

Online Journal for Global Engineering Education

Volume 1 | Issue 1

Article 3

November 2006

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Recommended Citation

Grandin, John M. (2006) "Preparing Engineers for the Global Workplace," *Online Journal for Global Engineering Education*: Vol. 1: Iss. 1, Article 3.

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Preparing Engineers for the Global Workplace

Cover Page Footnote

This article is based on a paper read at the Annual Conference of the American Society for Engineering Education (ASEE) in Chicago, Illinois on June 19, 2006. The paper was subsequently published in the "Proceedings of the Annual Conference of the American Society for Engineering Education" and is reprinted here with kind permission.



Preparing Engineers for the Global Workplace: The University of Rhode Island

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ABSTRACT

The University of Rhode Island takes pride in the fact that 20% of its undergraduate engineering students complete a Bachelor of Arts degree in German, French or Spanish (and soon Chinese) along with their BS engineering degree. Its distinctive International Engineering Program (IEP) is characterized by the two degrees, but also by the fact that each IEP student spends the fourth year of the five-year curriculum abroad, completing a semester of study at a partner university and a six-month internship with affiliated global companies. Over 200 undergraduates have completed the IEP curriculum, which is now well institutionalized in the culture of the University of Rhode Island.

IEP faculty have recently expanded the program to the graduate level through implementation of a Dual Degree Masters Program with the Technical University of Braunschweig. Students in this program complete half of their masters work at both institutions, and the thesis abroad, with oversight from faculty at both schools. At the conclusion students receive the MS from the University of Rhode Island and the *Diplom* from the Technical University of Braunschweig.

Building on the Dual Degree Program, URI faculty are now creating an International Ph.D. Program in partnership with Braunschweig and the National Science Foundation. Recently awarded a grant from the NSF Program in International Research and Education, URI faculty plan to develop a comprehensive international education program for the benefit of all engineering students, from day one of the freshmen year through the post-doctoral level.

This paper presents a basic overview of the URI International Engineering Program at the

undergraduate and graduate levels. It focuses on the value added through the experience of engineering work and study abroad, as well as on the lessons learned over the seventeen year history of the URI program, in an effort to share such insights with interested colleagues from other institutions.

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Given the fading importance of time and distance in a world now bound so closely together by the Internet and modern transportation means, coming generations of engineers will inevitably be working in far different ways than their predecessors. Products are rarely designed for single national markets today, meaning that research and development work is often assigned to widely dispersed global teams. Manufacturing likewise is typically multi-locational or outsourced to countries in Asia, Latin America, Eastern Europe, or all of the above. 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.¹

If American engineers are to be competitive in this global scenario, they must not only be equipped with cutting edge technical skills and knowledge, but also with cutting edge personal and communication skills for collaboration across nations, continents, languages and cultures. They must be informed, flexible, mobile, open to different cultural perspectives, sensitive and able to adapt to difference. Given the new and highly rigorous emphasis on engineering and science education in the rapidly emerging economies of nations such as China and India, where work can be done at a

fraction of the cost and where a great deal of attention is paid to dealing culturally and linguistically with others, American students must be prepared to understand, work and communicate with their peers abroad. It is therefore critical that engineers be educated as global citizens, trained to work in global teams, and prepared to develop and manufacture for a global market. Without these skills, they will fail and their work will be handed off to peers from other parts of the world where such global preparation is already valued and broadly practiced.²

The International Engineering Program (IEP) at the University of Rhode Island (URI) presents itself as one model to address these requirements. It is a comprehensive program providing the next generations of engineers, whether at the bachelors, masters, or Ph.D. levels, with the necessary skills to work effectively in today's global workplace. Undergraduate IEP students complete the BA degree with a major in German, French, or Spanish (and soon Chinese) along with the BS in any of the engineering disciplines. Graduate level IEP students are able to complete a simultaneous Dual Degree Masters Program with a partner university abroad and doctoral students will soon be able to complete a Joint Doctorate, based upon a new model being developed with the *Technische Universität Braunschweig* in Germany. This paper will provide an overview of the critical aspects of each of these IEP components as well as a summary of key lessons learned over the nineteen-year history of the program.³

The undergraduate IEP is a five-year BA/BS program, comprising simultaneous majors in a language and an engineering discipline as well as a semester of study abroad and a six-month internship with an engineering-based firm in a country of the target language. Students study their language of choice along with the engineering major for the first six semesters and then spend the entire fourth year abroad, studying language, culture, and technical subjects in the target language, with the expectation that they return home for year five fully proficient in their second language and with substantial cross-cultural communication skills. Students complete their two degrees in the fifth year at URI, with the expectation of then finding employment with a firm actively engaged in global activities. Indeed, the placement rate for IEP graduates is extremely high, with the great majority employed by firms working globally and many students joining the companies with which they interned. Most graduates are based in the U.S. but each year a few launch their careers in positions abroad.

Now in its nineteenth year, the IEP enrolls approximately 200 students or 20% of all URI engineering undergrads. The program was begun in 1987 as a partnership of language and engineering faculty and its interdisciplinary nature has maintained itself with the executive directorship still in the hands of a professor of German. The IEP has proven to be a good recruiting tool for highly motivated and gifted students in search of degree programs with special added dimensions, or programs offering experiences beyond the purely technical, promising greater options upon graduation, greater chances of finding a challenging position and the tools to move into leadership tracks early in their careers. The IEP has also proven to be an attractive option for women and minorities. One-third of the IEP students are women and one-half of the students in the Spanish IEP are of first or second generation Latin American background. Over half of IEP students (110) opt for German as their language of choice, with the rest quite evenly divided among French and Spanish. The program now graduates approximately 35 students per year, most of whom go into employment with global companies or to graduate programs in engineering. Some choose to branch off from their technical background through the study of law or medicine.

The IEP has developed valuable working partnerships with excellent engineering universities in Germany, France, Quebec, Switzerland, Spain, Mexico and China.⁴ The relationships are designed on a one-to-one exchange basis, with tuition obligations covered at the home institution and a simple exchange of students which must balance out over the long run. Students pay tuition at home, but room and board costs at the host institution. Through extensive advising and careful preparation students are able to take course work at the host institution and transfer full credit back home, thereby studying abroad without loss of time toward the degree. The IEP is sending 30-35 students abroad for semester-long study at a partner university each year. In turn, that same number of students, on average, comes to Rhode Island for coursework either at the advanced undergraduate or masters level.

IEP students are required to complete a six-month internship with a firm abroad in the fourth year of the program and usually do so immediately after the semester of exchange study. For that reason, 30-35 IEP students are placed in international internship positions each year. The IEP has built relationships with numerous global companies operating in the target countries and is able to arrange placements with approximately six months advance preparation. The companies are asked to provide a meaningful engineering experience for the students, a housing

accommodation and a subsistence stipend enabling the students to live with very little out of pocket expenses. Placements are often with subsidiaries of American-based global firms such as Texas Instruments, Pentair, or TRW, or with European-based global firms having significant operations in the United States, such as Siemens, BMW, Saint-Gobain, Daimler-Chrysler or BASF. In many cases students are able to complete summer internships with a branch of a company in the U.S. before completing the full internship abroad with the same company. The latter arrangement provides the student with exposure to the company's operations on two continents and likewise gives the companies the opportunity to know the student in greater depth and thereby assess the desirability of making an offer upon graduation.

The IEP experience at URI has been enriched by the addition of an on-campus administrative and residential center known as the IEP House. The latter is a former fraternity at the heart of campus, which was renovated nine years ago and houses program offices and meeting space, along with accommodations for forty IEP students. The IEP House, with its full dining program, has become a hub of activity for all students and faculty in the program. Recognized as a successful model learning center, the IEP House has likewise become the American home to several students from partner universities abroad who make up about 20% of the residents each year. Because of the success of this creative living/learning experience for IEP students, the program is now in the process of acquiring and renovating a second fraternity building adjacent to the current IEP House, thereby expanding to a two-building complex with housing for 75 students.

It was at the request of the exchange students from the *Technische Universität* Braunschweig that the IEP first considered expanding the program to the graduate level. Braunschweig exchange students were coming to Rhode Island toward the end of their German academic program which typically concludes with a masters-level degree called the *Diplom*. When considering that they had already completed the equivalent of the BS and were doing graduate-level work at home, it was agreed that a year of full-time coursework with a thesis would fully justify granting successful candidates the URI Masters of Science. After successfully negotiating this portion of the program, it was then proposed that Rhode Island graduate students in the engineering disciplines should also be able to complete a graduate level program in Braunschweig. The resulting Dual Degree Program enables masters-level students at either institution to complete half of the MS work at home and half abroad, with the thesis jointly coordinated by faculty from each school, but completed at the partner school. The resulting certification is the

Rhode Island MS and the Braunschweig *Diplom*. While many Braunschweig students have taken advantage of this option, Rhode Island students have only recently begun to do so. Reluctance of the latter to join the program is rooted in the difficulty of finding financial support for the extra year abroad and the fact that IEP students tend to find good jobs quite readily with the BA/BS of the undergraduate IEP. These hurdles have been at least partially addressed through new grant-funded scholarship opportunities and the gradual recognition on the part of students that the extra time invested for the Dual Degree can well make an enormous difference for long-term career opportunities.

The first URI Dual Degree student has just completed his thesis, which is actually based on research done at the BMW headquarters in Munich. Two more URI students are in Braunschweig for their second year of the program, and they will be followed by three more students next year. The numbers are modest, and yet the model is now in place and the first pioneers have proven that Americans can earn the title of *Diplomingenieur* along with their Masters of Science.

The IEP at the graduate level was given a significant boost this year through the award of a grant from the National Science Foundation's (NSF) Program in International Research and Education (PIRE), the latter being designed to promote international collaboration among universities and increase the international mobility of graduate students in science and technology. PIRE supports innovative international partnerships with university colleagues abroad, based on the rigorous common investigation of scientific or technical problems, involving close collaboration and graduate student research at both locations. In the URI case, the NSF is supporting educational and research initiatives in collaboration with URI's partners in Germany. Building on the existing relationship with the *Technische Universität Braunschweig* (TU-BS) in the area of microfluidic technology and its Dual Degree Master's Program, this new project will develop research opportunities from the undergraduate through the graduate level, culminating in a proposed new Dual Degree Doctorate Program.

The NSF funding will support several graduate students in the coming five years, all of whom will be spending part of their programs in Braunschweig. The project's technical goals are focused on two applications: 1. The design of a system to detect the early response to pathogen infection using a microfluidic "lab-on-a-chip." 2. The use of microfluidic technology to study the generation of fluid pressures in sediments due to seismic loading which will lead to a better

understanding of the triggering of tsunamis. A key element of the project is the collaboration with scientists and students in Braunschweig, who have the complementary technical infrastructure and expertise necessary to pursue this program of research. URI has already partnered with Braunschweig on engineering education for undergraduates for 10 years, and has exchanged over 300 students in both directions during that period.

As part of these grant-funded activities, URI and Braunschweig faculty are developing a new optional dual-degree doctoral program, leading to both the Ph.D. and the *Doktor der Ingenieurwissenschaften*. Students in this curriculum will be required to complete all traditional requirements of a Ph.D. in the engineering disciplines. In addition, doctoral candidates will be expected to complete at least a year of their coursework and dissertation research at the partner university abroad and to submit a thesis supervised and deemed satisfactory by the faculty of both institutions. The two institutions are working closely together to establish creative, effective and viable ways of preparing students for global research careers.

For both the undergraduate or graduate levels, the IEP leadership is very cognizant of the fact that it can no longer be completely viable as an international engineering program without paying attention to China. The program faculty have been approached in recent years by several corporate leaders who have praised the IEP for what it is and what it has accomplished, but who have also pleaded for young engineers with experience in China, with proficiency in Mandarin and with the skills to work together with the Chinese. For these reasons, the IEP has taken steps to build a Chinese IEP, to form a partnership with a Chinese university and to establish internship opportunities with companies in China. In 2005, discussions were opened with Zhejiang University in Hangzhou and the IEP will send its first group of engineering students to Hangzhou in the summer of 2006 for a Chinese language and culture program, and it will also send its first student to a professional internship in China following that course.

The Chinese IEP will be formed on the BA/BS model, but, due to the linguistic and cultural complexities, will begin as an Asian Studies Major with the parallel engineering degree rather than a Chinese language major. This is due not only to the fact that URI does not yet have a full Chinese major, but also to the reality that engineering students going to China need to be more soundly prepared in terms of culture, both in the formal and day-to-day sense. Students will be able to study

Chinese at URI through the third-year level, and will complete more intense language training at our partner university in China prior to their internships.

Preliminary discussions suggest that URI will be able to build an exchange with Zhejiang University very much like the exchange with the *Technische Universität Braunschweig*, at both the undergraduate and graduate levels. Our native speaking Chinese faculty, for example, are already in discussion with colleagues at Zhejiang about research exchanges in the area of microfluidics. Amazingly, these colleagues are already collaborating with our partners in Braunschweig.

Lessons learned: As a second part of this paper, the URI faculty wish to share a few observations based on the efforts to build the IEP over the past nineteen years. Though the topic is complex and perhaps worthy of a book, one nevertheless can delineate and recommend a few ingredients for success.

1. "Chemistry" and Credibility: Building cross-disciplinary programs and taking the curriculum in new directions requires innovation and collaboration among faculty who are not necessarily accustomed to working together. For this to happen, people from disparate ends of the campus, and yet of similar convictions, need to meet each other, agree on a common goal, and commit a great deal of time and work to the endeavor/project. Sometimes collaboration comes about through conscious effort and a pre-determined decision, and, at other times, it happens by chance, by circumstance, or by surprise. However it happens, it is important to recognize the fact and to take advantage of opportunities as they present themselves.

At URI, the IEP was launched when the new dean of engineering at that time, Dr. Hermann Viets, who happened to be German-born, moved into the house next door to the head of the German faculty and the author of this paper. In their first backyard conversation, they discussed engineering and foreign language education, and agreed emphatically that the new global age called for some kind of creative collaboration between these two areas. Out of this a committee was born, a core group of interdisciplinary faculty became convinced of the value of the idea, a grant was written, and the concept of URI's IEP was launched.

Nothing is, of course, that simple. And yet, when credible and hard-working people agree on an idea with a certain level of excitement, that is a critical ingredient for success. Little will happen on a long-term basis with ideas supported by just one or two persons or by one side of two-sided partnerships, or by persons unable to

involve the interests of influential persons in the campus community. There must be a spark, a meeting of the minds, an enthusiasm, an ability to work together, and the potential for influencing opinion.

2. Cross-Disciplinary Collaboration and Commitment: Programs like the IEP face long-standing hurdles and traditions buried deeply within academia. Language faculty, after all, tend to see themselves as humanists with a mission to teach national literatures to young persons inspired to pursue advanced degrees in highly specialized areas. Engineering faculty, in a related manner, traditionally see little value in language learning. What is primary to most engineers is technology, and, if more work is to be done by their students, it should be in that area. And this view is not helped by the American view that the whole world speaks English, and that there is, therefore, no need for us to concern ourselves with language learning.

At URI we were fortunate to have capable faculty in both engineering and languages who were enthusiastic about the idea of an international engineering program, who could bring specific skills to the effort, and who were not bound by traditional paradigms. The program was begun in German because there were several engineering faculty with German language skills and/or valuable relationships with industry and higher education in German-speaking countries. Another major factor was the eagerness of the German language faculty to work with new audiences and develop applied language programs such as the IEP. Indeed, the German language program at URI has built a curriculum and a research agenda around this pedagogical direction which has become a major factor in the program's now substantial reputation in language as well as in engineering circles.

URI's successful establishment of the IEP came about because of commitment and determination on the part of faculty in BOTH language and engineering disciplines. The faculty leadership involved in this project realized the importance of working together, and of capitalizing on each other's strengths. The likelihood of doing serious language work, which is, after all, absolutely necessary if one hopes to send students to study engineering abroad or to carry out internships with companies in non-English-speaking environments, could not be done without the involvement of language faculty. On the other hand, there was no way to convince engineering students to study language in depth, or to develop internships abroad, or to design a new international curriculum without the commitment and participation of engineering faculty.

3. A "Win-Win" Situation: At URI, faculty from engineering and languages consider themselves close colleagues today, and are equally proud of the program which has evolved. Underlying this happy union is the fact that the IEP has become a fact of life at URI to the benefit of all parties. The IEP is a drawing card for both languages and engineering at URI. All faculty are equally aware of the fact that the distinctive IEP curriculum is often the factor that makes the difference as good students choose URI over other institutions. Bright young students interested in engineering are inevitably accepted by five or six schools, all of which can provide a good engineering education. Many of these excellent students select URI, however, because URI offers the opportunity to study a language and culture alongside engineering, and to do an internship with a company abroad.

Both language and engineering faculty have "profited" from their common program. Just as engineering faculty now often find larger numbers of brighter and stronger students in their classrooms, so too do language faculty. In a time when German enrollments have languished at colleges and universities throughout the United States, the German program at URI has grown, and now boasts over 100 undergraduate majors.

4. An Entrepreneurial Spirit: Academia must learn to be responsive to societal needs and must continually ask itself if its curriculum is indeed in line with the requirements of the workplace and the demands of a continually changing and evolving economy. Too often university faculty rest on the traditions imparted to them in graduate school, and on their long-standing perceptions of what it is important to know.

Many would argue that certain fields and certain contents have an inalienable right to be a part of the curriculum of a university, and that no force or budgetary analysis or student opinion should ever be able to alter this. Unfortunately, this attitude is not in line with today's fiscal realities, and neither German departments nor electrical engineering departments, to take two examples, will necessarily survive in the absence of students, or in the absence of good programming.

Faculty, therefore, must look at themselves and their programs critically, and ask to what extent they are meeting their students' and their constituencies' needs, and to what extent they are competitive when compared with neighboring higher education institutions. Yes, technology is important; yes, languages and the humanities are important. But, neither has the right to remain, if they are not responsive to the needs of students and society.

International engineering, as an interdisciplinary response to the demands of today's global workplace, is a good example of academic entrepreneurialism. From an idealistic level, IEP students receive a broader and more liberal education, and yet, from a practical perspective IEP students are also more competitive in the world marketplace. The German program at URI, as an example, is doing well today not by any inalienable right, but because its faculty adapted their program to the needs of their institution and the needs of its regional and national constituencies.

5. Partnership with the Private Sector: The Rhode Island IEP could not exist without close collaboration with business and industry, i.e., with those persons and organizations for whom the students will intern and ultimately pursue their international careers. For this reason, the IEP faculty worked from the beginning to establish relationships with subsidiaries of foreign firms in the Rhode Island area, and with American firms heavily involved abroad. Because global work is the reality of business today, finding internationally involved companies was not a problem. Also, because the success of global companies is dependent upon reliable cross-cultural and cross-lingual communication, there was little problem in finding firms which recognized the importance of the goals of the IEP.

The IEP established an Advisory Board in order to involve companies in the process of building the program and in order to develop internship and long-term employment opportunities. The Board is active today in many ways: advising faculty, coordinating internships, recruiting students, raising funds for scholarships, and in other aspects of program development and support. The Board meets annually, either at URI, at a company location, and every other year at a European location.

6. Private Sector Outreach Skills: For anyone establishing a program comparable to the URI program, which relies on close collaboration with business and industry for a variety of reasons, it is essential that the program leadership include persons with strong development skills. In order to build an internship program, a university representative must visit with leadership-level persons in the companies involved. In most cases this calls for good presentation skills, and, in the case of visits abroad, presentations in a language other than English, with sensitivity to cultural differences. The IEP corporate liaison must be capable of board room visits, and feel comfortable in the social environment of the business world. Annual board meetings with corporate supporters are likewise

expected, and, here again, the IEP faculty need to be able to present themselves appropriately.

7. Recruitment of Good Students: Inasmuch as an International Engineering Program cannot exist without a critical mass of students, and since the concept of bilingual American engineers is still relatively new, it cannot be assumed that large numbers of students will enroll in the IEP without active encouragement. The IEP, therefore, relies on an active advertising, promotion, and recruitment program. Mailings consisting of letters and brochures go out to high school students, to teachers, and to faculty. A high school outreach team, made up of current students and faculty, makes annual visits to high schools in the Rhode Island area. A regular newsletter, newspaper advertisements, journal advertisements, and even radio ads are a part of the regular cycle. In the same spirit, a great deal of effort has been put into the IEP Web site: (<http://www.uri.edu/iep>). It is the strong opinion of the URI faculty involved in this program that the IEP cannot be taken for granted, and that recruitment will be ongoing for years to come.

8. A Long-Term Commitment: It may sound trite to say that international engineering programs are not built overnight, and, yet, as we now complete our nineteenth year of program building, there is still much work to be done. Though the program is healthy, and though we now have French and Spanish IEPs alongside the German program, there is no assurance that the program would survive without the extraordinary efforts of its key advocates, its faculty and staff. We say this not to discourage others, but only to emphasize that such programs require a long-term commitment and a steady and sustained effort. Each year, the IEP needs to be sure that a new group of good students will be joining the program, each year the faculty need to work on retention rates, i.e., on motivating and supporting students, and encouraging them to maintain their own long-term perspectives. Each year, a new group of interns needs to be placed with European companies, each year scholarship funds need to be generated, and so on.

9. External Funding: Programs such as the IEP are labor intensive, and require many activities beyond the normal routine of the academic year. Faculty need to travel to develop internships, to maintain relationships with the private sector, to visit students on site during their internships, to visit high schools for recruiting and to develop study abroad opportunities. A program such as the IEP also requires continual curriculum review and the creation of specialized courses such as advanced intermediate German for engineers. To do this work properly, faculty need release time and

summer course-development stipends. Expenses such as these are not generally allowable within the budgetary framework of an institution such as the University of Rhode Island. It is safe to say, therefore, that international engineering programs rely on external funding for their development. For us at URI, grant writing and fund-raising have become a part of the routine academic year.

10. Outreach: Outreach is a key word which is applicable to any and all of the previous categories. If the impetus for reform begins with language faculty, then this group needs to reach out to interested colleagues in the engineering disciplines. Likewise, if the impetus begins with engineering faculty, they should not undertake internationalization without the collaboration of language and international studies faculty. Just as one group cannot develop a program such as this exclusively within the university, higher education as a whole must reach out to the private sector rather than attempt program establishment internally. Only by means of a multi-sided partnership will the program be successful; only by means of a program, which is in the interest of all parties concerned, will the student truly be served.

11. Faculty Rewards: Finally it needs to be recognized up front that the traditional academic tenure and promotion system is not designed to support faculty who commit large amounts of time to programs such as the IEP. Just as young engineering faculty are promoted according to their ability to teach, to attract funding and to carry out significant research programs, language faculty must also establish strong teaching credentials and a consistent program of research and publication. At URI we have learned to expand the scope of appropriate research and publication to include IEP-related activities and their associated dissemination activities, such as this article, as acceptable items for a tenure/promotion dossier. In short, there is a wealth of program and curricular development associated with the IEP, which presents an entire realm of research activity and related publication and dissemination opportunities. Higher education must learn to think more broadly about faculty roles and responsibilities if it wishes to be responsive to societal change and needs. Only then will programs such as the IEP take root and flourish across the country.

Notes

¹ Recommended reading on the rapid changes occurring in the current wave of globalization includes:

Friedman, Thomas, The Lexus and the Olive Tree: Understanding Globalization, Farrar, Straus & Giroux, New York, 1999.

Friedman, Thomas, The World is Flat: A Brief History of the 21st Century, Farrar, Straus & Giroux, New York, 2005.

Prestowitz, Clyde, Three billion New Capitalists: The Great Shift of Wealth and Power to the East, Basic Books, New York, 2005.

McGregor, James, One Billion New Customers: Lessons from the front Line of Doing Business in China, A Wall Street Journal Book, New York, 2005.

² For a review of a Rand Corporation study on the personnel needs of global corporations in the age of globalization, see: Developing the Global Work Force – Insights for Colleges and Corporations (1994). A CPC Foundation/Rand Corporation Report. Bethlehem, Pennsylvania: The College Placement Council, Inc.

³ For further information on this program, see: www.uri.edu/iep and furthermore:

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Grandin, John M. and Verducci, Kristen, "The International Engineering Internship Program at the University of Rhode Island," in The Journal of Chemical Engineering Education, May 1996, pp. 126-129.

⁴ For links to the IEP partner universities abroad, see: <http://www.uri.edu/iep>

