and most important market in the European Union (EU). The Germany economy focuses on industrially
produced goods and services. In particular German mechanical engineering products, vehicles, and chemicals are highly valued internationally (Hintereder, 2013).

- Germany is a social market economy, in other words: The state guarantees the free play of entrepreneurial forces, while at the same time endeavoring to maintain the social balance. Even in economically difficult times Germany enjoys a high degree of social harmony, something reflected in the fact that labor disputes are so rare here. The social partnership of trade unions and employer associations is enshrined in the institutionalized settlement of conflicts as outlined in the collective labor law. The Basic Law guarantees employers and trade unions independence in negotiating wages, and they accordingly have the right themselves to select the working conditions (Hintereder, 2013).

- Germany continues to be one of the leading nations in several promising technologies. These include biotechnology, nanotechnology, and computer science, as well as high-tech fields such as biometry, aerospace, electrical engineering, and logistics (Hintereder, 2013).

Cultural
- Ever since the era of Kaiser Wilhelm II in the late 19th century, German culture as the expression of a single German nation was suspected of being the reflection of a craving for status. The disaster of National Socialism ultimately resulted in a re-alignment. Following the Second World War the opinion gradually gained sway that Germany would only be able to return to the world community if it avoided all semblance of exaggerated emotionalism as regards the national culture. This is one of the reasons why, when the Federal Republic was founded in 1949, one bore the federal tradition in mind and handed over cultural sovereignty to the federal states (Hintereder, 2013).

- It is impressive proof of a form of national cultural policy that has become necessary since the dawn of the 21st century. Cultural federalism, in turn, kindles the ambition of the federal states. Cultural policy is local policy. For years now the Ruhr area, for example, a former mining and steel-producing region in the federal state of North Rhine-Westphalia, has been re-inventing itself as a cultural region and, as the Ruhr 2010 European Capital of Culture, documents how creative milieus open up paths to the future (Hintereder, 2013).

- In 19th century, Germany could become great and lead civilization by actively creating higher-level human beings through the process of bildung (the activity of self-cultivating through the study of texts from the classical period, which has established a high level of civilization)- also a time of great philosophy that dominated entire Germany culture (Lucena, Downey & Mitcham, 2007).

- During the Third Reich (WW2), through a deliberate political neutrality oriented only to technical work, they stumbled into the role of collaborators who sanctioned through inaction and sometimes obedience, a willful and active misuse of tekniks to undermine humanity rather than enhance it (Lucena, Downey & Mitcham, 2007).

- Germans never drink coffee while driving so their cars do not have cup holders (Grandin, 2011).
Technical
- A dense and efficient network of motorways, railways, and waterways connects the country with major centers and the world. In 2000 the total length of paved highways was 650,891 kilometers (404,444 miles), including 11,400 kilometers (7,083 miles) of express-ways. More than 45 million motor vehicles were on the road, causing high road usage and frequent traffic jams, but the lack of speed limits on highways helped alleviate traffic problems (Germany - infrastructure, power, and communications, 2013).

- Germany's flagship air carrier, Lufthansa, is among the world leaders in the airline industry. Marine transport is also developed, with major ports on the Baltic Sea, including Kiel, Rostock, and Luebeck, and on the North Sea, including Emden, Hamburg, Bremen, and Bremerhaven (Germany - infrastructure, power, and communications, 2013).

- Historically, industrial centers have grown closer to ports due to the supply of cheaper raw materials and coal. In recent decades, refinery and chemical industries have gravitated towards the 1,550 miles-long network of oil pipelines (Germany - infrastructure, power, and communications, 2013).

Historical
- Germany’s path to a liberal constitutional democracy and a functioning parliamentary system involved many historical ruptures: particularism in the early years of the Modern age, the failure of the March Revolution and the Weimar Republic through to the “flaw in history” caused by National Socialism. Unity and liberty, key concepts since the 19th century, also occupied Germans during the nation’s division after the Second World War. Not until reunification in 1990 was the “German issue” resolved (Hintereder, 2013).

- Late 19th and 20th century Germany offers a story of the rapid rise of high-quality German industry, especially in the steel and chemical industries (Downey & Lucena, 2004).

- Patent system- the imperial patent law of 1877 that the inventor could not ‘own’ something that in face belonged to humanity as a whole (Downey & Lucena, 2004).

- During the Post WW II era, stress was put on German engineering to ensure that they were developing technologies to “benefit human society with a minimum of negative effects” (Lucena, Downey, & Mitcham, 2007).

Geographical
- Germany is located in Western and Central Europe. It shares borders with Denmark to the north, Poland and Czech Republic to the east, Austria and Switzerland to the south, France and Luxembourg to the south-west, and Belgium and the Netherlands to the north-west (Maps of the world: Geography of Germany, 2013).

- Germany has a temperate and marine climate, dominated by humid westerly winds. The northern region of the country experiences precipitation throughout the year and has mild winters and cool summers. The eastern region of the country has chilly winters and hot
summers, while the southern and central regions have continental climate. South-west regions are the warmest regions of the country (Maps of the world: Geography of Germany, 2013).

- The ‘agglomeration effects in European countries (France, Germany, Italy, Spain, and the UK) are only slightly lower than in the US and do not vary significantly across countries’ (Crescenzi, Rodriguez-Pose & Storper, 2007).

- In Europe the process is much more linked not just to having an adequate local socio-economic context, but to proximity to other innovative areas and to the capacity to assimilate and transform inter-regional knowledge spillovers into innovation (Crescenzi, Rodriguez-Pose & Storper, 2007).

- Specialization is also negatively associated with the genesis of innovation in Europe, where agglomeration is a better driver of innovation (Crescenzi, Rodriguez-Pose & Storper, 2007).
SPAIN CONTEXTS

Political
- Today Spain is governed as a parliamentary monarchy with an executive branch made up of a chief of state (King Juan Carlos I) and a head of government (the president). Spain also has a bicameral legislative branch made up of the General Courts (made up of the Senate) and the Congress of Deputies. Spain's judicial branch is composed of the Supreme Court, also called the Tribunal Supremo (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).

- There is not a single ministry of science and technology, but various ministries are involved in the whole policy process. Among them, the Ministry of Education and Science, and the Ministry of Industry are the most important. They are responsible for the promotion and general coordination of scientific research, development and technological innovation, and industrial development and competitiveness (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).

- The Spanish political system is highly decentralized with 17 political entities (“comunidades autónomas”) with their own parliaments and regional governments. Regional governments have been very active in S&T policies in the last years. Most of them have their own R&D plans resembling the national one. National and regional levels are coordinated in the General Council for Science and Technology (“Consejo General de Ciencia y Tecnología”) (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).

- In contrast with other countries where the legal jurisdictions in the research area are shared between the state and other political entities (e.g. regional), in Spain the central state has exclusive powers on the general framework for R&D policies. But the regions can develop and fund their own S&T policies, fund research projects, scientific infrastructure etc. (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).

Economic
- Spain has strong economy that is considered mixed capitalist. It is the 12th largest economy in the world and the country is known for its high standard of living and quality of life (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).

- The major industries of Spain are textiles and apparel, food and beverages, metals and metal manufactures, chemicals, shipbuilding, automobiles, machine tools, clay and refractory products, footwear, pharmaceuticals and medical equipment (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).

- Agriculture is also important in many areas of Spain and the main products produced from that industry are grain, vegetables, olives, wine grapes, sugar beets, citrus, beef, pork, poultry, dairy products and fish. Tourism and the related service sector is also a major part of Spain’s economy (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).
**Cultural**

- The culture of Spain is rooted in the influences left behind by the various peoples who passed through the country over the centuries. Its history, geography and peninsular nature have helped shape the country’s culture. Although a common cultural heritage exists, the various regions have each developed separate features in their cultural traditions that they reflect through their expressions of art, languages and dialects, music and gastronomy. A key differentiating feature of Spain is the wide linguistic variety with which its people communicate. Catalan is the official language, but there exists many varieties around the country (Spain business, 2013).

- The mild, dry summers have given rise to a culture in which a lot of time is spent outdoors. The courtyards typically found in buildings and public squares are where people meet to chat and enjoy the climate (Spain business, 2013).

- Spain possesses numerous buildings and architecture that UNESCO has declared World Heritage Sites for their historical and cultural value. There are also notable architectural remains from the era of the Roman conquest. The architecture in the South of Spain reflects the presence of the Muslims: fountains as an integral part of urban design, courtyards in homes, ceramic roof tiles and the decorative use of glazed tiles. With regards to modern architecture, outstanding names include Antonia Gaudi, one of the precursors of the genre whose work blended traditional designs and natural shapes with new styles (Spain business, 2013).

**Technical**

- Strategic Infrastructure and Transport Plan put forth by the Spanish Government makes huge investments in the roads system. Railway transportation takes the center stage in the Plan, accounting for almost 50% of the total investment (Spain business, 2013).

- The Government’s investment packages means that Spain will be able to call on a wide-reaching motorway and dual carriage network, granting direct access to all Spaniards and meaning that 94% of the population is never more than 30 kilometers from a high capacity road (Spain business, 2013).

- High-speed railway networks have come one of the priorities in the government’s infrastructure plans (Spain business, 2013).

- The freight sector liberalization of 2005 has led to the creation of private enterprises that transport goods by railway. This aim is to encourage this type of transportation to reduce the costs of the Spanish industrial sector, increasing the energy efficiency of transportation and reducing greenhouse gas emissions (Spain business, 2013).

- The country has over 53 international ports on the Atlantic and Mediterranean coasts, making it a leader in the EU for maritime activity and trade (Spain business, 2013).
Historical
- The area of present-day Spain and the Iberian Peninsula has been inhabited for thousands of years and some of the oldest archeological sites in Europe are located in Spain. In the 9th century B.C.E. the Phoenicians, Greeks, Carthaginians and Celts all entered the region but by the 2nd century B.C.E., the Romans had settled there. Roman settlement in Spain lasted until the 7th century but many of their settlements were taken over by the Visigoths who arrived in the 5th century. In 711 the North African Moors entered Spain and pushed the Visigoths to the north. The Moors remained in the area until 1492, despite several attempts to push them out. Present-day Spain was then unified by 1512 according to the U.S. Department of State (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).

- By the 16th century, Spain was the most powerful country in Europe because of wealth obtained from its exploration of North and South America. By the later part of the century however, it had been in several wars and its power declined. In the early 1800s it was occupied by France and it was involved in several wars, including the Spanish-American War (1898), throughout the 19th century. In addition many of Spain's overseas colonies revolted and gained their independence at this time. These problems led to a period of dictatorial rule in the country from 1923 to 1931. This time ended with the establishment of the Second Republic in 1931. Tensions and instability continued in Spain and in July 1936 the Spanish Civil War began (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).

- The civil war ended in 1939 and General Francisco Franco took over Spain. By the beginning of World War II, Spain was officially neutral but it supported Axis power policies; because of this though it was isolated by the Allies following the war. In 1953 Spain signed the Mutual Defense Assistance Agreement with the United States and joined the United Nations in 1955 (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).

- These international partnerships eventually allowed Spain's economy to begin growing because it had been closed off from much of Europe and the world prior to that time. By the 1960s and 1970s, Spain had developed a modern economy and in the late 1970s it began to transition to a more democratic government (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).

Geographic
- The Kingdom of Spain occupies an area of 504,782 square kilometers in the southwest of Europe, and it is the second largest country in the EU (Spain business, 2013).

- The strong maritime tradition of Spain is a direct outcome of its peninsular geography. The territory of Spain covers most of the Iberian Peninsula (Spain business, 2013).

- Spain has Mediterranean and Atlantic climates, meaning it is mild and generally rainy throughout the year. Along the coastlines it is mild in the winter and hot and dry in the summer. The most extreme differences occur in the center of the peninsula where there is
a Continental climate characterized by hot summers and cold winters (Spain business, 2013).

- Most of the topography of Spain consists of flat plains that are surrounded by rugged, undeveloped hills. The northern part of the country however is dominated by the Pyrenees Mountains. The highest point in Spain is located in the Canary Islands with Pico de Teide at 12,198 feet (3,718 m) (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).
INRODUCTION TO ENGINEERING EDUCATION

- Engineering educators bear the responsibility for addressing and answering the question: What does it take to become a good engineer? Accordingly, examining the contents of engineering education as well as the evolution of struggles to adapt and change those contents can offer insight into how engineers have understood whom they are and what sorts of service they see themselves contributing through their work (Lucena, Downey & Mitcham, 2007).

- You can see that countries are redefining their priorities and re-plotting their directions of travel by looking at any changes made in their educational systems (Downey & Lucena, 2004).

- European Council established the goal of making the European Union the ‘most competitive and dynamic knowledge-based economy in the world’ (Crescenzi, Rodriguez-Pose & Storper, 2007).

- University systems abroad expect a far greater maturity of students than does the American system and are consequently less nurturing; the US tends to spoon feed the learning process and provide support for just about any conceivable problem (Grandin, 2011).

- Incorporating international preparation into engineering curricula has proven to be a major challenge due to the highly sequences and content-demanding nature of the curriculum (Lohman, Rollins, & Hoey, 2006).

- Calls to bring back foreign language requirements are met with strong resistance in science and engineering programs already under heavy pressure to accommodate an ever-expanding body of knowledge in the core curriculum (Blumenthal & Grothus, 2008).
ENGINEERING IN U.S.

Education/Certification Process
- Registration or Licensure of Professional Engineers is performed by the individual states and is only valid in the state it is issued. Therefore, many engineers have licenses in several different states.

- Processes to get an engineering license
  1. Graduate from an Accreditation Board for Engineering and Technology (ABET) accredited four-year College or University program.
  2. Complete the Fundamentals of Engineering (FE) Exam which tests basic principles.
  3. Accumulate a certain amount of engineering experience. In most states it is 4 years, but it is lower in some.
  4. Complete the Principles and Practice in Engineering (PE) Exam which tests the knowledge and skills in a specific engineering discipline (civil, mechanical, electrical, computer etc)

Facts About Engineering Education
- STEM graduate programs consist of 47% international students so other countries are outpacing the US in producing scientists and engineers (Blumenthal & Grothus, 2008).

- America’s higher education system is one of the largest and most flexible in the world, supported with an enviable mix of public and private funding for research and academic innovation (Blumenthal & Grothus, 2008).

- Unlike in Europe, the US does not have a “ministry of education” at the federal or state level, so our academic institutions are largely responsible for developing their own academic programs to respond to new challenges; some schools have been altering their mission statement to include commitment to produce ‘globally competent’ graduates; there is no pressure from any kind of government agency in the US (Blumenthal & Grothus, 2008).

- ABET expanded its expectation of skills required in graduates of accredited engineering programs by adding the following “soft skills” in Criterion 3 of ABET 2000 (Blumenthal & Grothus, 2008)
  - Ability to function in multidisciplinary teams
  - Ability to communicate effectively
  - The education necessary to understand the impact of engineering solutions in a global and societal context
  - Knowledge of contemporary issues

- In 2000 ABET added that graduates from engineering programs have to have “an understanding of professional and ethical responsibility” (Grandin, 2006).

- ABET states “engineering programs must demonstrate that their graduates have a recognition of the need for, and an ability to engage in life-long learning” (Downey & Lucena, 2005).
- ‘Engineering Cultures’ a modular approach to cross-cultural training for engineers that has proven enormously successful at the undergraduate level (Downey & Lucena, 2005).

- Also, any government-funded project, including ones resulting from the stimulus package, requires an engineer to have passed the test to get a professional engineering license. Only one in 10 engineers has that advanced-level document, Jacobson says (Weiss, 2009).

**Engineering Identity**
- By what criteria should one judge whether someone is an engineer? His self-identification as such? Her job description and job title? Having an engineering degree? Having a degree in a related field? Indeed, does an engineer have to have a degree? Should someone still be counted an engineer if she has become a manager? (Engineers in the United States: An Overview of the Profession, 2004).

- The National Science Foundation decided that in future surveys it should not frame its definition of the science and engineering workforce solely on the basis of occupation but should also take into consideration education, degree level, and professional self-identification. It developed a carefully balanced, multidimensional definition for use in its next survey.
ENGINEERING IN GERMANY

Education/Certification Process
- Two types of Engineering Schooling in Germany
  1. 5-year university programs (Heitmann, 2000)
  2. 4-year Fachhochschule programs (Diplom-Ingenieur degree) (Heitmann, 2000)
- Two main types of higher education in Germany (Heitmann, 2000)
  1. The Technische Universität/Technische Hochschule
     - Standard admission requirement is the Abitur (a certificate awarded by the general secondary schools after 13 years of general education)
     - Final degree awarded in engineering is the “Diplom-Ingenieur (Dipl.-Ing)”
     - Universities offer 5-year courses of study which are research oriented
     - Liberal system of studies in Germany permits the extension of the actual duration of studies; thus the avg is about 13 semesters
     - As a prerequisite, half of a year of internship must be spent in industry, usually 13 weeks before entering university and 13 weeks during the semester breaks.
     - The studies are theoretically and research oriented and therefore their Diplom-Ingenieur is judged as being equivalent to the master of science degrees of high ranking foreign universities
  2. Fachhochschule (university of applied science)
     - Degree is the “Diplom-Ingenieur (FH)”
     - Four year courses of study
       - 8 semesters including at least one practical semester in industry
       - Average time for graduation is 9 semesters
     - Felt to be equivalent to a bachelor level honors degree in the U.S.
     - Admission requirements are either the Abitur (after 13 years of general schooling) and usually 13 weeks of practical experience as a prerequisite, or the Fachhochschulreife, a certificate issued after ten years of general school education plus two years of specialized education at an upper secondary vocational school (Fachoberschule)
     - Alternatively, the Fachhochschulreife can be awarded after ten years of general school education followed by an apprenticeship in a related technical field plus one additional year at an upper secondary school

Facts About Engineering Education
- European Study Abroad Programs such as ERASMUS, SOCRATES, and LEONARDO: students spend a semester in other European countries because their future careers will require the ability to function in several European languages and cultures (Blumenthal, Grothus, 2008).
- European countries have been developing the American style graduate programs too, pushed by the Bologna process and the market; also reforming higher education so that academic credits can be pushed across borders (Blumenthal, Grothus, 2008).
- Only 5% of US baccalaureate degrees are awarded to engineering majors, while 18% in Germany (Blumenthal & Grothus, 2008).

- The Bologna Process: aim to create a European Higher Education Area with compatible and comparable degrees by the year 2010; substitution of traditional national degrees with a three tier system of bachelor’s, master’s and doctoral degrees (Blumenthal & Grothus, 2008).

- With the introduction of more internationally compatible degree programs in Germany, the number of students studying there has increased 50% from 1999 to 2004 (Blumenthal & Grothus, 2008).

- “The only problem to be solved seemed to be how to ensure broad international academic and professional recognition of the German qualifications and degrees” (Heitmann, 2000).

- Higher education is nearly completely state financed
- Government regulates things such as
  - Legislation, framework regulation and directives
  - Funding and budgeting
  - Approval of study programs and examination regulations
  - Appointment of professors based on proposals of the institutions
- VDI (The Association of German Engineers) requires engineers to evaluate all technologies according to 8 metrics of value in three categories including functionality, economy, and material standard of living; safety, health, and environmental quality; and development of individual personality and quality of life- engineers can find support in a guideline that has been authorized be the engineering community as a whole (Lucena, Downey & Mitcham, 2007).

- Accreditation (Heitmann, 2000)
  - A new form of accreditation will be implemented in the near future for the new bachelor and masters programs
  - A central Accreditation Council was appointed in July 1999, and soon will itself authorize certain Accreditation Agencies. These agencies will then organize or undertake the necessary procedures for accreditation in the various subject fields

**Engineering Identity**
- The VDI developed of an active collaboration between engineers and philosophers of technology in working committees designed to help insure that German engineers would develop technologies to benefit human society with a minimum of negative effects. Engineers are to evaluate all technologies according to eight metrics of value in three categories, including functionality, economy, and material standard of living; safety, health, and environmental quality; and development of individual personality and quality of social life (Lucena, Downey, & Mitcham, 2007).
“Verein Deutscher Ingenieure’s Fundamentals of Engineering guideline stands out by calling special attention to the engineer’s responsibilities in technology assessment
- evaluating and mitigating the impacts and effects of technological developments” (Lucena, Downey, & Mitcham, 2007)
- “accept responsibility for quality, reliability, and safety of new technical products and processes”
- “informing customers about both appropriate use and possible dangers of misuse of new technical solutions”
- “Design technologies that take account of the societal, economic and ecological feasibility of technical systems; their usability and safety; their contribution to health, personal development and welfare citizens; their impact on the lives of future generations”

Individual engineers are not left alone to evaluate the situation on the basis of personal conscience but can find support in a guideline that has been authorized by the engineering community as a whole (Lucena, Downey, & Mitcham, 2007).

Although most of the German engineering industry is dominated by small and medium sized businesses, that doesn’t at all hinder its success. In more than half of all exported items, computer and electronic expertise is included within the products manufactured. (German engineering is a leading engine in our world, 2013).

You have to think about those wonderful German cars you purchase, like BMWs or Porsches. It’s not only the cars themselves that are engineering wonders, but over 25% of the value of the car is in the electronics and software these days. It makes for a good opportunity to work in the industry as the demand is high for excellent employees. That is why Germany has become a very attractive place to come to train in computer and electrical engineering (German engineering is a leading engine in our world, 2013).

Then you can’t forget the incredible worldwide products stemming from top German companies. There’s the sleek and beautiful BMW, the luxurious Mercedes, and of course, Audi and Porsche. These companies are known and respected the world over (German engineering is a leading engine in our world, 2013).

Another global powerhouse is Siemens AG, producing in the energy and healthcare areas. They have been working at giving us high quality products for over 125 years. Hearing aids are just one of the most popular that they make. These hearing devices have been deemed the most technologically advanced and fit all (German engineering is a leading engine in our world, 2013).

And then you have Bosch, a corporation that is the largest manufacturer of power tools and accessories in the world. They have branches in other parts of the world as well, such as North America. Krupp and BASF are other German leaders in engineering. Krupp makes coffee makers as well as espresso machines and blenders, toaster ovens and mixers. BASF manufactures chemicals used in fibers, resins and finishing compounds (German engineering is a leading engine in our world, 2013).
ENGINEERING IN SPAIN

Education/Certification Process

- The Engineering Educational System is organized as a parallel two first cycle system: Engineer (nominally 5 years) and Technical Engineer (usually lasting 3 years). Mean duration of studies up to graduation is about 40% higher the quoted values and there is a quite high drop-out rate. Entry requirements are the same for both long and short Degrees, but Technical Engineering studies have quota reserved for students coming from Professional Education different from "Bachillerato". Graduated Technical Engineers could enter at the 4th of Engineer in the same field of Engineer curricula in limited percentages granting places only to those with the best marks (Augusti, n.d.).

- Apart from this there is a reduced number of programs lasting only two year and leading to an Engineer Degree usually on a specialized field. Access is granted to Technical Engineers in similar fields and to students in Science and Engineering after completing three years of study. While new first cycles Degrees are still waiting for a proper regulation and the reform has not started yet, a certain number of second cycle programs according to Bologna system have began recently (Augusti, n.d.).

Facts About Engineering Education

- Universities are very important actors in the Spanish research landscape. There are approximately 60 public universities all over the country that perform the largest part of Public Sector research activities. They report to the regional authorities from which they receive their funding (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).

- Higher education in Spain is carried out at Universities, structured in Faculties, Higher Schools and University Schools. The number of Higher Education students in Spain has increased from about 170,000 students in 1960 to a million and a half in year 2000. Relatively speaking, Spain is the second European country in number of students for every 100,000 inhabitants (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).

- In Spain there are around 65 Universities, and about 20% of them are privately owned some by Church organizations. Universities are autonomous institutions, and higher education matters are under the regional governments’ rule although there is a common framework defined by the central government (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).

- Technical Engineer Degrees could only be issued until a few years ago by the so called Technical Engineering Schools. More recently, some of these Schools have become Higher Schools then issuing both Technical Engineering and Engineering Degrees. In Spain both types of Schools may belong to the same University as it happens in many cases (Polytechnic Universities and many others as the University of Valladolid) (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).
- By law, both Technical Engineers and Engineers have recognized professional competences and acceptance to the corresponding Technical Engineers and Engineers Councils (“Colegios”) as chartered membership is automatically granted upon request after graduating. Engineers and Technical Engineers Councils try first to maintain the status quo and, if possible, enlarge their respective fields of operation. In particular Engineering Councils do not favor the extension of a first Degree previous to the Engineer one, the same attitude which is very extended among lecturer at Higher Engineering Schools. On the other hand, Technical Engineering Councils support the extension of study programs from 3 year which is usual now to 4 years, which is the length adopted for new first degrees in Spain (Braun, Filiatreau, Inzelt, Kunova, Csonka, Meisner & Siman, 2006).

Engineering Identity

- Spanish researchers are in active and increasing exchange with their counterparts around the world. Professional journals abound. The most important establishment that publishes books and journals, funds research, and employs scholars in research positions across the entire span of academic disciplines, including the humanities, is the Consejo Superior de Investigaciones Científicas (the Higher Council for Scientific Research), founded in 1939. The Consejo has its seat in Madrid but its various sections and institutes sponsor research and publication of books and journals in and about the various regions and provinces and on a wide range of topics (Countries and their cultures: Spain, 2013).

- Historically, Spain held a world monopoly on merino sheep and their wool; Spain's wool and textile production (including cotton) is still important, as is that of lumber, cork, and the age-old work of shipbuilding. There is coal mining in the north, especially in the region of Asturias, and metal and other mineral extraction in different regions (Countries and their cultures: Spain, 2013).

- The physical sciences, along with the engineering sciences, have all long been instituted in the Spanish educational system. Some of the social sciences as they are instituted in the United States are younger in Spain. Social-cultural anthropology is one of these, dating from the 1960s, although ethnography, folklore, archaeology, philology, and physical anthropology are older, and there are national, regional, and local museums dedicated to these topics as well. Today, such younger fields as cultural anthropology and psychology are thriving and are taught throughout the university system. Sociologists are importantly engaged in the self-study of Spain as well as the study of other societies (Countries and their cultures: Spain, 2013).
TO: Professor Cohen  
FROM: Caroline Goss and Perry Schiff 
DATE: March 5, 2013  
SUBJECT: Annotated Bibliography Memo

With the growing importance of developing globally competent engineers, we have finalized our project to focus on how Lafayette students can harness their study abroad programs in order to improve their own, and their classmates’ engineering education. It is important that students are well educated about the education systems and methods for certification of foreign countries before they study abroad so that they can make the most of their experience. Once abroad, the students will then be able to both acknowledge the areas in which other countries thrive, while also criticizing their practices and processes compared to those in the U.S. After students return from studying abroad, they need to be educated on how they can apply the knowledge and skills they learned in other countries toward their education at home, whether that be in the classroom, in a club like Engineers Without Borders, or in an internship with an international company. The list of sources that we have compiled can be categorized into the three stages of going abroad that we plan to study. The information that each source contains will help contribute to the final product of our project of developing a series of workshops for Lafayette students who intend to go abroad.

Preparation: Understanding Foreign Processes  
Before students begin their study abroad programs, it is important for them to know background information about the particular countries, as they all undoubtedly differ to that of the U.S. In order to grasp an understanding of the processes abroad, it is important to first learn about the educational systems and how their structure may be different. Also, the process of becoming certified in other countries is important so that the American students understand the challenges that other students may face. After knowing the background knowledge, it becomes more evident why certain countries excel in certain engineering disciplines more than others. Often the educational system and certification processes are geared toward developing engineers that are suitable for the products and innovations that a country generates.

The sources that are most valuable to this first part of our project are the non peer reviewed ones, as they provide the most credible and unarguable facts. The ones that we use in our list are divided into two groups. The first group is comprised of two articles that give information about the French educational system and German branding. The second group includes the main websites to ABET, NSPE, EC and FEANI, which are all organizations that contribute to the education and certification of engineers in the U.S., the U.K., and the E.U. Although not peer reviewed sources, we made sure that they came from reliable databases such as the New York Times.

Participation: Making the Most of Your Experience  
Once students have an understanding of the parallels between the processes of becoming an engineer and the workspace, we will explain in our workshops some of the salient points that our Capstone class addresses. In essence, we would like to educate the engineering students who plan to study abroad to think about the relationship between the education and the workplace in various countries. We intend to explain the importance of context and how countries have their
own methods for certain reasons. Often those used in one country will not function in another due to cultural, economic, social, religious, or political reasons. In other words, we would like to use this second part of our project as a means to create a mindset for the engineering students who will be studying abroad to think about context while they are there. This is important especially for non-EGRS students who might not have been taught these ‘soft skills’ that help shape an international engineering education experience.

When making our list of sources for this section of our project, we realized that using the peer reviewed sources would be most valuable for providing information about how to balance the technical and non technical aspects of an international education. The list is comprised of articles published in well- accredited academic journals and offer primarily qualitative data. However, they are reliable because these data are accompanied by some quantitative data. They do have different approaches to addressing this issue: some articles study programs at certain schools, some analyze the importance of the global market, and others offer solutions to make the most of your engineering study abroad. However, the perspectives come together in all these articles because they all argue that studying abroad only brings positive results.

**Implementation: How to Harness Your Experience**

Through our research thus far, one of the primary problems with engineers studying abroad is that the programs are not linked to the rest of the students’ educations. From our sources, we have determined that the main reason why this occurs is because study abroad for engineers is relatively new. Historically, the programs have been geared more toward other fields in the arts rather than in engineering. However, with globalization and the increase in foreign aid efforts, it is important that engineers contribute the useful information and skill sets that they get from going abroad to their education and lines of work back in the U.S. Therefore, in our workshop we are hoping to educate students on how they can do so.

The sources that we compiled in order to formulate a solution to this problem are all peer reviewed. This is primarily due to the fact that there is no one solution to the issue because it is so dependent on context. Therefore, all the proposed solutions come from various opinions of people in academia. From some sources we found, the answer lies in reconstructing the engineering syllabi to incorporate international classes. Others encourage study abroad programs and state that they are the only opportunities to truly grasp international processes. The list of sources for this section of our project is going to be extended as we delve further into the project. This section is the conclusion part to our project, so we will need to complete the other two sections thoroughly before we truly know what type of information and sources we need for this section. By studying models from various schools and countries, we will hopefully be able to draw conclusions about the most effective methods for studying engineering in order for American students to become globally competent engineers.
ABET, the Accreditation Board for Engineering and Technology, is an organization that accredits post-secondary education programs in applied science, computing, engineering, and engineering technology. They strive to ensure quality and innovation in engineering and science education. This pertains to our research because we will be able to grasp a more comprehensive understanding of what it takes to become an engineer in the United States, and will then be able to compare this with our other sources describing what it takes to become an engineer abroad. While ABET accreditation is voluntary for institutions, it provides credibility for that program, and ensures a quality education. For that reason, we will be using this website’s information for the first phase of our project; the differences and similarities in engineering education in the US and European countries.


Certain countries are more reclaimed for the engineering capabilities than others, and thus other less developed ones tend to look to those for example. This article describes how due to recent technological failures in Japan, the country intends on redefining its educational system. The author, Henri Angelino, a French chemical engineer, states that the most efficient way for Japan to determine new methods is to look at the leading countries as models. He uses Germany, France, and the U.K. as case studies to analyze their educational systems. He does so by first describing the process of receiving a degree and certification, and then draws his own conclusions about the methods used based on the statistical and quantitative data that he provides. This source will be primarily useful for our project because it gives an in depth description and critique of the educational systems in three countries that we are studying. It also gives valuable advice for our final project, as it suggests that a combination of pre-existing methods might be the most effective way to redesign the American system. Ultimately for our final product we would like to instruct students studying abroad how to evaluate others in order to return to the U.S. and suggest changes to their current curriculums and programs. A problem with this article is that it was written about ten years ago, and with the educational systems being so dynamic, it may be outdated. We would need to verify the information by comparing it to other sources.

In recent years, countries around the world have realized that the education of their engineers is not complete without adding an international perspective as competition has become fierce between nations for job opportunities. The authors, who work for national level non-governmental organizations devoted to stimulating international exchange of academics, offer an outside view of engineering education. They highlight the growing importance and popularity of study abroad programs by analyzing the strategies of the U.S. and Germany use toward developing more globally competent engineers. They recognize the fact that studying abroad has historically not been as popular for engineering students as in other fields because professors are reluctant to grant credit for studies, students are not fluent in other languages, and their requirements are more restricted. In order to solve these problems, increasing funds from their government, industry, and academia so that their students can compete more vigorously for international talent is the proposed solution. Programs such as the Lincoln Scholarship Program that expand the number of Americans studying abroad show that our country is trying to make this issue a national priority. This source is valuable to the first stage in our project that describes the educational processes in the U.S. and Germany. It also highlights why studying abroad is so important for engineers, something that we intend to stress during our workshop. This source complements others by Lucena and Downey well because it gives a different view point, as neither of the authors are engineers.


This article speaks directly to the second phase of our capstone study; the post academia comparison of innovation and engineering prowess of the United States and Europe. Innovation is a relatively intangible quality, but the authors do a great job of generating an in-depth look into the innovative status of these two regions by providing quantitative analyses on various measurable concepts. These concepts include the amount and geographical spread of technology patents. The article mentions that the United States is at the forefront of innovation, being the most “competitive and dynamic knowledge based economy in the world”. They also explain the significance and role that geography plays, citing the differences between the United States and Europe. The authors explain why certain methods work better in each region, while others don’t. It is argued that innovation usually occurs in self contained geographical environments in the US, while specialization is negatively associated with innovation in Europe. The article includes a large amount of mathematical and graphical information that may not be useful for our study, but the majority of the concepts included provide excellent insight for our capstone project.


When countries redefine their national priorities, engineers often become anxious over the accreditation of their knowledge. Lucena and Downey, professors at Colorado School of Mines,
and Virginia Tech respectively, describe how the educational system is thus typically adjusted accordingly so that countries remain in parallel with national priorities. They use brief case studies from the U.S., the U.K., Germany, and France and argue that nations want to make their engineers appropriate for the time period and location in which they work, and should do so by considering the cultural and historical context. This source provides valuable information for our project because it addresses a fundamental question that we are trying to answer: how do transnational forms of industrial capitalism inflect patterns of engineers and engineering knowledge? The article answers the question by analyzing national patterns in the educational systems, the balance between influence and determinism, and how countries measure their own progress. The authors encourage readers to appreciate the differences that exist between countries rather than seeing it as a limitation. This contributes to the first stage of our project, as answers how the structures and content of the educational systems are dynamic in countries around the world. This source seems credible for our project primarily because Lucena is an author of the textbook from our Capstone class, it cites other scholarly articles, and it has too been cited in articles published in a variety of academic journals.


In this article, Downey and Lucena, experts in engineering education, focus on the ever increasing internationalization of engineering. They discuss how this has evolved significantly since the end of the Cold War, and that it has affected the engineer’s sense of identity. A great example is included; “if I am a Japanese engineer working for IBM Japan, am I working on behalf of Japan or of IBM’s host country, the USA? Or both? Or neither?” This increasing lack of identity is the basis of the authors’ argument that engineers must demonstrate the ability and acknowledgment of need for lifelong education. They point out how various national organizations such as ABET and the British Engineering Council are mandating this mindset through their accreditation processes. While this article was written in 2005, the concepts are still in effect today, and are significant in studying how someone becomes an engineer not only in the U.S., but in foreign countries as well, which contributes to the first phase of our project.


This article is written by a number of highly educated experts in various engineering and education fields. They pool their knowledge and expertise to discuss the importance of the globally competent engineer. The article explains how engineers from various countries have differing values, and this may pose a problem for collaboration. For this reason, the authors argue the importance of teaching engineering students the knowledge, ability, and predisposition to effectively work with people who define problems differently. This coincides with the second phase of our project. We intend to prepare students to have an open mind when they participate in their study abroad programs and rather than discrediting the methods used in other countries,
they should consider them in an American context. We will be able to use these arguments to supplement our goal of creating more globally minded engineering students at Lafayette College.


The Engineering Council is an organization in the UK that is responsible for accreditation of engineering schools and programs, doing so while maintaining “internationally recognized standards of professional competence and ethics”. They are the regulatory authority for registration of Chartered and Incorporated engineers and technicians, who are comparable to Professional Engineers in the United States. The provide assessments for licensing throughout the UK. Their website provides more detailed information regarding their testing as well as their role in engineering society in the UK, which will be greatly beneficial to our study of British engineering. We will be able to better understand the steps necessary to become an engineer in the UK, and compare them to those of students in the United States.


The European Federation of National Engineering Associations (FEANI) is a collaboration of professional engineers that unite the national associates from 32 European countries. This website maintains a database of qualifications that engineers must uphold in order to be professionally qualified in Europe. Each engineer is registered as long as they have undergone seven years of ‘formation’ which includes at least three years of engineering education and at least two years of professional experience. This source is useful to our project because the countries that we plan on studying (France, Germany and Spain) are all part of the FEANI. The UK however, because it is not part of the European Union, has its own board of accreditation. It also contains instruction on how to apply to become a member, something that every European engineer has to go through. There is also a section of the website for publications and agreements that contains a number of papers and agreements between nations on the qualifications of engineering. This source is a credible one because it is a secure agency that the European Commission has registered as a good example of a self-regulated entity.


This article provides excellent insight into the various methods of engineering education as well as engineering learning by modeling the differing learning styles of engineering students. Dr. Linda Silverman is an expert in educational psychology, and Richard Felder is an expert in engineering education. Felder and Silverman go into depth in explaining the different ways students effectively learn engineering material as well as the varying methods that professors employ to teach that material. Often times, there is a severe mismatch of teaching and learning types, causing a lack of transfer of knowledge. They suggest that engineering professors include a few different teaching types to ensure they various types of learners can grasp the presented
knowledge. One area that this article falls short is in comparing this American teaching and learning study to those of foreign countries. The article is also relatively dated, yet the information seems to remain true even today. Aside from these shortcomings, my capstone group will gain valuable insight in learning these various methods of engineering education, their benefits and drawbacks, and we will then be able to draw our own connections to the systems in other countries.


With increases in globalization, companies must be prepared to go to the international market system to remain competitive and innovative by cultivating the best talent regardless of location. This article stresses the importance for American students not only to be well versed in the technical aspects of their engineering degrees, but also have perfected personal and communication skills for collaboration across nations. Grandin, the Director of IEP at URI, suggests his program as a model to provide the necessary skills for engineers to work effectively in today’s global workplace. Although bias, the author does validate how the five year BA/BS program is effective, comprising of simultaneous majors in a language and engineering discipline as well as a semester abroad and a six-month internship with an engineering firm. Although he does not cite many outside sources, he does cite a number of his own additional sources that one can look up to read more about this program. This source is particularly helpful to our project because ultimately we are trying to create a study abroad program that is most effective in creating a globally competent engineer. We intend for the abroad program to become a more integrated part of an engineer’s education, rather than just a supplementary entity. By giving it more context within the overall degree, the study abroad program could be much more useful than it is right now.


From the other sources our group has studied thus far, it is obvious that a global education for engineering students is becoming increasingly crucial as engineers face competition with international students. In this journal article, Grandin describes his study of a number of students and how their study abroad experiences contributed to their successes in the workplace. Through one study in particular of Eric Sargent, an IEP graduate who studied in Germany, the author was able to list the benefits of the exposure to another culture, learning another language, developing an appreciation for other cultures, and learning to be mobile. As quoted by Sargent, he could not have been such an effective cross-cultural communicator in his role at BMW without his fluency in two languages and an understanding of the differences between the way Germans and Americans behave and function in their daily lives. This source on one hand is questionable because it does not cite any sources other than the students that the author interviewed. However, this source serves a different purpose than the others; it addresses the personal side to the
descision of going abroad. This story would be one that might inspire a student to participate in a program who may be hesitant. This source is another example of one that would only be credible when accompanied by quantitative data from another source. Also, this it would be interesting to compare it to a personal study of a student who had a negative experience abroad.


Although one of the leading suppliers of engineering innovation, France continues to wrestle with the organizational system that dates back hundreds of years. As described in a NY Times article, the French system is rigidly divided between the grandes écoles and the public universities. The former is a series of schools that could be compared to the Ivy League schools in the US, while the latter are debatably comparable to community colleges as they do not have any restrictions in their admissions. This system stems from the long history of France being segregated dependent on class system. Therefore only the rich and powerful would be able to achieve an impressive education while the rest of the country falls behind. The problem that the author addresses is that France has come so far in their engineering innovations but their educational system impedes their development. This source is useful for our project because it gives information about the nature of the educational system in France, along with a critique of its current structure. Therefore it would help us in the first step of our project that defines the differences between the educational systems in the US and Europe. This source is credible because it comes from the NY Times which is a reliable source. It also provides direct quotations from accredited people such as the Deputy Mayor of Paris that adds to the reliability of the source.


This article focuses on the various difficulties involved with striving for quality assurance in engineering education such as creating criteria for accreditation. Germany is the main focal point, though the article does a nice job of comparing it to other countries, such as other European Union members, in terms of quality control of engineers and engineering education programs. The author talks about some methods different countries use to assure quality engineers, such as their accreditation agencies and criteria. Later in the article, the approaches to quality assurance in engineering education specific to Germany are discussed in further detail. We as readers gain insight into what it takes to become an engineer in the German society. My capstone team will be able to use this information in our comparisons between Germany and the United States. One deterrent may be that this article was published in 2000, though most of the information still seems to be completely relevant in today’s world.
Agreement has been reached in the engineering field that developing globally competent engineers is important in the educational system. However, the authors argue that there has yet to be determined exactly what skills and abilities are considered useful toward global competence, how to achieve them, and how to evaluate them. The three professors from Georgia Institute of Technology suggest a number of solutions to each of these problems ultimately by using their university’s program, the International Plan, a four-point plan that can each be expressed in measurable terms. It sets participation goals, assessment methods, and performance criteria so that the university can analyze the effects of international study for its students. Although this source does not provide that much new information, as similar and more in-depth information appears in the other sources, it does give our group a method the quantify the level of value a student’s study abroad experience. From this, we will be able to communicate to the students during our workshop a way to self-evaluate their experience abroad during and after they travel. This source is particularly credible as it has an extensive list of references that come from reliable sources. The biographies are also included at the end of the article, giving the authors more credibility as the readers can understand that they have impressive and in-depth backgrounds in both the international and engineering realms.


As we have addressed in our Capstone class, the responsibility that engineers have to society is becoming more prominent with such drastic increases in technological development. This article addresses how the ethics of engineers in the U.S., France, Germany and Japan help answer the question of “who is an engineer?” The authors from Virginia Tech and the Colorado School of Mines argue that any inquiry into the identity of engineers stems from the engineering education, as it serves as the key location for negotiating relationships between the person of the engineer and the definition and responsibilities of the work performed. They suggest that in order to understand the issues that engineers face in their own countries, they should look at others. After an in-depth analysis of the mentioned countries’ ethics in engineering, they conclude that ethics emerge from engineers wanting to stay in line with the changed images of advancement in society. This source is useful to the first part of our project as we analyze the educational and workspace systems of engineering in various countries. It provides a breadth of information about the European systems as well as addressing a key question that our project is to answer of who is considered an engineer. The source is definitely credible, as the authors are well renowned and have been cited by many other scholarly works. They also include an extensive list of sources that they cite in this particular source.

The National Society of Professional Engineers, NSPE, acts as the voice for all licensed American engineers. This organization advocates for engineers and related disciplines by promoting leadership and ethics. This website will allow our group to fully grasp this major organization behind engineering. The NSPE, “through education, licensure advocacy, leadership training, multi-disciplinary networking, and outreach, enhances the image of its members and their ability to ethically and professionally practice engineering”. All of these qualities define engineering in an American sense, which we will then be able to compare to other countries on the global stage. While ABET is more focused on ensuring quality in America’s engineering students, the NSPE ensures quality and leadership in America’s professional engineers. This links well with our project, and will help in solidifying our second phase; post academic global engineering.


This is an article discussing the importance of branding, and how Germany’s engineering has helped it become one of the top producers of successful brands spanning numerous industries. The author, Barry Silverstein, has over thirty years of advertising and marketing experience and is currently a freelance writer and marketing consultant. He has written three marketing books, including one published by McGraw-Hill, co-authored with Arnold CEO Fran Kelly. Silverstein argues that German brands, and Germany itself, are so successful due to their discipline and attention to quality. The article compares this to America’s mentality, which focuses on efficiency and mass production. These concepts will be beneficial to our study when comparing engineering on a global stage, specifically between the USA and Germany. Though written in 2008, the German companies mentioned (i.e. BMW and Adidas) continue to function similarly and with great success.
Additional Work Cited


German engineering is a leading engine in our world. (2013). Retrieved from http://www.mygermancity.com/german-engineering


