

## **AC 2008-1691: FRESHMAN PROGRAM TO GERMANY: AN INTRODUCTION TO GERMAN ENGINEERING**

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# **Freshman Program to Germany: An Introduction to German Engineering**

## **Abstract**

Many exchange programs within engineering have suffered from low participation rates in the past. The reasons for this have been multi-faceted, but include such factors as lack of language skills, price of programs, concern over time-to-degree, curricular challenges and fear of the unknown.

The University of Kentucky (UK) College of Engineering has developed a program designed for freshmen and possibly sophomore engineering students, which addresses some of these concerns. Beginning in 2007, the College of Engineering took a group of students to Germany for a four-week, intensive Calculus III program that included a German Engineering component. Students stayed with English-speaking host families and completed their coursework in English. The Calculus III class is part of the engineering students' core curriculum, and fits well into the sequence as a summer class after the freshman year. The German Engineering component, through which students earned two hours of credit, consisted of company visits and discussions with engineers and business leaders.

Following completion of the program, a post-experience survey confirmed that the students would be more willing to work or study abroad in the future, and that they felt more internationally competent and ready to interact with people from other countries and cultures. Students also reported a higher awareness of how other people view them. Three of the eight participants who had no prior German language skills enrolled in German 101 after the tour.

## **The University Landscape**

U.S. universities still struggle with the education of globally competent engineers, some universities more so than others. The University of Kentucky is located in one of the states that is considered to lag behind when it comes to primary, secondary and tertiary education. Thus, for a University in a state that has trouble preparing students for College, the challenge to educate students for the global marketplace seems even more daunting than elsewhere.

The University of Kentucky is the largest higher education institution in the state, currently with about 27,000 students. Over 80 percent of the student population is "in-state."<sup>1</sup> However, as of 2006, the state had the lowest percentage of Bachelor's or higher degrees in the nation, with 20.2 percent of the population 25 years and older, according to Census Bureau estimates for 2006.<sup>2</sup>

In 2007, the College conferred 337 undergraduate degrees.<sup>3</sup> Engineering suffers from very high attrition rates, and ranks second highest among the sixteen colleges at the University. Only 31 percent of students who start in engineering obtain an engineering degree within six years.<sup>4</sup> There are many reasons for the high attrition rate in engineering, such as: (1) a more stringent curriculum that requires a solid basis in sciences and math; (2) lack of spare time for extracurricular and social activities, (3) lack of hands-on engineering projects in students' first

year of study; (4) the many distractions (both for work and enjoyment) afforded by a city of approximately 200,000; and, (5) until the Fall 2007 intake, a policy of admitting students into Engineering with only standardized test scores necessary for admission into the University. In the past year, the College has tried to improve retention by admitting students more selectively (i.e. a higher ACT Math score is required to enter engineering as a freshman), and offering a Calculus I course taught especially for engineering students, in order to better demonstrate the applications of math in Engineering. The short-term study abroad program, Calculus III in Germany, discussed in this paper also gives students something to work towards in their freshman year, since students have to successfully complete Calculus I and II in order to participate. Last year, the College has not had to limit participation in this program, since there were more spots available than participants. If selection criteria have to be applied, students with prior German language ability (high school or college) will be given preference over students who do not know German. With consideration for program logistics and optimum learning outcomes in Calculus III, fifteen is considered to be the maximum course size for each cohort.

Besides retention issues, a reason for the tour was also that the College of Engineering has been strengthening its German Engineering Program over the past two years. The German Engineering Program at the University of Kentucky is not a degree program, but rather is a program designed to send more engineering students abroad for work, study or summer courses in order to increase their exposure to German culture, language, business and engineering. The state is home to over 50 German-owned companies, many of which are automotive suppliers. German companies are the second largest foreign investor in the state (Japan ranks first, with Toyota Motor Manufacturing as the largest by far);<sup>5</sup> therefore, there is a significant German influence in the state's business and engineering landscape. As future engineers, graduates will very likely have to interact with engineers and business people from other countries, at home and abroad. Immersing students early into an international environment will help prepare them for this. Besides the German Engineering Program, University of Kentucky engineering students have structured study-abroad opportunities in Malaysia, Japan, and China, with the number of openings now far exceeding the current demand.

Also in 2007, a semester-long exchange program with the University of Karlsruhe (a university in southern Germany which mirrors the University of Kentucky in terms of its engineering programs in many respects) has been established, and the College is working on more international work opportunities for engineering students. The lack of language preparation and also the lack of motivation to go abroad for long-term programs have limited the success of these programs so far. Offering a short-term program, in the same city as the semester-long exchange program, is a way to introduce students to study abroad and to foreign-owned engineering companies. During the tour, students live with families in Karlsruhe. Through the short-term program, students are also exposed to the language and might be encouraged to take German after their return. Offering a summer program allows those students to participate in international programs who otherwise would think that their curriculum does not allow for a semester or year abroad.

The semester-long exchange program is available to students who have missed the opportunity to participate in Calculus III in Germany, as well as to students who did participate in the short-

term program. To date, only a few students have studied a full semester at Karlsruhe, mainly in Materials Engineering.

### **The Calculus III Tour to Germany – Curriculum**

The Calculus III tour to Germany is designed for rising sophomores, since the majority of engineering students at UK start by taking Calculus I in their first semester. In the spring, their second semester, students take Calculus II, and are then eligible to take Calculus III, either in the fall of their sophomore year or during the summer after their freshman year. 2007 was the first summer in which the College offered this tour, and nine students signed up to participate. In 2008, the College will limit participation to approximately fifteen students, and there currently (as of January 2008) is a short waitlist for the program.

In 2007, students spent four weeks in Karlsruhe, Germany. The University of Karlsruhe was one of only three German universities that were awarded recently the title of “Elite University” in a nationwide competition. The tour was priced at \$2307, which included housing and meals with the families, transportation within Germany, a weekend trip to Munich, health insurance, faculty salary and lodging, as well as tuition, but not the flight to Germany.

#### *Calculus III*

In order to ensure that the content of the class would be identical to Calculus III classes conducted on campus, the class was taught by a faculty member from our University’s Mathematics Department, who also was the interim chair of the Department immediately prior to the tour. The class was listed as a regular, “off campus” Calculus III class in the schedule of classes.

The tour, which was four weeks long, included only sixteen classroom days for Calculus III. This is a short time for a 4-credit hour class. Calculus III is normally taught in about fifteen weeks in a regular semester or in eight weeks in a summer session. In order to cover the course material in its entirety, students were in class from 8:30 am to 3:15 pm, interrupted by two short breaks and a longer lunch break. This included homework time, during which the professor was available for questions. This helped students understand the lessons covered that day. Once a week, on Thursdays, students took a test. On the last day of Week 4, students took the final exam.

#### *EGR 199: German Engineering*

Germany enjoys a world-wide reputation as a leader in engineering and science. The thought behind the German Engineering class was that students should have some exposure to how engineering is practiced in Germany and what kind of obstacles German engineering faces in a global marketplace.

Being essentially a first-year program, the Calculus III tour suffers from some of the same problems that the typical first year in engineering suffers from--high intensity and too little engineering. The company visits provide students with more exposure to engineering and allow

students to have discussions with company representatives about engineering in Germany, recruiting of engineers, and business practices. The company visits were formalized as an “EGR 199” class (Topics in Engineering: German Engineering), a two credit-hour class.

As part of this class, the group visited three companies, as well as the “Deutsches Museum” in Munich and the largest construction site in Germany at the time, Neue Messe Stuttgart. The visits offered something for each of the represented engineering majors: Civil Engineering (Neue Messe Stuttgart), Chemical Engineering (Sued-Chemie), Computer Science and Mechanical Engineering (Siemens) and Mechanical Engineering (Terex). Students also learned about how German companies operate worldwide (Siemens and Sued-Chemie), and how American companies operate in Germany (Terex).

These company visits took place on Fridays. In order to ensure that students would take these visits seriously, EGR 199 was graded. The grades were based on attendance, appearance and also on interactions with the company representatives.

### *Home Stays*

Because of the intensity of the Math class, there was not enough time to teach German language in addition to Calculus III. The only good way to offer students some exposure to culture and language was to have them stay with a host family. All students were highly satisfied with this arrangement, and even those who were in families very different from their own background embraced the experience.

The weekends, except for one (when the group took a trip to Munich) were open and students usually spent them with their host family, visiting local sites, festivals and extended family.

### *Credits and Grading*

Because most engineering students lack substantial foreign language skills, the College decided to offer the classes in English. Good students also struggle with transfer credits, since only credit, not the grade, transfers. Taking a University of Kentucky Math professor and an on-site coordinator allowed the College to offer the Math and the “Topics in Engineering” classes as graded UK courses. One benefit of this arrangement was that students were more motivated to do well in both courses, since these grades would appear on students’ UK transcripts. Students earned a total of seven credit hours for this tour, four for Calculus III, two for EGR 199 and one Study Abroad credit-hour (pass/fail). The Study Abroad credit hour is important, as it proves that the classes were taken abroad.

### **Funding**

Most students utilize a combination of funding sources to fund their College degree. Tuition is usually financed by parents, scholarships, summer and part-time work, and financial aid. Many of the University’s students are first-generation college students. For many of them, the step to come to UK is a big one, so asking students to go on a study abroad tour initially seemed

ambitious. When planning this tour, the College decided that giving students as much academic content as possible (i.e. credit hours) would help make students' decision to go abroad easier.

The College provided financial assistance to those students who demonstrated need. Also, the tour as a whole was subsidized by the German Academic Exchange Service (DAAD), which awarded the program a short-term travel grant of 420 Euros per student (approx. \$560 at the time). This support was used for travel and lodging. The University's Office of International Affairs also supported the students with \$350 each. This support brought the program fee down to \$2307. Due to higher participation rates in the current and future years, and through solicitation of outside funding, the College is trying to keep the program fee close to \$2500 each year. The outlook for being able to do this is promising. This is partially due to an alumnus' continuing support of German Engineering, as well as to the higher number of students, which helps defray the fixed costs, which mainly include faculty and coordinator program costs (instructor salary, housing, and flights).

While the College and the University of Kentucky both have a strategic plan that seeks to increase the number of students who study abroad to 40 per year by 2009, the College has not set aside a budget to implement this. However, the College's Director of Co-operative Education (and co-author of this paper) splits her time between Co-op (ca. 80 percent) and International Programs (ca. 20 percent). She also served as the on-site coordinator for the German Engineering tour in the summer of 2007 and plans to continue with that duty in 2008 and beyond.

### **Obstacles and Challenges**

Organizing study abroad tours is a very labor-intensive process. Organizers had to recruit students, interact with parents, set up company visits, deal with all logistics, and accurately predict a budget that had to be maintained despite exchange rate fluctuations. Since most students had never traveled to Europe, the group held several meetings in preparation for the tour. Students were briefed on topics including money conversion, foreign culture, behavior, host families, transportation, and voltage conversion. Results from the post-program study abroad survey indicate that these meetings should be mandatory in order to prepare each student better for his or her stay abroad. Host families and a classroom for the duration of the tour had to be organized, as well as lodging for the faculty member.

In order to alleviate pressure and workload for the Math faculty member, the College also sent an on-site coordinator, who had done most of the planning for this tour. This lightened the workload on the course instructor, since he only had a teaching load (albeit, a heavy one), but no responsibilities regarding extracurricular activities, travel or company visits.

While in Germany, it became apparent that the host families felt that students needed to spend more time with the families, and they criticized the lack of German language preparation. Overall, however, families were more than happy to share their culture and language with the visiting students, and the relationship between students and families was very friendly and constructive across the board.

## Outcomes

### *Language*

All students remarked that they were able to use English in most situations, but they all noted that they wished they had known at least some German. One of the nine students did have limited German speaking ability, but remarked that Germans preferred to speak English with her most times. After the tour, three of the eight students, who had never had any German, enrolled in German 101 at the University of Kentucky. The post-program survey yielded a high score on the items: “Study abroad increased my ability to interact successfully with people from other cultures,” and “Study abroad made me more aware of differences in peoples and cultures.”

### *Diversity*

In the College of Engineering, about 13 percent of all students are female. On our tour, three out of nine students were female, resulting in a 33.3 percent female participation rate. All participants were residents of this state. The students came from seven different counties; four came from remote parts of the state. Two of the nine students had never been on a plane before boarding the flights this past summer. Only one of the nine students had previously been in Europe or outside North America.

### *Post-Program Study Abroad Survey*

One ABET program outcome for engineering programs explicitly states that engineering programs must demonstrate that their students obtain “the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.”<sup>6</sup> The company visits included in this tour, as well as the stay with host families and travels in Germany, were designed to help students achieve this goal.

Students were surveyed after the tour about their learning outcomes and experiences. The survey contains 35 general questions, and six questions specific to engineering, each using the traditional Likert format.<sup>7</sup> All eight respondents (since the survey was anonymous, we were not able to require that students respond) rated the tour very positively. They agreed or strongly agreed that study abroad was important to their professional as well as their personal development. All students believe that the study abroad program will help them search for their first job after graduation and that it will enhance lifelong career opportunities. All but one student felt that they had gained self-reliance and independence. Eight respondents also felt assured in their engineering skills and all but two felt that the experience better equipped them to “solve real-work problems in a broader global societal context”. No students disagreed or strongly disagreed with any of the “engineering outcomes” questions, and there were only five neutral responses out of the 48 possible (eight surveys with six engineering-related items each). A copy of the actual survey instrument will be made available at the presentation. Upon returning from study abroad engineering programs, students are asked to complete this survey, which is then used by program administrators in a structured interview setting.

Seven of the eight respondents stated that it was important to obtain credit during the tour, and

all agreed or strongly agreed that, given the same circumstances, they would study abroad again.

In speaking with students, it has become very apparent that the experience abroad has shaped most of them in remarkable ways. One student will go back to Europe this summer, this time to Italy and Spain, while another has already visited Karlsruhe again over the winter break. Several others report that they plan to visit Karlsruhe within the next two summers.

### *GPA's and Grades*

The program tended to attract highly motivated students, and, while there was no stated minimum GPA for participation, there still seemed to have been some self-selection for the program. It tended to attract strong students. Only one student had a GPA below 3.0 before going on this tour, and only one other had a GPA below 3.0 after the fall 2007 semester.

### **Future**

The College is planning to offer the tour on an annual basis. For the 2008 year, the tour will be underway during the ASEE national conference. As of February 2008, sixteen students had expressed interest in participation, and the College is expecting to take all of them. The higher number of students will allow the College to keep the price close to that in 2007 (about \$2500) and to absorb most of the lost support from DAAD (that support was a one-time grant), and help offset the declining value of the U.S. Dollar.

A language component will be considered for future years as well. As of 2008, we have decided that the Math class is too intensive to include a German language course (not to mention that taking an additional instructor raises the costs), but priority will be given to those students who have taken German classes.

The hope is that, by offering this tour, more students will be given exposure to study abroad, and some of the students who successfully complete the short-term program will consider a longer-term exchange program in the future.

### **Conclusions**

Overall, the short-term study abroad tour has filled a void in the College, because the assigned credit did not require any departments to establish equivalencies or accept transfer credit. Students were able to take a mandatory class ahead of their peers and away from campus. This program serves as a good "trial run" for students who might be interested in longer-term experiences abroad. Due to the program being offered very early during a student's college career, there is time later for participation in longer programs. The experience on students' resumes and transcripts clearly boosts their marketability with employers.

The stay with host families allowed students a glimpse into the daily lives of German families, and any questions they might not have asked a peer were easily addressed in families' homes. All of the students expressed and self-reported a heightened sensitivity to other cultures and also to politics and different world views after the tour.



## Bibliography

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<sup>3</sup> UK Office of Institutional Research, "Degrees Awarded by College and Degree Level."

<sup>4</sup> UK Office of Institutional Research, "Graduation Rates: By College of Initial Program 1994-2000."

<sup>5</sup> State of Kentucky, Department for Economic Development, "German Foreign Investment Report."

<sup>6</sup> ABET: "2008-2009 Criteria for Accrediting Engineering Programs"; criterion 3 (h); [http://www.abet.org/forms.shtml#For\\_Engineering\\_Programs\\_Only](http://www.abet.org/forms.shtml#For_Engineering_Programs_Only).

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