International Technology Entrepreneurship: Immersion into Interdisciplinary Innovation (I^5) in Shanghai

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Abstract - Over the past six years, the School of Engineering and Computer Science (ECS) at Baylor University has designed, developed, and successfully implemented an international study abroad program aimed at giving engineering and computer science students an opportunity to study abroad while accruing course credit that counts toward their degree plans. For the past two years this program also integrated the commercial side of innovation by joining with the Hankamer School of Business (HSB), making the program a multidisciplinary experience in International Technology Entrepreneurship. With continuous improvements based on our students' and other constituents' needs and the insights gained during four successful study abroad trips to Europe, the School of Engineering and Computer Science and the Business School are now working to provide an enhanced summer study abroad program in an area of the world where economic growth and innovation are expanding rapidly - China. This paper will document the redesign of the summer abroad experience into a program where technology and business students from American universities are immersed in an intensive six weeks in Shanghai, with technology and business students from China, working on real-world technology innovation with real-world multi-national and Chinese companies. The program will also include critically important training in Chinese cultural awareness, including cultural sensitivity, history, and current business and technology working environments.

Index Terms – Engineering Globalization, Global Business, Innovation, Study Abroad for Technical Majors, Technology Entrepreneurship

RATIONALE FOR GLOBAL AND BUSINESS EXPERIENCES FOR TECHNICAL MAJORS

As the Chinese say, “may you live in interesting times.” In light of the demand for technical students with global experience and business skills, this certainly is the case for traditionally trained engineers and computer scientists.

The fusion of entrepreneurial business skills with keen technical insights to forge high-impact innovation is an American tradition dating back at least to Benjamin Franklin, continuing with Thomas Edison, and is accelerating in the high-tech era through Bill Gates, Michael Dell and their colleagues. The progression from the historical model of a brilliant sole inventor-entrepreneur to major corporations with highly specialized technical teams driving innovations and economic growth has not lessened the need for cross-disciplinary understanding and collaboration. Robert G. Cooper’s study of new product development processes [1], failures and successes over the past 20 years consistently demonstrates the criticality of integrating market inputs and business model definition into every phase of technical development and identifies the use of dedicated, multi-disciplinary teams as an important success factor.

Engineering graduates who effectively engage in these processes, exhibiting ease in cross-disciplinary environments are clearly what corporations who excel in new product innovation require. High-tech entrepreneurial firm’s needs are no different. They can be in fact more demanding of multiple skill sets almost by definition. Jeff Timmons’ model for the entrepreneurial process [2] depicts the ongoing task of an entrepreneurial team balancing the opportunity and resources required to understand and respond to it. Those actions are invariably carried out by a technology-business team working in a very integrated fashion.

Thus the connection of technical training to “real-world” commercial savvy is not a recent idea or priority in engineering education. But neither is it a fully solved problem, as the curricula for technical education allow so few degrees of freedom if the technical prowess of graduates is to be maintained. As a recent study in the changing qualifications for computer software designers and developers indicates, “Without adding courses the challenge to educators in the field becomes how to integrate the development of oral and written communication, teamwork, project management and business knowledge in addition to the technical skills in an already crowded curriculum.” [3]

When (in Thomas Friedman’s assertion) the world “went flat”, the requirement to also add a whole new level of global competency to the skill-set of engineers and other technology
graduates to the mix exacerbated the situation even further. The situation 2007 graduates from technical and business schools face is crystallized by Dr. Friedman when he writes, “Today, your first management job out of business school could be melding the specialties of a knowledge team that is one-third in India, one-third in China, and a sixth each in Palo Alto and Boston. That takes a very special kind of skill and it is going to be much in demand in the flat world.” [4]

In response to this reality, the School of Engineering and Computer Science (ECS) and the Hankamer School of Business (HSB) at Baylor University collaborated to create a summer abroad program that fits into an already tight degree plan while delivering a potent educational experience in international technology entrepreneurship to its participants.

**A BRIEF HISTORY OF THE ECS/HSB STUDY ABROAD PROGRAM AT BAYLOR**

Despite the benefits attributed to a study abroad experience, not the least of which is the importance of acquiring global competency, engineering students have not availed themselves of the opportunity to study abroad. Encouraging technical majors to take advantage of study abroad opportunities has historically been difficult, due in part to the limited time available in accredited programs, cost of the trips, and lack of elective hours in their curriculum for which study abroad hours could be substituted. In a 2003 report of the Council of International Education Exchange, engineering students topped the list of underrepresented populations among those participating in a study abroad program, representing only 2.9% of all study abroad students [5],[6],and [7].

In 2000, in answer to the needs of students, alumni, and other constituencies, the School of Engineering & Computer Science developed a summer study abroad program for its majors. For the first several years, ECS partnered with the Universiteit Maastricht in Maastricht, the Netherlands to provide students with an opportunity to take six hours that were required for their respective degree plans, during a summer session (where there would be minimum conflict with regular semester course offerings), at an affordable price. The two courses taken were “Technical & Professional Writing,” a required course for all ECS majors, and “Data Communication,” a hybrid course, based on the “Data Communication” course taught in Computer Science and the “Digital Networks” course taught in Electrical & Computer Engineering.

Although the reviews for these indicated a high level of satisfaction by the students, the students experienced a classroom setting nearly identical to what they experienced at Baylor, and there were no Dutch students in either of the two courses. Lessons learned from the first two programs indicated a need for:

- project-based course
- multi-disciplinary project teams
- multi-national project teams

In 2004, planning began to answer the needs for improvement indicated by the lessons learned from the first two programs. During the summer of 2005 and 2006, in answer to these lessons learned, the School of ECS partnered with the HSB in a joint endeavor to offer a six-hour project based summer study abroad program. The program, the “Baylor International Technology Entrepreneurship” summer study abroad program, was a multi-disciplinary, multi-national course, offered once again in conjunction with the Universiteit Maastricht. The project teams were made up of engineering, computer science, and business students; and the teams had both American and Dutch students as members.

For the ECS students, these six hours were petitioned as course substitutions for six hours of required courses. For Computer Science students, the courses were “Technical & Professional Writing” and a history/social science elective. The Engineering students were able to substitute the program hours for “Technical & Professional Writing” and “Engineering Economic Analysis.” The courses normally satisfy ABET-EAC/CAC accreditation requirements as well as Baylor University curriculum requirements.

The programs were extremely successful in that the students were challenged to:

- understand the cultural differences in their team,
- understand the discipline-specific differences in their team,
- strive to organize their team in a way that maximized the strengths of their team members,
- value the strengths of each team member,
- develop a business plan for a technology new venture, and
- present their findings, in both oral and written form, to a panel of North American and European entrepreneurs, venture capitalists, businessmen, and engineers.

One of the most notably difficult tasks for the teams occurred within their attempts to understand the differences between the disciplines (business versus engineering and computer science). In fact, this turned out to be a much more difficult task than the understanding and valuing of the cultural differences found between the American and Dutch students. Because of the difficulty, and the importance of having this experience prior to their first full-time position after college, this has proven to be one of the most valuable lessons from the BITE program [8].

**MOVING THE PROGRAM LOCATION – SHANGHAI, CHINA**

In 2006, once again in answer to the ever-changing demands of society and industry, the program has transformed itself. In his March 2, 2007 speech to the River of Trade Corridor Coalition (ROTCC) National Quarterly meeting in Los Angeles titled “Ladies and Gentlemen, There is an Eight Hundred Pound Gorilla in the Room!”, Da Hsuan Feng, Special Assistant to the President for Global Strategies and International Relations, pointed to the globally unique impact China and its burgeoning economy will have on the US. His title is indicative of his perspective on China’s transformation.
the growth of China’s economic impact simply cannot be ignored.

Engineers and entrepreneurs alike must understand how their roles in creating technology and wealth will be influenced by the gravitational pull of such a massive, growing economy. So when considering options for relocation of the Baylor International Technology Entrepreneurship summer study abroad program, finding a partner school in China was the first choice.

While India and its high growth of software development, IT support and call center businesses was also intriguing, the strengths of China’s infrastructure, and breadth of industries served make it ideal. In particular the special economic development zone of Shanghai / Pudong, created in the 1980’s has become “the dragonhead of the Chinese economy” [9].

The design of the Technology Entrepreneurship course (described in detail below) which is being adapted for deployment as the summer abroad program, furthermore demands a high degree of connection to companies and ventures, making the network of relationships in a new location critical to its success. Several long-standing Baylor University partnerships with Universities in China lent credibility to the proposal to link the program to local businesses and provided options for host schools with strong logistical support to a new program like this. The University of Shanghai for Science and Technology (USST) is proved to be an ideal partner for several reasons:

(1) Baylor University has had a relationship with USST for much of its 100 year history beginning with its inception as Shanghai Baptist University in 1906, and maintained a formal cooperation agreement between the schools since 1986.

(2) The goals of the two schools are aligned on the issue of advancing the technology entrepreneurial preparedness of their respective engineering graduates. (3) The Universities are of similar size and both have extensive international programs, creating an ease of joining harmoniously for this new effort.

Finally the timing of initiating a venture focused on Technology Entrepreneurship in China is perfectly suited to the priorities of the national and regional governments, making collaboration with local and global firms especially welcome. Participants in the 4th International Conference on Global Entrepreneurship and Strategic Human Resource Management at Zhejiang University in June 2006 heard this message from key governmental and regional economic development leaders [10], [11].

Together these factors, amplified by the readiness to engage expressed by industry representatives introduced to the Baylor University team, made it clear that the USST partnership for this program was ideal in both location and timing. As summarized by Boston Consulting Group [12], “China’s 1.3 Billion consumers are at a crossroads. They are embracing new economic ideas and habits and devouring goods that have long been unavailable, unaffordable, or forbidden. At the same time, they are part of a culture and an economic system that remain quite different from those of developed countries.” It is into this caldron of raging growth and uncertainty that the technology leaders and entrepreneurs we are educating today will be thrust in many ways, and this new program gives a few of them a first opportunity to test their mettle in its fire.

**DESIGN OF THE I^5 PROGRAM**

The BITE program, now renamed the Baylor I^5 experience, is designed to teach and contextualize technology commercialization in the Shanghai, China setting. By deploying teams of students which are both cross-functional and cross-cultural to assess the opportunities of specific ventures and firms, the course delivers a much higher immersion level experience than is normally achievable in a 6-week summer abroad program. An overview of the tools and processes required to successfully take a technology from idea to launch is applied by the students to the specific firm they work for as they assess how each of these processes has been or will need to be done for their “client” to succeed. Further, a specific opportunity or challenge presented to them by the firm becomes the focus of a detailed evaluation and recommendations are delivered to the firm in both written reports and presentations.

A particular feature of the I^5 experience is that the course’s hands-on learning will take place inside Chinese ventures. The project sponsors include multi-national companies located an strategically positioned in China such as Dow Corning Corporation, high-tech start-up companies which are incubated in the USST Science Park, and includes some traditional Chinese manufacturing firms which are in process of transitioning to more innovation based approaches. Because of the criticality of this material to these firms’ success, many have requested that their projects be brought to the course rather than sent to us to work on independently. Thus the students will have opportunity to have company leaders on the teams and with that gain much higher access to the inner workings and thought processes than would otherwise be expected.

The learning from this integration will be demonstrated when final presentations are made, as each team will be expected to make their communication effective for the mixed audience of Chinese and American business personnel.

The course is organized into 6 Modules, each of which is one week in length, running Monday through Friday or Saturday leaving Sunday open for personal exploration except the first one which is shortened due to travel time. The first Module is a Start-Up Module and the last is focused on presentation skills and development, along with final written report generation. Modules 2 through 5 are comprised of 4 class days and one day of on-site observation of technology entrepreneurship in action at a China-based company. The first three class days in each module are focused on Technology Entrepreneurship methods, tools and practices in general, and the fourth class day is focused on the application of these to specific China-related issues and firms. The core
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I. Course Objectives

Upon completion of the course, students should be able to:

1. To develop an understanding of technical innovation characteristics, tools and evolutionary nature.
2. To become familiar with tools and processes for screening and testing technology-based ideas and concepts for commercialization of new products.
3. To understand options for protection of intellectual property that is basis for technology ventures and the range of strategic choices regarding intellectual property.
4. To apply basic financial and funding concepts to the cases of starting up and growing a technology based venture as stand-alone entity or inside a corporation.
5. Understand the processes by which technical innovations move from R&D to operations and the marketplace.
6. To become familiar with the business plan features particular to technology entrepreneurship.
7. To demonstrate ability to apply the above in a “real-time” technology-based venture environment.

II. Course Schedule

Module 1 Orientation and Kick-off

Day 1 Introduction to USST, to the core faculty, to the Project Sponsor companies, to the assembled students from Baylor, Thunderbird, and USST, to the setting of Shanghai, China and an overview of the topic of Innovation and Commercialization.

Day 2 Presentations of the projects to the students by the company representatives and team formation around these 10 projects, based on skill sets needed as well as student preferences.

Day 3 An overview of project management methods and a framework for the consultative work will be taught, and then each team will develop its Scope of Work and weekly milestones in conjunction with the company representative.

Day 4 The dynamics of cross-cultural team building workshop, with breakout sessions designed to explore the keys to understanding that arises from the mix of American culture with Chinese culture.

Day 5 Day-trip to multi-national firm where Sino-American mixed teams are commonplace and where the issues have been addressed.

Module 2 Opportunity Recognition and Assessment

Day 1 Recognizing and Screening Technology Opportunities, including treatment of creativity, opportunity recognition techniques, sources of opportunity, and screening tools for technology opportunities.

Day 2 Developing and Testing a Technology Business Concept, built upon skills in defining the concept, performing feasibility assessments from market and technical perspectives, matching up the team to the opportunity, and putting it all together into an assessment.

Day 3 High Technology Product Development Strategies, including the processes needed to manage the flow of ideas to market, meaningful metrics for success, and the concept of outsourcing technology.

Day 4 Applying Module 2 to China specific context.

Day 5 Visit to early stage company in process of evaluating a number of options, and a VC firm who also specializes in early stage funding.

Module 3 Intellectual Property

Day 1 the Concept of Intellectual Property and the theory behind these protections with details and tools specific to patents, trademarks, copyrights and trade secrets.

Day 2 Licensing Intellectual Property, from the perspectives of the owner and the acquiring party. Structuring agreements and establishing value will be covered as well as development of strategy for licensing.

Day 3 Intellectual Property Strategy, with particular emphasis on patent strategies. The tools and impact of a range of approaches to patent writing and how the construct affects the value derivable will be covered.

Day 4 Applying Module 3 to China specific context.

Day 5 Visit to law firm dealing with patents and a company pursuing IP protection as key strategy in China.

Module 4 Financial Strategy for Technology Innovation & Start-Ups

Day 1 Building and Valuing the Business Model, including understanding the drivers of value, matching the model to the opportunity, and the special case of radical, market-creating innovations.

Day 2 Funding the Technology Start-Up, with an overview of capital sources, requirements, suitabilities as matched to the team and the opportunity.

Day 3 Funding growth after company is established, including discussion of debt vs. equity, venture funding, IPO’s and customer-funded growth.

Day 4 Applying Module 4 to China specific context.

Day 5 Visit to High Tech Company based in China whose growth is being fueled by a range of financing tools.

Module 5 The Transition from R&D to Operations

Day 1 Overview of the challenges as scale of operations changes, including transitions in legal entity structure, organizational structure and human capital acquisition.

Day 2 Marketing High Technology and Managing Growth, including key marketing concepts, tools and skills and a review of managing innovation for sustainable growth through multiple new products.

Day 3 Corporate Venturing – the Intra-preneur, including the differences from new companies in terms of skills, tools, and methods for creating breakthrough growth.

Day 4 Applying Module 5 to China specific context.
**Day 5** Visit to China based company in process of creating technology-enabled new product growth from a stable operational base.

**Module 6 Communicating for Results**

**Day 1** Effective Business Presentations Workshop I  
**Day 2** Effective Business Presentations Workshop II  
**Day 3** Overview of key business consulting report writing styles, skills and tools.  
**Day 4** Delivering Final reports and presentations (Teams 1-5)  
**Day 5** Delivering Final reports and presentations (Teams 6-10). The teams will present to a panel of North American / European experts, and then to a panel of Chinese experts.

**III. Cultural Immersion: Chinese History, Culture, Excursions, and Business Practices**

During each of the weeks in Shanghai, the students involved in the Baylor I5 experience will also have the opportunity to learn from Chinese scholars and experts in the areas of culture, history, and business practices.

- Cultural sessions in Shanghai will include a city orientation conducted by the students of USST, a welcome dinner hosted by USST, lessons in Tai Chi, tours of local art and science museums, and tours of the beautiful parks and shops of “Old Shanghai.”
- Each week the students will also enjoy Chinese history classes and tours. These sessions will be lead by the faculty and staff of USST. The Chinese Business block will cover the “do’s and don’ts” for foreigners doing business in China. These sessions will be led by the Project Managers from our participating Chinese ventures.
- To wrap up the week’s instruction the students will participate in a discussion with their Project representatives. This discussion will put the academic topics learned throughout the week into Chinese business perspective, and will give the project teams a time to go over any problems and questions that might arise in the design and development of their feasibility studies.

During four of our weekends in China, all program participants will participate in a series of cultural/business excursions, including Xi’an, Beijing, Suzhou, and Jinan.

**PLANS FOR THE FUTURE**

**I. Baylor I^5 Experience**

The Baylor I5 experience is the “premium offering” of the Technology Entrepreneurship program being developed as InCITE (International Center for Interdisciplinary Technology Entrepreneurship) at Baylor University, and will grow in its scope and impact as the overall programming expands in scope. The vision for growth of InCITE includes two key dimensions – breadth of disciplines engaged and geographic locations for the summer offering. The initial program is built on a partnership between the Hankamer School of Business and the School of Engineering and Computer Science.

**Session T2E**

Over the next 5 years it is the vision of this program to expand participation of Chemistry, Biology, Environmental Studies and other technical disciplines but assisting them in the creation of Technology Entrepreneurship certificates or concentrations that include industry specific, business introduction courses (e.g. Industrial Chemistry) and then pulls those students into the capstone experience of the Technology Entrepreneurship course itself. The “premium” version of that capstone experience will be Baylor I5, and it will also continue to be available as a semester course on campus.

With enough students and greater disciplinary breadth it will be feasible to create additional summer program “nodes” in other high-growth, entrepreneurial environments such as India and Dubai and to offer a Texas program to foreign students as well. The programming and course will be identical, but of course the projects and the companies who sponsor them will vary based on the industrial focus of the particular locale. As examples, India would present an opportunity for pharmaceutical companies as well as telecom industry projects, whereas the Waco Texas program may feature alternative energy or avionics industry projects.

And finally the vision is to increase the circle of collaboration to include additional universities. The Thunderbird Center for Global Entrepreneurship is committed to join the Shanghai I^5 program in 2008 (and indeed has been a design partner already), and other partnering relationships will make it possible to achieve the scale needed to blossom this initial single-site program into the network described above. A key to success in this expansion is to deliver a scalable program that is replicable in high growth settings.

**II. Two-Course Sequence at Baylor University**

In conjunction with the summer study abroad opportunities for ECS students, and as part of a concerted effort of the School of Engineering & Computer Science to address ABET-EAC criterion C [14], a parallel two-course sequence has been developed to allow those ECS students not able to participate in a study abroad program the opportunity to gain global exposure and requisite business skills at Baylor in a similarly diverse population. The goal of this endeavor was to offer an alternative to some of the courses in the ECS curricula that have been in place primarily to satisfy ABET-EAC/CAC accreditation requirements, without jeopardizing either accreditation or the engineering students’ preparation for the Fundamentals of Engineering (FE) Examination, and without adding additional hours to any of the affected degree plans [15].

The result of this study was a two-course sequence that would take the instruction in technical and professional writing as well as engineering economic analysis, introduce it within a global context, and implement the skills gained in a multi-disciplinary course in technology entrepreneurship.

The first course in the sequence, “Global Business Communication,” emphasizes instruction in the basics of economic analysis, technical writing, and technical speaking, with opportunities to implement what is learned through a series of discussions, presentations, and papers on a variety of
technology, business, and economic topics. The objectives of the course were met through a series of two-week instructional cycles, within the context of a relevant global business research topic. Each cycle culminated in a written assignment for half of the students, and a video-taped and critiqued presentation by the other half of the students. These groups switched writing and presenting with each cycle.

This course was offered for the first time during the Fall 2006 semester, and although the initial results were quite impressive, a detailed analysis of whether this course if as effective as the courses normally taken (“Technical and Professional Writing” and “Engineering Economic Analysis”), as measured by the ABET visits and the results of the FE Exam, is under way.

The second course in the sequence is “Technology Entrepreneurship,” a course designed to enable students to learn through first-hand, applied experience. It strives to combine what can be taught with what can be observed and integrated when working with an experienced, seasoned professional mentor. The key elements of the course design are similar to those being deployed in the I² Experience in Shanghai this summer, with multi-disciplinary groups working with and for sponsoring companies in the U.S.

Combining the elements of interdisciplinary teamwork, the opportunity to contribute real value to real companies in the commercialization process, and coaching from experienced professionals has built skills and confidence that the students can leverage as they approach graduation and their first foray into industry. In the words of a recent participant, “Technology Entrepreneurship not only changed how I look at the world of business, it has changed the way I look at my profession.” [16]

### SUMMARY

In the last six years, 45 engineering and computer science students have participated in one of the ECS summer study abroad programs. Of these students:

- 35 of them (78%) have graduated and gone on to full-time employment or graduate school.
- 7 of them (16%) are still undergraduates.
- 3 of them (7%) left the program (transferred to another major or another school).
- Of those graduating, 13 of them (29%) are pursuing various graduate degrees.
- Of those graduating, 22 of them (49%) were employed after graduation (of these 3 have subsequently entered a graduate program.
- Of those who have graduated, 33 of them (94%) attribute their job/promotion or acceptance to graduate school in part to their study abroad experience.
- Of those who have participated, 100% of them highly recommend the experience to their peers.
- The Board of Advocates for the School of Engineering & Computer Science has strongly encouraged the program, and has suggested that we expand it.

### Session T2E

- The Board of Advocates for the Hankamer School of Business has endorsed the Baylor I² Experience in Shanghai, and many of the members consider it only a first step toward enabling students toward professional success in a global workplace.

Additional study on the effect of the study abroad program on recruiting and retention, graduation rates, success in career (from both an alumni and an employer perspective) is underway, but these initial findings indicate a high level of satisfaction from our students and those who employ our graduates or accept them into a program of graduate studies.

What does a flat world require? It requires students with science and technology insight. It requires students with business savvy and integrity. It requires global and cultural competence. It is the goal of the Baylor I² experience to help our students become the leaders of the 21st century.

### REFERENCES


Southwestern Annual Conference, University of Texas-Pan American, March 2007.