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Globalization is producing significant changes in the engineering profession. The Marquette University College of Engineering is evaluating the deployment of industry's global model for engineering in the university environment and examining ways that cooperation with international institutions can significantly improve the effectiveness of teaching, research, and research commercialization. A key element of this effort is the development of an International Engineering Student and Faculty Exchange Program (IESFEP) to:

- Create an international learning and research environment that prepares students to effectively function on global entrepreneurial teams
- Leverage R&D capabilities and researchers at partner schools to significantly augment results and commercialization of the college's R&D programs
- Generate global technology-oriented business opportunities through cooperative student and faculty entrepreneurial project teams
- Provide high-relevance extracurricular educational opportunities for students and faculty

Introduction

Globalization of the economy is producing significant changes in the engineering profession. Globalization has opened international markets for new products, and has provided strong economic incentives for US-based companies to closely couple with global manufacturing and service providers. Globalization is now impacting the manner in which products are invented and designed. The migration of traditional engineering functions to so-called "low cost countries" (LCCs) significantly impacts the types of functions that engineers perform, as well as how and where they perform these functions. In short, it is now the turn of engineering to experience the impact of outsourcing and offshoring being felt by manufacturing, IT, etc.

Engineering education must synchronize with this evolution of the engineering profession. Marquette University's College of Engineering (Milwaukee, Wisconsin) is augmenting education in traditional how-to-do-it engineering functions with what-to-do entrepreneurial engineering education focused on technology generation and transfer to viable new technology-based products and business opportunities. As part of this emphasis on entrepreneurial engineering, the college is initiating an International Engineering Student and Faculty[1] Exchange Program (IESFEP) that includes:

1 In some educational systems, the term "faculty" denotes a department within a college, or a college within a university. Here, the term is used to denote course instructors and researchers, i.e., the technical staff of a university.

- C*reating an international learning environment* that is representative of and helps prepare engineering students for participation on global entrepreneurial teams and in the global business environment.
- G*enerating global business opportunities* The program is expected to produce real new opportunities. The creation of global business networks is an important element of this objective, and the IESFEP is a strong stimulant to student and faculty network building.
- *Pursuing cooperative research* with institutions with complementary research programs. Cooperative research coordinated through the IESFEP is an effective means of developing the innovations that enable the resulting entrepreneurial network to generate new global business opportunities.
- *Providing a set of highly relevant extracurricular educational opportunities* that enhance professional career and personal development of students and faculty.

This overview summarizes plans, actions, and results to date on the development and execution of the overall IESFEP plan, and on efforts to answer these two specific questions. The presentation includes:

- An overview of basic program elements
- A review of intellectual benefits of international cooperation
- An analysis of broader program impact
- Overview of initial site visits
- Site visit special issues
- Resulting cooperative opportunities
- Resourcing of initial efforts
- Extracurricular opportunities
- Lessons learned and outstanding issues

Basic program elements

A growing area of focus within the engineering profession is the field called entrepreneurial engineering[1]. As this field develops, engineering and business colleges are responding by adapting complementary educational and research programs[2]. The goals of the Marquette University College of Engineering's entrepreneurial engineering initiative are to:

- *Teach* the basic elements of engineering entrepreneurship
- *Generate* new technology-based business opportunities
- *Commercialize* university R&D as a source for new opportunities

Currently the college's focus in this area is centered in the Masters of Science in Engineering Management Program, jointly offered with the university's College of Business. Potential extension of entrepreneurial engineering education to undergraduate programs at the college are being examined.

The College of Engineering's International Engineering Student and Faculty Exchange Program (IESFEP) is a key element in the strategy to develop and maintain a strong entrepreneurial engineering element in the college. Since globalization is a primary driver behind the rising importance of entrepreneurial engineering, the impact of globalization must be acknowledged explicitly in the structure of the associated educational program.

The general concept behind the IESFEP is illustrated in Figure 1. US and global technology-based business opportunities are created by leveraging College of Engineering and partner school cooperative research programs augmented by the college's entrepreneurial engineering capabilities and partner school technical capabilities.

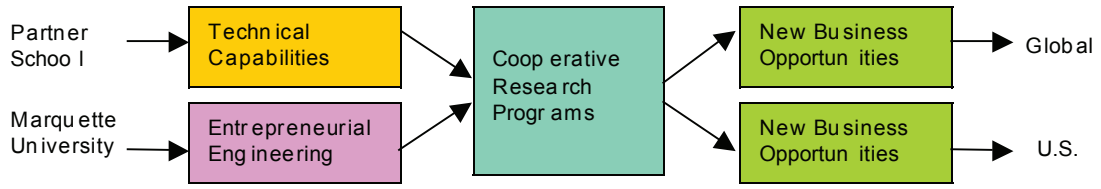

Figure 1: The IESFEP Concept

The intent of the IESFEP is to institutionalize the model of Figure 1 with formal, structured, long-term cooperation agreements producing a steady flow of exchange with a number of international partner schools. The steady-state goal is a presence of about fifty international participants on campus, with about half that number of college participants abroad. In the steady-state, the college should be pursuing at least one cooperative research project with each partner school.

The manner in which students and faculty participate in the ISFEP is illustrated in Figure 2. Initially the IESFEP focuses on graduate students, but will eventually include undergraduates as experience allows. The college's students will take primarily technology-oriented courses at partner schools, and partner school students will take primarily entrepreneurial engineering courses at the college. Students will also participate in research programs at partner schools. The college's faculty will teach primarily entrepreneurial engineering classes and participate in research at partner schools, and partner school faculty will teach primarily technology-oriented classes and participate in research at the college.

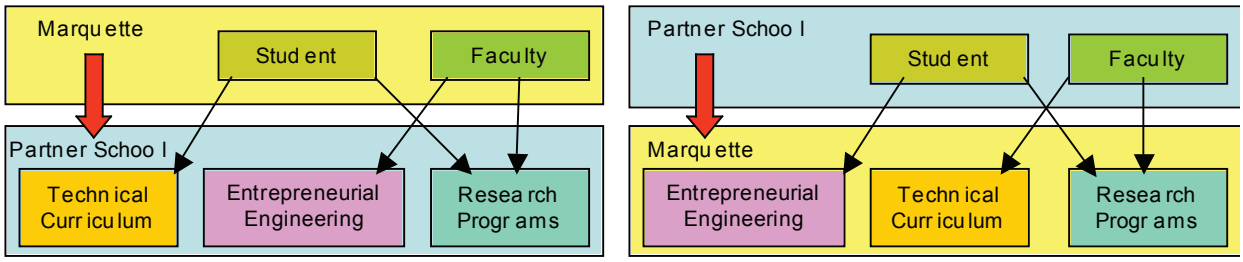

Figure 2: IESFEP Student and Faculty Participation Model

Note: This summary emphasizes the differentiation between technical curriculum and capabilities and entrepreneurial engineering curriculum and capabilities, and denotes the primary contribution of the college in the area of entrepreneurial engineering and the primary contribution of the partner schools in the area of technology. While this differentiation provides the basic value proposition behind this program, it is, of course, expected that all involved institutions and participants will contribute to and benefit from all relevant technical and entrepreneurial elements of the program. In fact, a well-executed program will have the effect of minimizing the technology vs. entrepreneurship differentiation between participant capabilities.

Intellectual Benefits of International Cooperation

To understand the essence of the particular and unique benefits obtained through the intellectual cooperation as pursued in the IESFEP, it is necessary to describe the fundamental value proposition behind the program.

A primary force behind today's global economy is the migration of manufacturing, services, and now product design and development to LCC sources. This migration is driven not only by cost disparities, but also by increasing availability of capable technical resources in LCCs. While there are many questions about the societal impacts of this trend, and while the difficulties of outsourcing and offshoring are well-known, especially for product design and development, the economic drivers behind this business model are quite strong, motivating industry to aggressively and persistently pursue successful approaches that support this model.

It is asserted here that these same forces apply to the development of the technology and the innovations that fuel the front end of emerging global virtual design-manufacture-service pipelines (as evidenced by the growing trend to outsource/offshore engineering functions). Further, it is asserted that these forces apply to university-sponsored education, and especially research programs, as well.

Conducting research at US educational institutions can be an expensive proposition. Expanding research capabilities can be even more difficult given increasingly challenging resource issues. Replacing outmoded research programs with more relevant programs can be still more difficult, with the barriers to exit being as significant as the barriers to entry (further complicated by tenure considerations). These are the same forces that drive industry to cooperation with sources in LCCs. It is asserted here that universities that apply business models for conducting research equivalent to models currently being executed by industry can significantly improve the effectiveness of their teaching and research programs.

The IESFEP is based on the hypothesis that international intellectual cooperation is a key element in developing a cost-effective means for the college and its partner schools to more aggressively pursue research programs that drive new technology-based business opportunities.

While the IESFEP focuses on technical research, a basic foundation of the program is integration of research with the field of entrepreneurial engineering. This linkage is an important motivator for the college's partner schools to engage in intellectual cooperation through the IESFEP. In addition to bringing the college's technical knowledge and experience to the cooperative research teams, cooperation with the college can provide entrepreneurial knowledge and experience to partner school participants. This will be helpful in the partner schools' efforts to commercialize the products of the joint development activities, and thus forms a strong motivator for partner school intellectual cooperation. (After all, LCCs don't *want* to be LCCs!)

Broader program impact

The IESFEP accrues benefits beyond those associated with advancement of knowledge obtained through the specific cooperative research projects ultimately supported. The program is directed at both technology development and transfer to new business opportunities. Conducting research in association with the IESFEP increases the extent to which potential benefits become actual social benefits through application of new knowledge. An objective of the

IESFEP is to teach researchers how to transfer technology to new business opportunities (entrepreneurial engineering), thus creating the potential for lasting social benefit beyond the specific research programs supported here. From this perspective, a fundamental means of disseminating new technical knowledge for this program is through commercialization as new products and services.

It should be noted that the fields of innovation, entrepreneurship, and technology transfer are themselves important topics of current research. By operating on real opportunities, the IESFEP advances this type of research as well. The college is actively communicating with universities conducting research in this area, most notably though the efforts of the National Collegiate Inventors and Innovators Alliance and the Kern Family Foundation[2].

The IESFEP has an important impact on underrepresented student populations. Global exposure to diverse ethnic and cultural environments is acknowledged as an area of special concern for underrepresented US students. The IESFEP provides these students at the college with an excellent opportunity to expand their experiences far beyond the range of their current environment. This particular extracurricular aspect of the program can be highly beneficial for this student group.

The migration of design, manufacturing, and service jobs to LCCs can have a strong positive impact on the economies and standards of living of both LCCs and non-LCCs, as long as the front ends of the global virtual pipelines are continuously filled with innovative new products, services, and technologies. If these pipelines dry up, both LCC and non-LCC economies suffer. The goals of the IESFEP are directed at filling these pipelines. The combination of international entrepreneurial engineering education and experience as supported by the IESFEP with emerging global virtual design-manufacture-service pipelines can create powerful engines for economic growth that can raise standards of living across the board.

Initial site visits

The first major effort associated with the IESFEP was a series of five site visits conducted over two weeks in July 2005 at the largest polytechnic universities in Poland (combined enrollment of over 120,000 engineering students). The general purpose of the site visits was to initiate a response to these two fundamental questions:

- Is it possible for Marquette University's College of Engineering to generate and sustain significant levels of bi-directional student and faculty exchange with non-US institutions?
- Is it feasible for the college to develop a systematic process that continually initiates internationally based entrepreneurial teams that successfully cooperate to commercialize jointly developed R&D for the global marketplace?

The universities visited were located in Gdansk (gd-*eye*-nsk), Krakow (*kra*-coof), Poznan (*poze*-nine), Warsaw (var-*sha*-va), and Woclaw (*vrots*-waff). (See the Appendix for an overview of these institutions.) The general reasons for selecting Polish universities for the first major IESFEP activity were:

- Poland is a major target of offshoring by US businesses (it is currently considered an LCC), thus increasing the opportunity for industrial participation in research commercialization.
- Poland has a well-developed technical educational system, increasing the probability of forming productive cooperative exchange and research relationships.
- Polish technical universities generally have good English language programs, and significant numbers of faculty and students have adequate capabilities in English.

- Poland has a cultural affinity for Western-style entrepreneurship, thus increasing the probability of success for this first venture (not necessarily a long-range objective).
- Poland has a high unemployment rate (19%), needs to create new jobs in Polish businesses, and generally views the entrepreneurial engineering approach as a means of addressing this problem. (See, for example, the Regional Innovation Strategy for Pomorskie Vivodeship, available from the author, which has a lengthy English abstract).

Poland is certainly not the only country with these characteristics, but Poland also has certain specific characteristics that made it a good choice for a first venture:

- Milwaukee has a large and active community of descendants of Polish immigrants, thereby providing a natural support structure for exchange students and faculty.
- The College of Engineering had a strong exchange program with Polish universities in the 1970s (especially at Wroclaw), and some personal linkages remain.
- A number of influential college alumni have ties to Poland, thus increasing the opportunity for industry cooperation and providing a possible funding source.

Finally, as a new member of NATO and the EU, and as a strong supporter of the US, it is important for Poland to develop a strong economy and a strong presence in Central Europe. Targeting IESFEP activities supports this need.

Site visit special issues

Before describing results of the site visits, there are some special issues to note. First, July is the holiday season in Poland, so not all faculty and administrators were available for discussions at these visits. Second, all senior leadership positions at these institutions (presidents to deans) are elected (three-year term, two-term limit). This was election year, and September 1 the start of the new term, so this caused some confusion as to who was responsible. Also, there were some language barriers, primarily at Krakow. Finally, these were all cold calls by the college's representative (the author), with only emails and phone calls exchanged with key contacts before the visits. (Copies of various documents associated with the entrepreneurial engineering initiative and the IESFEP were sent ahead to provide some detailed context for the visit.) But given these issues, discussions were well and enthusiastically attended at all the institutions, with contacts ranging from faculty researchers to rectors (presidents).

With regard to stimulating interest in participation in the IESFEP, all parties are well aware that intentions in this (or any) endeavor are useless without funding to pursue opportunities. At this time, none of the parties involved in the discussion have access to funds to support future cooperation at substantive levels. But all parties recognize that until someone actually generates some type of results through cooperative efforts, substantial funding will be very difficult to obtain. For this reason, discussions focused primarily on "low-hanging fruit." Fortunately, since the college has not been heavily involved with Polish universities for over twenty years, and since Poland is ripe for entrepreneurial engineering, several opportunities presented themselves.

Cooperative opportunities

One area of discussion involved small projects that could demonstrate the ability to cooperate and produce useful results. Specific characteristics of initial cooperative opportunities include:

- Low or no incremental cost, work already being done or planned by both partners
- Highly synergistic, don't require significant changes in direction by either partner
- High probability of success, clear and simple linkages between efforts
- Make a visible difference, things that might be difficult to do well independently

The desire is to find at least one such potential initial cooperative opportunity at each institution. These initial opportunities might not ultimately prove to be the optimal area of cooperation between the institutions (i.e., the best opportunities for research commercialization), but the focus is to open the door and prove the ability to cooperate to leverage future funding for more ambitious efforts, and to provide the linkages that will enable more ambitious and highly aligned activities.

A number of potential cooperative project opportunities arose during the site visits, several of which are being pursued at this time. A brief description of some of these can provide a flavor of the types of initial projects that meet the preceding characteristics.

Dr. Irena Chmielewska at Poznan University of Technology is doing research on speaker recognition. Not surprisingly, speaker recognition algorithms need to account for the native language of the speaker. This researcher has a large database of Polish native speakers, of course, but desires to expand the database to other languages. Milwaukee has a large population of native Mexican Spanish speakers, and Marquette's College of Engineering has a speech recognition recording lab. The cooperative opportunity here is for Marquette to record local native Mexican Spanish speakers per Dr. Cmielewska's protocol, which can then be incorporated into her database. Initial contact has been made with Milwaukee's United Community Center to bring native speakers to the college's lab.

Dr. Marek Sowinski, also at Poznan, has developed simplified computer models of sewerage drainage systems that can predict conditions such as system overflow caused by events such as heavy rainfall (an important contributor to water system contamination). To prove out the models, actual flow and rainfall data is needed, but such data is not readily available to Dr. Sowinski at this time. The cooperative opportunity here is to provide data from the Milwaukee Metropolitan Sewerage District, which has heavily instrumented its system. Initial contact with sources responsible for recording the needed data has been established.

Dr. Jerzy Swiatek at Wroclaw Technical University is attempting to apply pattern recognition analysis to human body motions. The approach is to use techniques similar to those commonly used for speech/voice/speaker recognition to characterize body motion, thus eliminating the need to develop complex dynamic structural models of motion (the standard approach). The goal is to use the models to optimize an individual's physical rehabilitation protocol. Researchers at Marquette are working toward a similar end, but are matching body motions to brain activity patterns using MRI scanning. Again, the initial opportunity here is to provide Polish researchers with data on human body motions, with significant potential for linkages beyond this initial opportunity.

It should be pointed out that although these are preliminary efforts to establish the ability to cooperate, commercialization opportunities do exist. For example, speech-related work at Poznan has potential in areas such as speech prosthetics for laryngectomy patients, and speech-based security systems.

In addition to these more specific opportunities to cooperate, several more general avenues are being discussed.

Gdansk University of Technology has an undergraduate program in Environmental Planning and Management (a major issue in Poland that has taken on an even greater significance since entry into the EU). This program is has chosen English as a common language, because the focal point of the program is the Baltic Sea, surrounded by six countries speaking six different languages. The opportunity here is that graduates from the Gdansk program that pursue a Master's degree tend to study in one of the other countries on the Baltic. Studying at Marquette University would be an attractive alternative, since the students speak English and Milwaukee is on Lake Michigan, which has environmental issues similar to the Baltic Sea.

The universities in Gdansk, Warsaw, and Wroclaw expressed a strong desire to have a mini-course in the basic elements of entrepreneurial engineering taught at their institutions. The author is in the process of revising the Strategic Technology Planning and Development course now being prepared for the college into a one-week format suitable for Polish students and faculty. Providing this one week course would:

- Introduce an important subject area not covered at the Polish universities at this time
- Stimulate future R&D cooperation between institutions
- Stimulate future exchange of students and teachers
- Give Polish students and teachers an opportunity to experience a class taught by a native English speaker

This last point is important. Although significant numbers of students at these institutions are enrolled in English language courses, they often lack self-confidence in conversing with native English speakers. This is a major obstacle to student exchange. The opportunity to experience a course taught by a native English speaker can significantly increase self-confidence, and stimulate interest in participating in the exchange program.

As described above, the IESFEP long-range plan calls for partnerships with universities in several countries. But for now, activities will focus on leveraging initial work on Poland. In addition to the opportunities cited above, three additional activities are planned for the near future.

An NSF proposal for return site visits to Poland in the spring of 2006 is being prepared. These site visits would reenforce the specific opportunities outlined above and explore further cooperative activities.

An NSF proposal for a workshop to be held at Marquette University and attended by up to ten representatives from the five Polish universities is being prepared. This would coincide with the upcoming annual North American Manufacturing Research Conference, being hosted by the college May 23-26, 2006 (http://www.eng.mu.edu/namrc34/). The workshop would provide the first and essential face-to-face discussions among IESFEP researchers and participants.

The author accompanied representatives of Wisconsin industry on the Governor's trade mission to Poland in November (http://commerce.state.wi.us/IE/IE-CentralEuropeMission.html). The purpose of college participation in the mission was:

- Work with US and Polish businesses participating in the mission to identify and overcome technical hurdles inhibiting international acceptance of products. This could result in initiation of joint research commercialization programs involving Marquette and Polish universities.
- Examine the possibility of establishing an industry-supported international manager-in-training element to the IESFEP program that would aid in preparing engineers for international engineering management assignments. This would involve trade mission participants considering or expanding their businesses presence in Poland.
- Visit the Krakow and Warsaw universities to identify initial projects of the type described above. (Good initial efforts are already being pursued with Gdansk, Poznan, and Wroclaw.)

Resourcing initial cooperative research efforts

Regarding the types of international cooperative research projects cited above, a critical success factor is that they need to be low/no cost until a track record of success warrants application for significant funding levels. Where will the resources come from to bootstrap these activities? Five resource bases can help initiate and sustain the types of cooperative research and commercialization being pursued, all of which rely on graduate and undergraduate student participation.

The Strategic Technology Planning and Development course under development for the Engineering Management Program at the college is a project-centric course culminating in a student-generated technology commercialization prospectus. Student teams in this graduate-level course will generate such studies for the joint research efforts pursued through the IESFEP. This provides exactly the type of international entrepreneurial experience that is an essential part of the college's overall entrepreneurial engineering initiative. It also adds an element to the research activities that can significantly enhance commercialization potential, but which is often not generated for many research projects.

All college undergraduate engineering students are required to take a senior design course in which student teams select new products to design and prototype. Student teams will be encouraged to choose products related to IESFEP cooperative research activities. Again, the international element of these activities will significantly enhance the relevance of this experience for these students, and will contribute directly to research efforts.

NCIIA-sponsored Advanced E-Team grants provide an excellent means of funding initial efforts to commercialize university research (http://www.nciia.org). This avenue will be used to augment the project activities described above.

The university sponsors several annual internal competitions such as the Office of Research and Supported Programs Forward Looking Research Competition, and the University's Kohler Center for Entrepreneurship sponsored business plan competition. These provide additional support for collaborative efforts at the stage addressed in Item 3 above. The speech prosthesis work has been entered into both of these competitions in the fall 2005 semester.

The Golden Angels Network, associated with Marquette University's Kohler Center for Entrepreneurship (http://www.mukohlercenter.org) is an angel investor group that supports Marquette student, faculty, and alumni new

venture mentoring and financing. This is another important funding source that can augment commercialization efforts.

Extracurricular opportunities

The traditional model for engineering education includes a fairly distinct separation between intra- and extracurricular activities. It is the nature of entrepreneurial engineering to blur this line, especially in the area of the school vs. work boundary.

In this sense, the entrepreneurial engineering initiative and the IESFEP are not business-as-usual activities at the college. (In fact, they are both entrepreneurial in nature, forcing faculty involved to practice what they preach.) Success will depend heavily on enthusiastic participation by faculty and students in out-of-the-box activities, and especially extracurricular opportunities.

The most visible extracurricular program element will be participation in international research teams. The expectation is that faculty, graduate, and undergraduate students will be involved in extracurricular activities such as:

1. Attending and teaching classes at partner institutions
2. Traveling to partner institutions to participate in research projects
3. Attending and presenting papers at international research conferences
4. Interfacing with industry to conceptualize technology-based global business opportunities

Initially, extracurricular activities of these types will be short in duration due to funding limitations. One-week activities for activities 1-3 above are feasible. Eventually semester-long, and then two-semester opportunities of this type will be generated.

Another highly visible extracurricular element will be the pursuit of course projects beyond the limits of courses that generate associated new business opportunities. Program participants will be expected to develop extra-university funding sources to pursue this extracurricular work through vehicles such as NCIIA Advanced E-Team grants, Golden Angels funding, various internal competitions, industry support, etc.

Lessons learned and outstanding issues

Although this program is in its infancy, several lessons have already emerged, some of which have been touched on in the preceding discussion of site visit special issues. What will be emphasized here is the importance of strong person-to-person networking (face-to-face whenever possible).

All five Polish institutions are large (20,000 to 35,000 students), and tend to be somewhat bureaucratic. Teaching loads are high. These factors make person-to-person communication links difficult to establish and maintain. Furthermore, senior leadership positions are elected, causing convoluted and shifting roles, responsibilities, and spheres of control and influence. These factors combine to create equally convoluted and impermanent channels of communication, a problem which can be exacerbated by language difficulties. The ultimate effect is that it is difficult

to determine exactly who needs to be contacted to generate specific program actions and results, and difficult to establish and maintain robust communications links with these individuals once they are identified.

Compounding these communication problems is the relatively new nature of the field of entrepreneurial engineering, which adds two additional complexities. First, since the field is new, there is no defined cooperating entity within the partner universities (e.g., Department of Entrepreneurial Engineering). Second, this new field requires relatively detailed explanations to stimulate the interest of key decision-makers at these fairly conservative institutions.

It is the goal of this program to maintain long-term, systematic, self-sustaining cooperative linkages to international partner schools. It took almost six months to work through the factors related above to set up the initial site visits in Poland. While the site visits were successful from the perspective of creating a base communication network and establishing initial cooperative efforts, all of the complicating factors are still at work, and robust communication linkages do not yet exist. Failure to rapidly and firmly cement program linkages jeopardizes this program. The program is in a critical stage of development and face-to-face next-step planning meetings are necessary to cut through the factors cited above.

At this point, discussions with the involved institutions have not directly addressed intellectual property issues. While common practices regarding authorship of research papers will be applied, it will be necessary to directly address IP ownership, an especially critical issue given this program's emphasis on commercialization of results in new products and services.

Conclusion

The initial site visits conducted as the first major initiative in the IESFEP activity provided initial verification of the validity of the fundamental concept and the approach being taken, as well as a set of feasible initial cooperative activities. Specifically:

- The basic philosophy behind the college's general entrepreneurial engineering initiative and the IESFEP in particular were well-received by the sites visited.
- The sites visited proactively support international exchange and research programs, though primarily within Europe, and were interested in pursuing this opportunity with the college (letters of intent in preparation).
- Specific and feasible initial activities were identified at Gdansk, Poznan, Warsaw, and Wroclaw.
- Due to the size and strong reputation of the Krakow University of Technology, continued efforts to identify initial opportunities are justified.
- Means of resourcing these limited initial efforts have been identified.
- First steps in executing several cooperative efforts have been initiated.
- Near-term follow-through visits are being planned.

Based on these conditions, it is expected that a credible assessment of the overall feasibility of the IESFEP will be possible to conduct by fall of 2006.

References

1. Polczynski, M.H., S.V. Jaskolski. Entrepreneurial Engineering Education. Proceedings of the NCIIA Ninth Annual Meeting, San Diego, CA, March 17-19, 2005.

2. NCIIA Report on the Kern Engineering Entrepreneurship Initiative Summit, February 2005, Kern Family Foundation.

Appendix – Site Visit University Profiles

Krakow University of Technology

Krakow University of Technology (http://www.pk.edu.pl/) serves 17,000 students. The university has a staff of 2,200, with 1,200 academic instructors. The university has 215 professors and associate professors, including seventy-seven full professors. The university has seven faculties, all of which grant doctoral degrees (currently about 230 PhD students):

- Architecture
- Civil Engineering
- Mechanical Engineering
- Electrical and Computer Engineering
- Environmental Engineering
- Applied Physics and Computer Modeling
- Chemical Engineering and Technology

Gdansk University of Technology

Gdansk University of Technology (http://www.pg.gda.pl/) employs 2,500 staff, including 1,200 academics. The number of students approximates 20,000. Current faculties:

- Applied Physics and Mathematics
- Architecture
- Chemical Engineering
- Civil Engineering
- Electronics, Telecommunication and Informatics
- Electrical and Control Engineering
- Hydro and Environmental Engineering
- Management and Economics
- Mechanical Engineering
- Ocean Engineering and Ship Technology

Wroclaw University of Technology

Wroclaw University of Technology (http://www.pwr.wroc.pl/) has 32,000 full-time and part-time students studying in Wroclaw and at three branches located in the largest towns of the region. It employs a staff of 4,200, including 2,035 academic teachers. Current faculties:

- Faculty of Architecture
- Faculty of Civil Engineering
- Faculty of Chemistry
- Faculty of Electronics
- Faculty of Electrical Engineering
- Faculty of Mining Engineering
- Faculty of Environmental Engineering
- Faculty of Computer Science and Management

- Faculty of Mechanical and Power Engineering
- Faculty of Mechanical Engineering
- Faculty of Fundamental Problems of Technology
- Faculty of Microsystem Electronics and Photonics

Warsaw University of Technology

Warsaw University of Technology (http://www.pw.edu.pl/) has 30,000 students, 370 professors, 1,000 tutors, 500 lecturers and 340 teaching assistants located on three campuses. Current faculties:

- Architecture
- Automobile and Heavy Machinery Engineering
- Chemical and Process Engineering
- Chemistry
- Civil Engineering, Mechanics, and Pertochemistry
- Economics and Social Science
- Electrical Engineering
- Electronics and Information Technology
- Environmental Engineering
- Geodesy and Cartography
- Mathematics and Information Science
- Material Science and Engineering
- Mechatronics
- Physics
- Power and Aeronautical Engineering
- Production Engineering
- Transport

Poznan University of Technology

Poznan University of Technology (http://www.put.poznan.pl/) has 19,000 students and 1,000 academic teachers. Current faculties:

- Architecture
- Civil and Environmental Engineering
- Mechanical Engineering and Management
- Electrical Engineering
- Technical Physics
- Information Technology and Management
- Working Machines and Transportation
- Chemical Technology