

---

## **AC 2011-694: ENCOUNTER ENGINEERING IN EUROPE, EQUIPPING STUDENTS TO BE SUCCESSFUL IN THE GLOBAL MARKET PLACE**

### **Paige Davis, Louisiana State University**

Paige Davis has 20 years experience as an Instructor in the College of Engineering at Louisiana State University. In addition to teaching she assists with the STEP program. She received her baccalaureate degree in Engineering Technology and her master's degree in Industrial Engineering from Louisiana State University.

### **Summer Dann Johnson, Louisiana State University**

Ms Dann is the Project Manager for the College of Engineering's STEP program. She has her Master's of Science in Mechanical Engineering and worked for industry for 9 years prior to returning to academia.

### **Emma M. Allain, Louisiana State University**

### **Harald Thomas Leder, Louisiana State University**

### **Warren N. Waggenpack, Jr., Louisiana State University**

Warren N. Waggenpack, Jr. is currently the Associate Dean for Academic Programs in the College of Engineering and holder of the Ned Adler Professorship in Mechanical Engineering at Louisiana State University. He obtained both his baccalaureate and master's degrees from LSU ME and his doctorate from Purdue University's School of Mechanical Engineering. He has been actively engaged in teaching, research and curricula development since joining the LSU faculty in 1988. As Associate Dean, he has acquired funding from NSF to support the development of several initiatives aimed at improving student retention and graduation rates as well as supporting faculty with development with effective learning and teaching pedagogies.

# Encounter Engineering in Europe, Equipping Students to be Successful in the Global Market Place

## Introduction

Universities across the United States must train their undergraduates to function in an international arena in order to be competitive in today's market. Students not only need to possess the educational knowledge for their specific discipline but must also be able to function globally. This is especially true for engineers. Working individually or in small groups within a corporation is not how engineering is conducted in the 21<sup>st</sup> century. From design, to prototyping to production requires many of today's engineers to work across the continent or around the globe.

“Cultural diversity is a fact of professional life. Engineers are being employed in ever greater numbers by multinational and transnational corporations and are routinely working across national and cultural boundaries. Engineering projects may take them, for varying periods of time, out into the field--which might be any corner of the globe--or into design workshops, laboratories or head offices which may also be located far from their own homes and countries of origin”(1).

Students need to be culturally aware and culturally sensitive (including differences in language, religion, food, socioeconomic conditions, educational and working variants) in order to work effectively with other engineers from around the globe. The ABET document, *Criteria for accrediting engineering programs*, states that engineering programs must demonstrate “the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context (2). Louisiana State University (LSU) strives to provide more opportunities to equip our engineering students to be prepared for the global market place. One option for students to gain international exposure and awareness is participation in a study abroad program. According to the U.S. Department of Education, “Study abroad programs provide young citizens with cognitive and affective competencies necessary for them to thrive in a global economy, while concurrently providing the nation with a citizenry that is economically competitive and politically savvy” and in addition “study abroad experiences promote personal growth, development and maturity among participating students” (3).

## Background

Parkinson outlines eight program formats (dual degree, exchange, extended field trip, extension, internship or co-op, mentored travel, partner sub-contract, project-based learning/service learning, research abroad) for students to gain international experience (4). While these formats have been effective at providing students global exposure, LSU chose a unique approach of collaborating with the College of Humanities and Social Sciences (CHSS). The partnership was established in August 2009 when the College of Engineering joined the established German history and language study abroad program to create a new opportunity exclusively for engineering students. E<sup>3</sup> was designed to operate in tandem with LSU in

Germany (a CHSS program), capitalizing on the program's successes by utilizing the existing housing, travel logistics, and local contacts.

Baylor in Maastricht (BIM), developed at Baylor University in 2001, was a forty-one day summer study abroad program in the Netherlands (5). There are many similarities between the framework for E<sup>3</sup> and BIM including: summer programs approximately the same length, students enrolled in six degree credit hours, classes that met 4 days per week, and 3 day weekends for student travel. The program formats varied in that Baylor's program worked with a local company to conduct research each morning and attended classes each afternoon while LSU's program was based on two full days of classes and two full days of touring a variety of factories, universities, and museums that were selected by the faculty. Also, the Baylor program stayed in university housing while E<sup>3</sup> used local lodging.

The university visits, use of public transportation, and local lodging were all designed to familiarize the students with another country generating an appreciation for the differences across cultures. "There is an almost unquestioned assumption that study abroad is good despite the fact that there is no assurance that students will immerse themselves in the host culture, use its currency, learn its language, associate in any meaningful way with citizens of the host culture, or engage in a thoughtful way in the culture other than as a consumer of it" (6). The central aim of the program at LSU was to incorporate all aspects of the country and its people so that students fully immersed in the host country.

As of fall 2009, the only opportunity for engineers at LSU to gain an international experience specific to their discipline was to participate in a semester or year-long exchange program. While these programs have distinct advantages to provide students with a valuable international experience there are limitations including significant costs, substantial time commitments that potentially may delay graduation, and foreign language requirements. Additionally, the College of Engineering is selective when accepting transfer credits, especially from schools overseas. Since the summer courses are LSU courses taught by LSU faculty, the course credit is not a problem. Therefore, a study abroad program that was shorter in length, more affordable and required no second language was explored. A pilot program created as a summer study abroad experience was initiated so that engineering students would have an opportunity to study abroad. The result was Encounter Engineering in Europe (E<sup>3</sup>). This paper will detail the E<sup>3</sup> program that was launched at LSU's College of Engineering in the summer of 2010.

## Program Development

Traditionally the number of engineering students who participate in study abroad programs is not high. While study abroad numbers at LSU in comparison to general enrollment are close to the national average of about 2%, the percentage for engineering students is considerably lower than that. Similar to our peer universities students had the option to study abroad for a semester or a year, or to take electives or general education courses on LSU's summer programs. Few engineering students, however, took advantage of the study abroad opportunities. The following table shows the number of engineering majors compared to the number of overall participants for LSU summer programs and for LSU semester or year-long study abroad options.

Table 1. Comparison of Engineering vs. Overall Student Involvement in APA

Year	Engineering Programs Abroad Participants	Overall Programs Abroad Participants
Summer Programs		
2007	3	328
2008	4	398
2009	9	343
2010	15	450
Semester Programs		
Fall 07/Spring 08	3	81
Fall 08/Spring 09	5	66
Fall 09/Spring 10	5	77
Fall 10/Spring 11	6	73

Table 2. Comparison of Enrollment in APA by Academic Year

Academic Year *	Engineering Programs Abroad Participants	Overall Programs Abroad Participants	Engineering students enrolled at LSU	Overall enrollment at LSU
07/08	6	479	2071	23397
08/09	9	409	2170	23400
09/10	14	527	2382	23017
Fall/ Spring 10/11	21	73	2624	23686

\* Summers are included in the following Fall and Spring

Academic Programs Abroad decided to develop a summer program taught by engineering faculty and offering LSU courses that would be geared specifically towards engineering students. This initiative targeted Germany for several reasons. First, engineering students regularly took part in that program because the history classes offered are accepted as electives in the majority of the engineering disciplines. Additionally, past participants encouraged the LSU in Germany director to explore taking advantage of the industrial aspects for engineering students. Finally,

Germany was a natural choice, since German engineering is not only widely recognized as world class, but also because Germany is one of the world's leaders in new technologies and automation.

The first challenge was to find an engineering faculty member who would be willing to take on such a project. LSU's summer program model usually relies on individual faculty members' initiative to develop every aspect of a program. While we had some faculty members who showed an interest in teaching a program overseas, we did not have anyone who had the connections or expertise in a country overseas to develop a program, find accommodations etc. The solution was to pair an interested engineering faculty member with a well-established program in a country that would be able to offer students hands-on experience. The next step was to develop a logistical framework. The expertise of the faculty member who had developed and led LSU in Germany was important. Since the German program faculty member is a native of Germany and very well acquainted with the region, he identified potential partners for excursions in the locations of his existing program itinerary that may not have been obvious to his colleague in engineering, yet could be useful for the teaching of the engineering courses. He was also able to assist the engineering faculty member in establishing contacts and arranging the visits. To prepare for the program, the two faculty members spent a week in Germany and visited most of the sites. This enabled the engineering faculty member to evaluate the suggested excursion targets on site and to integrate specific topics and issues into her course plan. She also got to access the hotels and classroom options where the groups would stay. During the program, one of the two faculty members teaching German was assigned to accompany the engineering group on all excursions to assist in any way necessary, while the administration for both programs was facilitated by the LSU in Germany director.

The two groups closely coordinated logistics and itineraries. Students from the different programs had an opportunity to share rooms and most of them did. They often planned outings together in their free time. This approach enabled the engineering faculty member to focus on teaching and not logistics and made the planning of the program more transparent and less daunting, since it followed a well-established pattern. Any issues could be addressed easily on location and the team worked together very well. Maintaining communication at all times was the key to success in this area.

### Participants

The requirements necessary to participate in E<sup>3</sup> included: (1) students must be enrolled in an engineering discipline (2) students must have a 2.5 or better cumulative GPA (3) students cannot be on academic or disciplinary probation (4) applicants must be legal adults (18 years of age or older) at the time that the short-term program starts. The pilot program included: seven engineering students (five majoring in industrial engineering, one in mechanical engineering, and one in biological engineering) 1 student each from the College of Basic Sciences, Mass Communication, and Art and Design and 16 College of Humanities and Social Sciences (CHSS) students. The gender split for the engineering students was two female and five male students. LSU in Germany had 7 male and 12 female students. Engineering students were recruited at the university wide Academic Programs Abroad (APA) fairs, at the Encounter Engineering Bridge camp for freshmen, and at student organization meetings.

Summer study abroad programs at LSU require students to take six hours of credit. All seven engineering students were enrolled in a three hour special topics course, *Manufacturing and Technology*. The five industrial engineering students took a three hour computer graphics course and the biological and mechanical engineer took a *German for Travelers* course. Although the *German for Travelers* course did not count for credit toward an engineering degree it was a class that enriched the study abroad experience for these students. The students chose to take this class so that they could learn more about the German language and culture. The LSU in Germany students had the option of selecting two courses from the four history and language courses offered.

## Program Details

The study abroad program was structured so that all students, both COE and CHSS, were constantly together for meals, housing and transportation except when they were in class or on an excursion. This situation is ideal for cross disciplinary learning that doesn't easily occur in traditional college classrooms. The daily schedule was designed with two days per week in class and two days per week for excursions with three day weekends for free travel or optional group travel. The engineering students had separate excursions from the CHSS students with the exception of a visit to Dachau Concentration Camp. Excursions for the engineering students included touring various manufacturing and production facilities such as Siemens Medical, BMW, Adidas, and Staedtler Pencil. The days that the engineers were traveling to manufacturing and technology sites, the CHSS students were visiting sites related to World War II and/or German Civilization. On most excursion days all twenty-six students would eat breakfast and dinner together in the hotel but have lunch separately.

Typically students would leave directly after breakfast for their excursions. Most engineering excursions would require forty-five minutes to an hour and a half of public transportation. Factory tours were usually scheduled for 9:30 or 10:00 a.m. and would last two hours. Students were assigned to document each visit in detail, either by taking notes, photographs or where permitted videos. Immediately following a tour the group would find a location close by, usually an outdoor café or park, and would spend time discussing the tour. Students that took pictures and videos would be paired with students that took notes. The students would combine their notes with the pictures to completely document their excursion. These debrief sessions lasted approximately forty-five minutes and were critical to the learning process. Many times the students were not able to capture everything that was going on while touring and these sessions allowed the students the opportunity to digest the information, document the experience and reflect on the experience.

In addition to the students keeping formal documentation on each excursion, they kept a daily journal for the 35 day program and a group blog. Students were required to make journal entries on their free days and weekends, without exception. In addition, students were responsible to make blog entries for specific days. The purpose of the journal assignment was for students to reflect about their informal learning including personal observations about the culture, German phrases or idioms, unique foods, sightseeing and scenery, while the blog provided a vital link to family and friends still in the States. The journals were primarily graded on completeness, not on specific content. The one exception was that students were required to

conduct an interview of a German citizen. The interview was assigned so that students would engage with a local resident and learn more about the culture. All students spent more time with locals than was expected because most lodging was in youth hotels or local inns where the students had frequent opportunities to interact with individuals in the community that were residing there.

## Qualitative Results

Although the engineering students who studied abroad went to Germany to study industry and technology, they became consciously aware of their culturally different surroundings. Excerpts from the students' journals that indicate the students were noticing and documenting the similarities and differences between the German and United States cultures are presented below:

Jordan, a Biological Engineering junior wrote in his journal,

“Woke up for breakfast, Sandwich Bar. There is a weird selection of meats. Some I know, but many I don't. They seem to have had seasoning injected into them before they were sliced. I try a few and they have interesting flavors.”

Trent, Industrial Engineering Junior, made the following blog posting after the Chile-Brazil public viewing:

“We headed back to the tram station to find our tram out of order. Lacking sufficient translator, we grabbed a few Germans who slightly knew English and figured out a solution. Our group clambered into two taxis and headed back to the hostel listening to Taylor Swift on the ride home.”

The community of Brandenburg offered students the opportunity to observe rural life:

Emma, a junior in Mechanical Engineering, recorded in her journal,

“I have really enjoyed living in the Alps. Every day we walk to and from the train station through a trail in the mountains. There are always local people wandering the trails. They seem to live such relaxed, slow paced lives.”

She added that she is from a rural town in the States and that she need a vehicle to get to various locations such as the grocery store or clothing store.

The Soccer World Cup was in progress while E<sup>3</sup> was in session. Students had the opportunity to participate in three public viewings on huge screens set-up in the city for residents in both Nuremberg and Berlin. After the Germany-Argentina World cup game on July 3, Jordan entered the following,

"After the final whistle was blown, everyone got onto their tables and started singing victory songs. There is nothing quite like it in the States."

The combination of the engineering students traveling with the history students provided a unique opportunity for each group of students to informally learn from one another. In the evenings over dinner and recreational time the students would discuss their daily tours. Because the groups dined, roomed and traveled together there was plenty of opportunity for the students to converse about their studies and excursions. In the evening it was not uncommon to see a

history student reading an engineering student’s assignment helping with editing or an engineering student assisting a history students memorize important facts and dates for a test. When both groups went on an excursion together, the learning experience across the curriculum became most obvious. Beth noted in the blog:

“After a brief a lunch, and listening through multiple presentations about the holocaust from the history students, we made our way into the front gate of Dachau. It was a moving experience to be touring the very first concentration camp in Germany.”

Although the students were enrolled in only six college credit hours the learning that occurred was significantly more. Some of this learning would have naturally occurred due to travel abroad however for these students the learning was enhanced significantly because the program was coordinated with the CHSS. The engineering students had the benefit of a history scholar, two language teachers, as well as their engineering instructor. The combination of diverse teachers created a unique learning environment where discussions about rapid prototyping, the Nuremberg trials and umlauts might be discussed over dinner.

Emma posted in the blog:

“Today was our first full day in Germany. It began with a tour of Nuremburg lead by Dr. LSU.... As Dr. LSU pointed out much of Nuremburg is a mixture of old and new buildings because most of the city was destroyed during the bombing in WWII.”

### Quantitative Results

In addition to the qualitative review of the students’ journals and blogs, a preliminary quantitative analysis was performed on their pre and post test on the geography of Germany. Prior to departure, students were asked to identify any city, region or landform in Germany) At the conclusion of the program, students were again to note on a map all of the geographic places and features they knew. The number of correct locations was tabulated for both tests. The pre and post test results are listed in Table 3 and presented in histogram form in Chart 1.

Table 3. Results of Pre and Post Testing on Geographic Awareness

<b>Participant #</b>	<b>Pre-Test</b>	<b>Post-Test</b>	<b>Difference</b>
Participant 1	5	18	+13
Participant 2	7	23	+16
Participant 3	3	14	+11
Participant 4	1	4	+3
Participant 5	4	15	+11
Participant 6	2	15	+13
Participant 7	7	13	+6
Average	4.1	14.6	+10.4



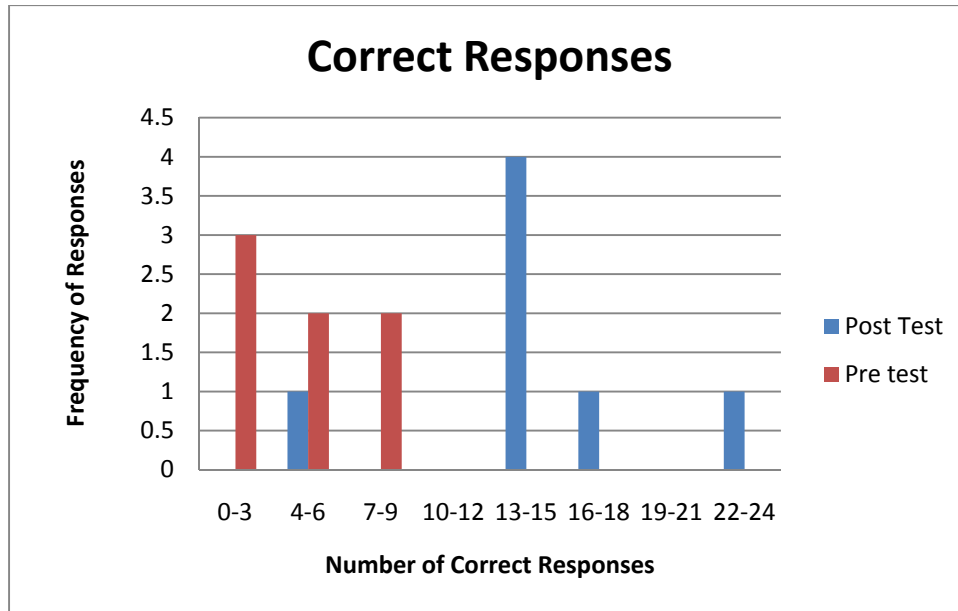


Chart 1. Histogram of Responses, Pre and Post Tests

All of the students indicated an increase in their geographic knowledge of Germany and the surrounding regions. The majority of the students increased their correct responses by more than 10 locations. In order to determine if the differences in the mean responses were statistically significant, a paired T-Test, 2 tailed analysis was performed on the pre and post test. ( $\alpha=0.05$ ) The null hypothesis for the test was that there is no difference between the means,  $H_0: \mu_2 = \mu_1$ . Results of the T-Test are presented in Table 4.

Table 4. T-Test: Paired Two Sample for Means

	Post-Test	Pre-Test
Mean	14.6	4.1
Variance	33.0	5.5
Observations	7	7
Pearson Correlation	0.69	
Df	6	
t Stat	6.18	
t Critical two-tail	2.45	

The results of the T-Test indicate that the null hypothesis is rejected and that the difference in the means between the pre and post tests is statistically significant. Although this sample size is small and may skew the results positively, the T-test, coupled with the review of the journals, blog, and their video, indicate that the students have increased their knowledge on geography, reflected on the similarities and differences in a variety of cultural aspects such as food and sporting events, and compared and contrasted solutions to global concerns through their analysis of the recycling programs and modifications to transportation to address air pollution.

## Challenges and Next STEPS

One of the most difficult challenges in developing a study abroad program for engineers was determining what classes to offer that allowed the students to receive engineering degree credit that capitalized on the travels and excursions unique to Germany. Because of very tightly structured curricula as well as accreditation issues that would arise with transferring credits from international partner universities, study abroad is an option very few students and faculty members have really considered. Like most other universities, LSU has not developed partnerships that would enable engineering students to go abroad for a semester or a year and transfer their engineering credits to LSU. Students who study abroad for a semester or a year usually focus on electives and science courses which usually do transfer without problems.

Because there was no existing course that catered to an international experience a three-hour course, *Manufacturing and Technology* was created. Since the program was going to be touring various factories a course designed to study the manufacturing methods and processes as well as the technology necessary for these processes was ideal. After the course was created, permission from each of the student's respective departments had to be obtained. Because an engineering study abroad program was new for LSU and the course was recently developed, each of the faculty advisors for the student's respective departments had to be consulted. Everyone would agree that study abroad was important for students but finding a place within each department's curriculum to give student appropriate credit was not easy; this was a tedious and time consuming task. In addition to the course *Manufacturing and Technology*, we are currently working on opportunities to offer the regular German first semester course to engineering students for General Education credit. This would be an additional step to integrate the two programs more and provide another course selection for students.

Appropriate classroom space and internet access for the students was the biggest logistical challenge for the students and faculty. Two of the housing locations did not have or had limited internet access so special arrangements had to be made for the engineering students to be able to finish their assignments and projects while on location.

The final challenge the new program faced was recruitment. The recruitment process encountered two obstacles: the cost to participate and student awareness of the program. Student's costs include a program fee, an airline ticket, and LSU summer tuition. The combined cost of these is approximately \$7500. Financial aid generally is also not geared towards encouraging study abroad. Recruiting students that have a desire to study abroad and can afford these expenses is difficult. Traditionally engineering students are trying to earn money during the summer. The team is investigating opportunities for scholarship and other financial strategies to address student's financial needs.

## Successes

“Even though short-term study abroad programs tend to have a set of discipline-specific objectives, their biggest achievements are those associated with changes in the mind-set of participating students, their attitude toward different cultures, and their eagerness to learn more about others and themselves” (7). Upon return, the E<sup>3</sup> students have continued to meet for social

and educational ventures. In November 2010, the students competed in the Transatlantic Climate Bridge “green shot” video competition, an international competition that is sponsored by the German Embassy (8). The students gathered photos and videos that depicted the diversity between the two countries that they observed while traveling abroad, and transformed it into a documentary amplifying the green initiatives of Germany and the United States. This video outlined the importance of recycling, alternative transportation, and cultural diversity. Students met during International Week on LSU’s campus to present their video and educate other students about all they learned while studying abroad.

In addition to cultural awareness, E<sup>3</sup> is an essential component of the retention model being developed by the College of Engineering. The program allows for continuation and development of relationships initiated in the freshmen year between students and faculty and staff in the college. Upper classmen who are Peer Mentors for the college were recruited to attend the inaugural E<sup>3</sup> program. One student attended in 2009. In reciprocal, another student was recruited from E<sup>3</sup> to be a peer mentor in the 2010 freshmen bridge camp, Encounter Engineering (E<sup>2</sup>). In 2010, both of those students hosted an Academic Programs Abroad panel for the freshmen in the E<sup>2</sup> camp and the College’s Introduction to Engineering course.

Prior to the creation of the Encounter Engineering in Europe program, students completing their freshmen year had a few options for their summers: internship, research experience for undergraduates and volunteer work. Given the economic downturn, fewer employers were hiring students between their freshmen and sophomore years and research experiences through REU’s are limited. Encounter Engineering in Europe provides a natural tributary for students between their freshmen and sophomore years in the college and provides them with global experiences that can enhance their academic records when they apply for internships.

Retention data collected the 14<sup>th</sup> day in the fall semester, for all of the retention programs is currently being collected; the E<sup>3</sup> program was added to the data set this semester and the students will be tracked until graduation. The expectation is that participation in this program will continue the relationships and community building that effect retention in the College of Engineering.

## Conclusion

LSU’s Academic Programs Abroad states “the purpose of group study abroad programs is to complement and expand on the lessons and opportunities students have on campus and to provide students with a unique learning experience they would be unable to gain on campus”(9). The partnership established between the COE and (CHSS) APA to create E<sup>3</sup> met and surpassed that goal. The engineering students’ experiences not only increased their technical knowledge and historical perspectives of manufacturing processes in the United States and in Germany but provided unique and valuable learning experiences in cultural sensitivity, geographic awareness and international partnerships. These tools and skills are necessary for connecting and communicating in today’s global economy. LSU’s APA hopes to establish more summer programs for engineering students as part of the summer program offerings. These programs are an excellent opportunity for the engineering students to become familiar and comfortable with

the world in which they will have to operate while at the same time learning to look at issue from a different perspective and getting to know cutting edge research and technology overseas.

## References

- 1) Johnston, S. F. "Towards culturally inclusive global engineering?" *European Journal of Engineering Education* Mar2001, Vol. 26 Issue 1, p77-89, 13p
- 2) ABET link: <http://www.abet.org/Linked%20Documents-UPDATE/Criteria%20and%20PP/E001%2009-10%20EAC%20Criteria%2012-01-08.pdf>; last accessed 1/5/11.
- 3) <http://www2.ed.gov/about/offices/list/ope/iegps/study-abroad.html>; last assessed 1/5/11.
- 4) Parkinson, Alan. "Engineering Study Abroad Programs: Formats, Challenges, Best Practices." *Online Journal for Global Engineering Education*, 2.2, 2007.
- 5) Fry, Cynthia C. "The Development of a Summer Study Abroad Program for Engineering and Computer Science Students at Baylor University." , 34<sup>th</sup> ASEE/IEEE Frontiers in Education Conference, Savannah, GA, 2004, T3D-1 – T3D-6.
- 6) Katula, Richard and Threnhauser, Elizabeth<http://ocs-web2.ocs.lsu.edu/apa/summer/International%20Proposal.pdf>. "Experiential Education in the Undergraduate Curriculum". *Communication Education*. Volume 48, July 1999.
- 7) Tajes, Maria and Oritz, James. "Assessing Study Abroad Programs: Application of the "SLEPT" Framework Through Learning Commiunities." *The Journal of Gen3eral Education*, Vol. 59, No. 1, 2010.
- 8) [http://www.germany.info/Vertretung/usa/en/09\\_Press\\_InFocus\\_Interviews/03\\_Infocus/03\\_ClimateBridge/TCBgeneral/ClimateBridge\\_general.html](http://www.germany.info/Vertretung/usa/en/09_Press_InFocus_Interviews/03_Infocus/03_ClimateBridge/TCBgeneral/ClimateBridge_general.html)); last accessed 1/5/11.
- 9) <http://ocs-web2.ocs.lsu.edu/apa/summer/International%20Proposal.pdf>; last accessed 1/10/11.