

# **Engineering Technology Concurrent (Dual) Masters Degrees – an Irish, Spanish and American Collaboration across the Atlantic: Innovations, Issues & Insights**

## **Abstract**

This paper describes the innovations and lessons learned from a European Union - Atlantis Fund for the Improvement of Post Secondary Education funded project to implement a dual/concurrent Masters Degree program focusing on Sustainability, Technology and Innovation between one US and two European universities.

The partners have learned many lessons on addressing issues with international collaborative programs, most importantly, the criticality of selecting the right partners and building significant understanding, rapport, and trust. The paper describes how the partners managed institutional and governance documentation issues and aligned the three university's curriculum with the program's objectives to ensure award requirements are reached for each institution. The paper describes the importance of the language component, faculty development, sustainability, and the independent evaluator role as central parts of the program. The resulting program prepares students for work in an international context and for effective citizenship in our increasingly interconnected, globalized world.

**Keywords:** International, exchange programs, graduate programs, masters degree, dual degree, Concurrent (Dual) Engineering Technology Masters Degrees – an Irish, Spanish and American Collaboration across the Atlantic: Sustainability, Innovations, Issues & Insights

## **1. INTRODUCTION**

*“We can’t solve problems by using the same kind of thinking we used when we created them.”- Albert Einstein*

Einstein was emphasizing that one’s knowledge and understanding are limited by one’s own experience, education, and research and that the advancement of knowledge and science required more. Friedman (12) and Senge, Smith, Kruschwitz, Lauer, and Schley (20) called for this type of thinking to solve complex global problems to produce a sustainable world. To develop the kind of thinker who contemplates complex global problems, universities must move to a more global educational model, and in particular, one that includes an international experience.

To better prepare students to become more effective citizens and problem solvers in our increasingly interconnected, globalized world, Purdue University (PU), the Dublin Institute of Technology (DIT), and the Universitat Politècnica de Catalunya (UPC) developed a dual/concurrent Masters Degree program focusing on Sustainability, Technology and Innovation (STIMS) through a joint US FIPSE grant and an EU-EACEA grant. Using previous international education experience, connections, and knowledge of international research literature, the partners addressed key institutional, administrative, curricular, and student concerns to implement the STIMS program.

## **2. PURPOSE OF THIS PAPER**

The purpose of this paper is to highlight key issues addressed and insights gained from this international collaborative Masters Degree initiative. The authors share perspectives and lessons learned in the areas of: 1) administration and partnership development, 2) communication, 3) curriculum alignment and approval, 4) marketing and recruitment, 5) admissions, 6) language and cultural development, 7) faculty development, 8) sustainability, 9) institutional change and support, 10) academic and intellectual achievement, and 11) third party evaluation.

## **3. INSIGHTS AND LESSONS GLEANED FROM THE LITERATURE**

An essential prerequisite to designing successful higher education international collaborative initiatives is first understanding the successes and challenges of international education. Even though the parties involved already had considerable international experience, to augment this, they first reviewed and assessed lessons learned from the literature. This subsection of the paper highlights the key literature reviewed, lessons learned and applied by the partners in developing the STIMS program that is the core of this paper.

Prior to initiating the project, and then continuing throughout it, the partners reviewed recent research and literature relevant to establishing international dual/concurrent degree initiatives. This literature included recent research findings of the Institute of International Education (IIE), the proceedings of the Atlantis project directors’ conference, the NAFSA: Association of International Educator’s website (16), and recent American Society for Engineering Education (ASEE) conference publications (2). In particular, the partners utilized the comprehensive list of lessons learned compiled in the IIE publication entitled *Joint and Double Degree Programs: An Emerging Model for Transatlantic Exchange* (17). Additional findings and recommendations were provided by Asgarya and Robert (3) and Culver et al (7). The research studies and reports indicate the importance of strong partnerships with institutional support from executive administrators, appropriate legal agreements, curricular, credit and transfer agreements, and student and faculty mobility plans. The ASEE conference proceedings (2) and FIPSE project director’s meeting notes (9) document well the lessons learned by engineers and technologists involved in international exchange programs (2). Similar studies are available from the related fields of business (18) and information technology (13).

In addition to exploring the international perspective, the partners examined the literature pertinent to the importance of dual and concurrent degree programs for preparing tomorrow's workforce with better skills in leadership, internationalization, research, and technological capacity. In particular, the partners delved into: the report prepared by the National Academy, *Science Professionals: Master's Education for a Competitive World* (6); Marginson and van der Wende's *Globalisation and Higher Education* (15); Bhandari's *Key Research in U.S. Study Abroad: Findings from the Institute of International Education's Study Abroad Capacity Series* (4); Zhang's *Response of Chinese Higher Education and SJTU to Globalization* (22); Porath's *Do Double Degrees Improve Career Opportunities?* (18); Blumenthal and Laughlin's *Key Research in U.S. Study Abroad: Findings from the Institute of International Education's Study Abroad Capacity Series* (5); and Yopp's *Importance of Employer's Involvement in the Learning Outcomes of Transatlantic Dual and Joint Degrees in Engineering* (21). The learnings from Lorenz' (14) 2001 report on best practices in International programs were also absorbed. The partners also continued to keep abreast of important emerging European reports in relation to preparing graduates for new jobs. These reports include a report prepared by the Expert Group On New Skills and New Jobs for the European Commission (8) and a July 2010 report (8) prepared jointly by the Directorate General for Employment, Social Affairs and Equal Opportunity, European Commission and The Institute of Population and Labour Economics, Chinese Academy of Social Sciences entitled *New Skills For New Jobs: China and the EU. Shared Labour Market Experiences To Inform The Harmonious and Sustainable Society Of The Future.* (8)

#### **4. STIMS PROGRAM DESCRIPTION**

STIMS is a concurrent/dual master's degree, involving three partner universities, that focuses on the critically needed technology, innovation and sustainability skills that will make individuals, enterprises, and nations more competitive and responsible. The degree program does this by synergistically combining the strengths of three leading universities as well as capitalizing on the sensitivities generated by significant international and language experience. The result prepares students for work in an international context and for effective citizenship in our increasingly interconnected, globalized world.

Students enter the concurrent/dual degree program, pursuant to a collaborative application and admissions process, via any of the three partner universities. The project's program of study, a sample of which is provided on the following page, is comprised of a slate of courses led by experienced graduate faculty at the three partner universities. These courses were part of two MS degree programs (PU, UPC) that existed before the inception of the current dual degree program and one (DIT) that was established specifically for the project.

Each institution has a program of required and elective graduate courses/modules and established graduate procedures in place. At the start of the Project, MOUs already existed between DIT and Purdue University and between DIT and UPC. Pursuant to the initiation of the project, a new tripartite MOU across all three partners was also signed.

Beyond the course requirements designated by each institution, each student's plan of study is tailored by his/her graduate faculty committee, consisting of Purdue and European faculty, to meet the students' individual learning goals. A capstone Directed Project/Thesis based on research and development is required of all students. The plan of study spans the program's four semesters -- which is a shorter timeframe than if students were to pursue two separate Master's programs on their own. This fact, in combination with the waiving of external student tuition fees for the exchanging students, and the 12K \$ or € stipend each student receives results in a substantially lower cost (in terms of both time and money) for the participating students.

Figure 1. Sample Program of Study for STIMS degree program

Atlantis Concurrent/Dual Master's Degree in Sustainability, Technology and Innovation			
Plan of Study 3, Purdue Admission Student, Fall Start, End in DIT, DIT or UPC, & Purdue Award (120 ECTS credits, 63 credit hours)			
Sem 1, Purdue Fall	Sem 2, Purdue Spring	Sem 3, UPC Fall	Sem 4, DIT Spring
Core Courses/Modules		Core Courses/Modules	
TECH 621 Building a Philosophy of Technology	TECH 646 Analysis of Research in Industry and Technology	Environmental and Ecological Economics	MECH 9002 Innovation and Knowledge Management or REEN 2215 Renewable Energy Technologies
STAT 501 Experimental Statistics I		Culture, Technology and Innovation	
MET 527 Technology from a Global Perspective		Systems Thinking and Complexity	
		Human Sustainable Development	
Spanish (If required)	Spanish (If required)	Spanish (If required)	IRSH 1211 Irish Cultural Studies 1A
	Joint Directed Project (Engagement in directed project must start no later than the start of this semester)	Orientation-Cultural Week	Joint Directed Project (Must be completed by the end of this semester)
Elective Courses/Modules (4 of the following if Spanish not required. 2 of the following, if Spanish is required) (1 and no more than 1 elective must be selected from the cultural courses listed)		Elective Courses/Modules (2 of the following if Spanish not required. 1 of the following, if Spanish is required)	
IT 507 Measurement & Evaluation in Industry & Technology		Ecology and Natural Resource Mgmt.	Whichever module above is not selected as core can be considered when choosing an elective.
IT 590 Special Problems in Industrial Technology		Urban ecology and Land Use Planning	ENER 1702 Energy Supply
IT 623 Contemporary Industrial Technology Problems		Sustainable Urban Planning	MECH 9010 Applied Surface Engineering
IT 668 Administering Technical Programs		Social and Environmental Aspects of Information Technology	SSPL 9055 Sustainable Construction
ECET 581C Efficient Energy Systems		Bioclimatics Architecture	SSPL 9030 Env. Design & Mgmt.
CIT 550 Organizational Impact of Information Technology		Global Democratic Governance	BITE 2216 Biomass Technology/Biofuels
CIT 551 Information Technology Economics			CBEM 1404 Artificial Intelligence
Culture courses, e.g. HIST 58400, SOC 51400, SOC 51500, SOC 52000			MECH 9000 Advanced Dynamics
			CBEM 1415 Computer Aided Design and Eng.
			ADEN 2211 Advanced Energy Systems
			ENCO 1104 Energy Conversion and Use
			MECH 9013 Computational Fluid Dynamics
			MECH 9014 Heat and Mass Transfer
			CBEM 1412 Engineering Systems Simulations
Other suitable electives			Other suitable electives

Notes: Awards on completion: UPC MSc (Sustainability) or DIT MSc (Sustainability, Technology and Innovation) and Purdue University MSc (Technology). Whether a DIT or UPC award accrues on completion will be decided by the programme committee in consultant with each individual student.  
\* Students must take IRSH 2101 and one other core module listed.



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After completing the program successfully, American students graduate with a Masters of Science (Technology) from Purdue University and a Masters degree from the European partner university of their choice. European students earn their European Masters from the university where they entered the program and the Masters of Science (Technology) from Purdue University. In addition to the two degrees awarded upon completion, each student receives a transcript and diploma supplement from each partner university. Because the degrees awarded are part of well established programs at the partner institutions, it is guaranteed that these degrees are recognized by the appropriate authorities in Ireland, Spain, and the USA.

#### **4.1 Program Objectives and Outcomes**

The STIMS program's chief objective and outcome is to exchange master's level graduate students among its three partner universities. These students benefit from an innovative program that develops leading edge understandings and skills with technology, innovation and sustainability and includes transatlantic mobility. By design, the student learning outcomes include increased global perspectives, multiple culture awarenesses and sensitivities, as well as improved professional level language capabilities.

Important additional outcomes for the project partners include:

- Scholarship pertaining how to do effective exchanges and promote international collaboration
- Collaborative research and teaching based on increased mutual understanding and faculty contact due to mobility
- Better administrator, faculty, and student understandings of cultures and global perspectives
- Enhanced procedures in place for collaboration and exchange due to increased transparency and reciprocal recognition of credits
- Increased transatlantic faculty and administrator mobility

#### **4.2 MS Degree Outcomes**

The MS Degree program outcomes are organized in six areas as listed in the following paragraphs. Upon completion of the Masters of Science in Technology Degree focused on Technology, Innovation and Sustainability, students will demonstrate:

1. Enhanced capability with research and development. They will:

- become familiar with research and experimental design sufficient to apply it to real world problems.
- be able to apply design and development procedures to real world problems demonstrate the necessary professional, research and development skills common to industrial technology disciplines, as evidenced by successful completion of either a thesis or a directed project, that are required for successful life-long learning and professional contribution.

2. Global perspectives on technology, technology management and sustainability. They will:

- be able to employ project management, technology assessment, sustainability analyses applicable both to their native culture as well as in other cultural settings.
- be able to establish the appropriateness of technology for specific cultural settings.
- use knowledge of how industrial technology impacts society and organizations, from both a technical as well as a leadership and management perspective and they will demonstrate critical thinking in these arenas.

3. Innovation and related process skills. They will:

- be able to employ key creative and innovation generation procedures.
- be able to sophisticatedly retrieve information from databases and global sources.

- advance product realization and commercialization skills.
4. Awareness of and capability with entrepreneurship procedures. They will:
    - become capable with entrepreneurial procedures and skills.
    - be able to secure business related information from sources around the world.
  5. Enhanced cross cultural communication & professional effectiveness. They will:
    - become proficient in professional communication (reading, writing and speaking/presenting) in at least two languages.
    - demonstrate effectiveness in operating in a culture/country other than their native one.
    - demonstrate ethical leadership and a commitment to their personal professional development and life-long learning.
  6. A graduate level of technological expertise in one or more of the technology fields.

## **5. ADMINISTRATION AND PARTNERSHIP DEVELOPMENT**

The STIMS program evolved out of the relationship and trust built by Dublin Institute of Technology (DIT) and Purdue University (PU) through their work on the FIPSE-funded Design, Entrepreneurship, Technology, Engineering, Collaboration, Transatlantic (DETECT) Exchange Mobility project. Universitat Politècnica de Catalunya (UPC) was asked to join DIT and Purdue in this concurrent degree effort because of the institution's strong background in sustainability. DIT already had an established relationship with UPC, a relationship that facilitated the partnership process.

Key to the development of this partnership was the involvement of key university administration from each university right from the onset of the project. This involvement was crucial because each institution was embarking on a new approach to a degree that entailed the breaking of some institutional barriers – after all, none of the three institutions had implemented such a concurrent/dual degree program previously. All university administrators were actively involved in developing the signed tripartite MOU that governs the project's operation. Each university has a key point of contact for the project who oversees all project activities, including decisions about budgetary matters. The identification of key contact persons and inclusion of university administration in the planning process clearly helped to establish the strong foundation that guides the development and implementation of the STIMS program.

## **6. COMMUNICATION**

One of the key success elements of projects such as the STIMS program is a strong communication network among the partners that allows members of each institution to have opportunities for input into the planning process and develop a sense of ownership in the project. This communication is key to building the trusting relationship that helps the leadership team to resolve issues when they occur. The team established a variety of mechanisms to ensure an open dialogue amongst the partners to discuss and develop the key components of the Atlantis Concurrent MS Degree program. Each institution established a prime point of contact and involved university personnel at all necessary levels of each university in the communication network. They met regularly, either in face-to-face-meetings, e-mail, telephone, or via video conferences using such technologies as *ooVoo* video call. Purdue established a *SharePoint*<sup>TM</sup> account to store and share Atlantis Concurrent MS Degree documents. Each institution created a website ([www.tech.purdue.edu/atlantis](http://www.tech.purdue.edu/atlantis), [www.stims-info.com](http://www.stims-info.com)), jointly linked between universities and to other key links necessary to administer the project.

## **7. CURRICULUM ALIGNMENT AND APPROVAL**

Key to the successful implementation of new programs, especially programs that have previously never been implemented at an institution, is the challenging task of wading through the

university bureaucracy to get the new program approved. None of the three institutions had previously implemented a concurrent MS degree international masters program, therefore, each institution was embarking on new territory. All three institutions were successful in having their programs approved. This success was due to two key factors: 1) having all the appropriate university administrators and faculty involved from the program's onset; and 2) having the MOU and other governing documents in place.

The curriculum was based on existing and newly developed programs at the partner institutions and to meet the accreditation principles of both the ABET and the EUR-ACE organizations.

## **8. MARKETING AND RECRUITMENT**

The leadership team members were asked about their use of a variety of recruitment techniques to make students aware of, and interested in, the STIMS program. The leadership identified five key recruitment techniques as being the most important for the STIMS program: Graduate Program Office announcements, college announcements, student interviews, in-class announcements, and departmental websites.

## **9. ADMISSIONS**

The partner institutions agreed to establish admissions standards and processes so students in the concurrent degree program are admitted to all three partner universities. In addition, the three partner institutions have finalized the program admission criteria so students are admitted into all three graduate programs. When thinking about the program outcomes and the selection of students to participate in the STIMS program, the leaders identified five key areas for the selection of students: undergraduate GPA, performance in specific courses or study areas, language capability, field-specific experience, and student attitude.

## **10. LANGUAGE AND CULTURAL DEVELOPMENT**

The language component, and eventually the gain in student language skills, is a crucial matter to address when establishing an international concurrent degree program, especially when one partner language is different from the other institutions. Purdue requires a Test of English as Foreign Language (TOEFL) or equivalent score for all international students. DIT and UPC have similar requirements for their international students. The three institutions are currently evolving further language development and support options to help students during their studies. Students are expected to be fluent enough in their exchange language to live comfortably in the exchange city. They are also expected to have a rudimentary level of competency reading and speaking about scientific and technical content in their exchange language in order to be successful in their studies and research.

## **11. FACULTY DEVELOPMENT**

Most of the STIMS leadership work has focused on building a strong foundation through a strong planning process that has included some effort towards faculty development. The roots of a strong faculty development component need to be established during the initial start-up year. The project has established this component and faculty development will increase as the program matures and faculty are provided opportunities to collaborate on course development, research, conference papers (such as this one), and other scholarly activity.

The leadership of each institution has visited each others' campuses to explore potential faculty development opportunities. Faculty development and mobility have been topics of the ongoing discussion during the leadership planning meetings. When asked about faculty mobility activities, the majority of faculty leaders strongly agreed that the partnership has set a strong foundation and made very good progress toward establishing faculty mobility activities. In

addition, the leadership team has developed a Sustainability Technology and Innovation (STI) Masters Faculty Mobility Proposal, a STI Masters Summary for Faculty, and an Atlantis Faculty Mobility Application. A number of faculty from each institution have already conducted short term faculty exchanges across the Atlantic. Readers should also note that the interaction of the dual thesis/project advisors as they coordinate the guidance of each thesis/project across the Atlantic comprises another significant faculty development activity.

## **12. SUSTAINABILITY**

Sustaining an initiative beyond the grant funding period is an important consideration that needs to be built into the initial planning process. The STIMS team has successfully established a strong foundation that should lead to the program being sustainable. From the concept development for this initiative, the leadership team has involved all key university leaders, from all three institutions when necessary. Participation included attending meetings and initiating key joint documents such as the MOU and other governing documents. They have established a sound communication network between the partnering institutions. The institutions are considering forming an advisory board to provide input for project growth and to guide potential internships, directed projects, or thesis opportunities for the students. In addition, the leaders have identified a list of United States companies that have a major presence in Ireland and Spain. The leaders plan to network with these companies to gain their support for the Atlantis project.

## **13. INSTITUTIONAL CHANGE AND SUPPORT**

Creating institutional changes goes hand-in-hand with developing sustainable programs. The leadership team has successfully involved their key university leadership in the project. Each institution was able to break institutional barriers by having a concurrent MS degree program approved at their institution and at the same time to create mechanisms to dually admit students to the program. This initiative matches the strategic plans of the three institutions. In addition, this program fits well within the standards of institutional and program accreditation (1, 9)).

The key factors identified by the STIMS leadership for creating institutional change and support were expanding alliances with other institutions and expanding institutional visibility. In addition, the STIMS leaderships shared successful ways of implementing international student exchange programs. They also share innovative pedagogical strategies, develop new courses, and expand collaborative conference presentations among partner institutions.

## **14. ACADEMIC AND INTELLECTUAL ACHIEVEMENT**

All three institutions agreed on the academic standards acceptable for the STIMS program. They also agreed to a three-person oversight committee with representatives from each institution. This three-person committee also serves as the directed project or thesis committee. Relative to developing strong academic and intellectual skills through the STIMS program, the leadership identified 14 skills important for academic success: 1) developing an ability to speak another language well enough to function in another country, 2) developing an ability to read and present in another language, 3) expanding cross-cultural and global awareness and experiences, 4) interacting with faculty, 5) developing independence/self-reliance, 6) demonstrating continuous improvement in coursework, 7) learning under a different educational system, 8) developing new logic and problem solving strategies, 9) expanding ability to design/apply sophisticated methodological techniques, 10) expanding ability to think critically, 11) developing stronger oral communication, 12) developing stronger written communication, 13) increasing accountability, and 14) increasing educational aspirations.

The leadership felt most strongly that faculty-developed test/exams, host faculty assessments, student presentations, faculty assessments, and language proficiency tests were the most

important ways assess learning gains. In addition, the faculty and the third party evaluator are using the following outcome—Capability matrix to guide the project’s data collection.

Table 1. Outcome—Capability Matrix Guiding the Project and Assessment

Outcomes  Capabilities	1. Enhanced capability with research and development.	2. Global perspectives on technology, technology management and sustainability	3. Innovation and related process skills.	4. Awareness of and capability with entrepreneurship procedures.	5. Enhanced cross cultural communication & professional effectiveness. Ethical leaders.	6. A graduate level of technological expertise in one or more of the technology fields.
1) developing an ability to speak another language well enough to function in another country		✓			✓	
2) developing an ability to read and present in another language					✓	
3) expanding cross-cultural and global awareness and experiences		✓			✓	
4) interacting with faculty	✓		✓	✓		
5) developing independence/self-reliance	✓		✓	✓		
6) demonstrating continuous improvement in coursework			✓			✓
7) learning under a different educational system		✓			✓	
8) developing new logic and problem solving strategies	✓		✓	✓		✓
9) expanding ability to design/apply sophisticated methodological techniques	✓		✓			✓
10) expanding ability to think critically	✓	✓	✓	✓	✓	✓
11) developing stronger oral communication			✓		✓	
12) developing stronger written communication			✓		✓	
13) increasing accountability	✓			✓	✓	
14) increasing educational aspirations.					✓	

## **15. THIRD PARTY EVALUATION**

Barnes Technologies International, LLC (BTILLC) planned and conducted an independent third party evaluation (TPE) of program effectiveness and provided ongoing formative assessment to guide improvement. Including a professional program evaluator early in the development of a new initiative is a characteristic of quality planning. In addition to being guided by the Outcomes—Capability Matrix provided in Table 1, BTILLC is evaluating how well the project improved teaching and student achievement and is also addressing the two Government Performance and Results Act of 1993 (GPRA) performance measures established for FIPSE Atlantis: 1) the percentage of students pursuing a joint or dual degree who persist from one academic year to the next (persistence), and 2) the percentage of students who graduate within the project's stated time for completing a joint or dual degree (graduation).

In addition, the TPE is assessing the degree to which U.S. students gained foreign language skills, especially how well U.S. students comprehend technical information written in a language other than English and their ability to make formal presentations in another language. Throughout the funded years of the project, the TPE provides an ongoing analysis of all program components, enabling the project director to make timely modifications in any component that is not functioning at an adequate capacity.

## **16. PROGRAM SUCCESS**

BTILLC evaluation of the STIMS program provides strong support that the program is making more than adequate progress towards the two GPRA performance measures for the project. To day, STIMS performance measure for GPRA 1 and 2 are 100 and 87.5 percent respectively. The Wilder's Collaborative Factors Inventory shows that the STIMS leadership works well together and involves the necessary components to sustain a programs beyond the life of its funding. The students have adapted well to studying under different educational systems. Of the eight students who began the program, all but one student completed their concurrent dual degree on or before schedule. Of the other 26 students enrolled in STIMS all students are matriculating through the program on schedule. Not any student, to date has failed a course or had difficulty with a non-native language. These evidence more than adequately documents that STIMS student's ability to perform successfully at each institution. The only shortcoming found by BTILLC is the need for more Purdue students to obtain their second masters at UPC.

## **17. SUMMARY**

The STIMS program provides an excellent model for designing engineering technology concurrent (dual) master's degree programs. The STIMS program was built on strong and existing relationships. Key to the success of this program, and paramount for sustaining the program once the funding ends, is involving key executive administrators from the beginning of the planning process, thus ensuring that all necessary formal agreements are in place and executed. A strong emphasis must be placed on language and cultural development, not just on the curriculum. It is also necessary to provide faculty development opportunities to build joint research initiatives, thus gaining the trust of more faculty and increasing faculty participation in the program. Establishing early curriculum alignment and credit transfer is important to ensure that students do not lose credit at their home institution due to courses not matching well with those of the host institution. A strong recruitment plan must be in place that explicitly explains the nature and benefits of the program. Finally, measures to foster sustainability and institutional change must begin in the planning phase of the initiative.

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