Project Narrative

Summary

Entrepreneurship education (EE) provides students with essential cross-disciplinary skills that improve their ability to pursue their dreams while contributing to the economy through the creation of start-ups and by assisting established firms to grow. Increasingly, policy makers and scholars recognize that ‘technology-based high growth’ entrepreneurship is particularly important as a route to competitiveness in the global market (e.g. Wong et al, 2005; Shane, 2008).

As educators we therefore need to pay greater attention to the methods of teaching students how to create technology-based high growth ventures (hereafter: ‘TEE’ for Technology Entrepreneurship Education). Traditional entrepreneurship curricula at the graduate level have relied too heavily on case studies and informal interactions with successful entrepreneurs. The institutions involved in this proposal are committed to improving TEE by replacing traditional approaches with a process-based curriculum derived from careful study of the relevant research literature and over a decade of experimentation and successful practice.

This proposal is to form a network of US and European institutions focusing on delivering TEE to a diverse group of graduate students. This proposal is to form a network of US and European institutions focusing on delivering TEE to a diverse group of graduate students. We label this joint effort “TECnet” (short for Technology Entrepreneurship & Commercialization network). The network will be based on prior successful bilateral cooperations between the partner institutions.

Within TECnet we propose to benchmark policies and practices for high growth entrepreneurship education, and provide a network of collaborative resources that will assist both the educators and the student projects within the partner institutions. TECnet will enable collaborative research on the outcomes of process-based TEE, and disseminate the results broadly in order to advance the field and build the network. Over the long term we expect to dramatically impact the creation of high growth start-ups.

I. Relevance and objectives of the project

In the face of rapidly increasing globalization, entrepreneurship ‘has emerged over the last two decades as arguably the most potent economic force the world has ever experienced’ (Kuratko 2005). However, there is increasing recognition that the economic impact of entrepreneurship is delivered primarily by new high growth enterprises (Autio 2006; Galloway and Keogh 2006; Shane 2008). And at the same time there is recognition that few entrepreneurship education programmes have demonstrated substantial impact on the generation of these technology-based growth ventures (Kirby, 2006; Storey, 2000).

In this context, a programme developed at NC State University (‘NCSU’) with National Science Foundation funding has proven to be effective in teaching high growth entrepreneurship, as measured on several dimensions (Kingon et al., 1997, 1999). The development began in the 1990s, in response to concerns about a mismatch between the training of scientists and engineers and the needs of the globalizing economy (COSEPUP 1995; Holohan and Markham 1996). The approach involved recognition that a particularly important route to high growth enterprises involved crossing the “Valley of Death,” i.e. the gap between the resources and competencies for science and technology research and the available resources and competencies for commercialization (Figure 1, Markham et al. 2002, 2008), Faculty from NCSU developed a structured, systematic, and academically underpinned process for creating new growth enterprises from science and technology sources. This process, termed the ‘Technology Entrepreneurship and Commercialization (or ‘TEC’) process, also formed the basis for a curriculum to teach technology-based high growth entrepreneurship to multidisciplinary teams of students (Markham et al., 2000; Kingon et al., 2001, 2002; Kingon and Vilarinho, 2004). While
there are a number of measures pointing to the success of the methodology, the most succinct is probably the fact that student projects have resulted in about 400 new jobs and $170 million in venture funding from NCSU alone in the past 12 years. Kingon has recently moved to Brown University, where the methodology is being adapted to a Engineering Masters degree entitled “Program for Innovation Management and Entrepreneurship.”

In Europe, the UK Government has made strenuous efforts to boost the number of science and engineering-based businesses (DTI 2000a; 2003). Alongside their traditional teaching and research activities, the 'Third Mission' for higher education institutions (HEIs) comprises a series of Government-funded Programmes that support UK universities in working with industry (DTI 2000b), such as initiatives to increase the quality and quantity of technology-based spin-outs (Kirby 2006; Davidsson 2002). The 'Third Mission' remit has also seen the growth of EE and TEE within UK universities (a theme taken up by the Oslo Agenda for Entrepreneurship Education in Europe: 2006).

Against this backdrop, Loughborough University ('LU') launched a TEE initiative based on the NCSU (TEC) framework. The TEC process, adapted for the UK and particularly to the institutional context, is offered as a double option on the LU part-time MBA Programme. This option has run twice, with about 50 students (half with STEM subject qualifications, half from arts/social sciences) enrolling in total. Early results are sufficiently strong that the module has become a compulsory element of the MBA curriculum. It is expected to contribute strongly to LU’s reputation for commercialising its research through licensing and the formation of companies (see http://www.loughborough-innovation.co.uk/).

In Portugal, the Government also gives a high priority to policies that capture the economic value of knowledge produced within the national scientific and technological system, through official bodies such as the Innovation Agency, and the Institute for SMEs and Innovation. Another important body, COTEC - a private not-for-profit association - is a member of the proposed TECnet.

COTEC has launched a number of programmes aimed at fostering an entrepreneurial culture among students and researchers in HEIs, along with the creation of high-technology, high-growth ventures. A nationwide TEE programme has had most impact, namely the COHiTEC Programme.
(a collaboration between COTEC and NCSU). Launched in 2004, COHiTEC aims to stimulate the creation of high-growth firms from research conducted within Portuguese universities, while giving science and engineering researchers and MBA students the skills required to start-up such ventures.

The TEC process is employed in the training phase of the COHiTEC Programme, carried out annually over a three-month long period in two business schools (Lisbon and Porto). This phase is attended by researchers from science and technology institutions from all over the country and MBA students from the two partner business schools. From 2004 to 2007, approximately 160 researchers and 130 MBA students have participated in this phase and 42 business opportunities have been presented. The Programme has a second phase that aims at generating ‘investment ready’ business proposals, selected from projects assessed in the training phase. By 2008, about a dozen start-ups had resulted; two start-ups supported by the COTEC second phase have already secured investments totalling more than €20m.

Overall, the process-based teaching focusing on high growth start-ups is proving to be very effective. We now propose to move to the next level by establishing a network to:

1) Exchange best practices and policies for teaching and promoting the process-based approach to TEE
2) Create a web-based, international repository of information on the methodology, projects and participants
3) Provide students with hands-on experience in creating high growth technology ventures through international collaboration
4) Conduct research that (initially) compares the outcomes from delivering the varied TEE curricula across TECnet institutions.

II. Nature and activities of the project and …
III. Strategies to achieve the objectives

For clarity, the narrative links each of the four objectives above with the primary strategies and activities planned to support that objective.

Objective 1: Exchange best practices and policies for teaching and promoting the process-based approach to TEE

The principal strategy to achieve this objective is to hold a series of faculty and practitioner workshops, to exchange and build on best practices for teaching and promoting TEE.

Three Workshops (to be held in months 1, 12 and 22 of the two-year funding cycle) will enable TECnet participants to address issues of best practices globally as well as concerns over local contexts. The focus will be on ‘Best Practices and Solutions’ through the exchange of ideas and observations. The outcome of these workshops will be an enhanced common core teaching approach, but with adaptations to meet the specific requirements of each of the partners. It should be noted that the workshops are not designed to develop a joint curriculum (excluded from this category of Atlantis funding), rather to ratchet up best practices and policies in delivering the existing TEC approach to TEE. This international co-operation should increase the opportunities for scaling up innovation in each country.

The discussions on pedagogy will focus mainly on the improvement of teaching and training materials, including (inter alia):

- Lecture topics and course materials
- Sharing of useful resources
- Methods of incorporating new academic thinking and/or key articles into the Programme
• Adaptation for different environments.

The workshops will also have a practical or commercial element as participants share information on, for example: issues in company formation; problems encountered by student groups and/or technologists across the globe and, critically, solutions to those problems; useful databases; etc.

TECnet participants will also use the workshops to promote the benefits of this process-based TEE, especially its relevance for academic researchers and institutions, and wider economic development.

**Objective 2: Create a web-based, international repository of information on the TEC methodology, projects and participants**

*The principal strategy to achieve this objective is to gather information from the workshops and from a variety of sources to create a repository that will support the projects and teaching of students in all TECnet locations as projects move from planning to implementation and beyond.*

The three workshops detailed above will be a key element in creating and then developing this repository, but information will also be collected on an ongoing basis from TECnet participants, secondary sources, academic journals, etc. This web-based, searchable knowledge base (database) should eventually serve as the foundation for sharing best teaching practices, lessons learned from past projects and so on, as well as contact information for alumni, industry leaders and so on. Subject to appropriate data protection safeguards, the repository will comprise:

• vetted and adapted course materials such as lecture materials, teaching tips, and articles/books by academic thought leaders
• information on past projects and their outcomes
• data of use to start-ups - regulatory authorities, company formation logs, term sheets, licenses, Non-Disclosure Agreements, business models, funding sources, etc.
• useful contacts, for example: instructors; alumni; students; investors; technology sources; and, industry experts.
• information gathered for research purposes (see Objective 4 below).

We see the website as critical in facilitating transatlantic communication and collaboration between educators, students, mentors, alumni and so on. The site will be designed and operated using "wiki" and "blog" approaches to allow an interactive exchange of ideas and observations rather than simply offering a static knowledge base. This resource should be a pool from which educators and students alike draw knowledge and inspiration. In generating an active community among TECnet participants (existing and new), this activity lies very much within the Atlantis ethos of e-learning and open education.

**Objective 3: Provide students with hands-on experience in creating high growth technology ventures through international collaboration**

*The principal strategy to achieve this objective is to use international collaboration, the web-based database, and international network to provide opportunities for students to operate internationally in the TEE programmes at the respective TECnet institutions.*

Achieving an international perspective is perhaps the most ambitious element of the project, but TECnet participants see great benefits in pursuing the Atlantis aim to ‘intensify the interface between transatlantic higher education, vocational training and industry’. The formation of TECnet should, in itself, send a clear signal to students and technologists about the importance of an international perspective. We wish students to operate in international arenas with nearly as much comfort as when they operate in their home countries. Other activities to achieve this international dimension include:
• collaboration between partners to identify technologies that have the most potential for global assessment by student teams, and …

• creation of (virtual) teams – people from different countries working together as either student teams in a class or as real entrepreneurs in multinational start-ups, supported by …

• an international support network comprising alumni and/or independent experts to review TECnet-affiliated business plans.

**Objective 4: Conduct research that (initially) compares the outcomes from delivering the varied TEC curricula across TECnet institutions.**

*The principal strategy to achieve this objective is to link scholarly research and practical applications through ‘engaged research’ that will assess the impact of this form of TEE on a variety of stakeholders - students, technology-oriented firms, the wider economy and so on.***

Data will be gathered systematically from, *inter alia*, students, technologists, and collaborators. This primary data will be supplemented by regular reviews of the academic literature in this field. The initial focus will be to study the outcomes from delivering the varied TEC curricula at existing TECnet institutions (NCSU, Brown, LU and COTEC); this study will then be extended to include any new members of TECnet. Research will also link efficacy of technology entrepreneurship to the national and local policies in place at each location.

TECnet will disseminate the results broadly to improve the teaching of high growth entrepreneurship globally and to build the network.

**IV. Role each partner will play in the project’s implementation**

Each partner will:

• offer resource-intensive TEE programmes based on the TEC process
• engage in data gathering for both pedagogical and research purposes, and share that data with TECnet participants
• attend the workshops to address implementation issues and also best practice and policies in relation to practical support for the technologists and their firms
• promote membership in TECnet by other universities and institutions
• contribute to the worldwide support network for student projects.

In relation to specific tasks:

• COTEC will establish the platform for the web-based repository of information and will take the lead in website development
• NCSU will organize and maintain the content of the website, although information will be gathered by all TECnet participants
• NCSU will lead the research programme, supported by LU and Brown
• LU and Brown will develop strategies and opportunities for dissemination of data and the promotion of TECnet to other universities and institutions.

**V. Innovative elements or strategies of the project**

The founding members of TECnet interact today as members of a loosely structured collaboration between organizations committed to training, support and research; each institution has separately adapted the TEC processes to local needs. This prior work and these existing
relationships provide a unique platform to learn from each other and hence improve what is already a highly developed and effective approach to TEE, and also to conduct research studies.

The key innovative elements on which we will build are the process-based pedagogy developed over the last decade and the intensive use of experiential learning based on immersion in real projects that have produced real commercial and entrepreneurial outcomes.

In addition, our strategy for this project will create innovations in three primary areas:

- We focus on technologies with the potential for global impact hence our approach to TEE demands that students engage in substantial and sustained international interactions; our goal is for students to operate on the global stage with as much comfort as in their home countries.

- We will build a multinational network of industry experts, start-up service providers, venture/risk capitalists and serial entrepreneurs. These international rather than local resources will be available to support projects in all locations. These resources will also provide the basis for experiments with international collaborative team projects (see Objective 3 above). Contact information will be made available online and personal introductions for students, faculty and researchers will be a regular component of TECnet.

- We will develop a data gathering protocol that allows us to monitor efficiently the outcomes of the common core teaching approach to TEE, with adaptations for local needs across the various TECnet contexts – including both existing and new members. The web-based repository of standard forms and tools central to the TEC approach will be updated regularly to incorporate developments in the relevant literature and/or White Papers and commentaries on the usage and effectiveness of TEE in various contexts. In this manner, we will integrate practical outcomes with scholarly research in a continuously-evolving, process-based pedagogy. Despite constant calls for more “engaged research” in the fields of entrepreneurship and technology commercialization, such an interlinking of theory and practice is highly innovative.

VI. Added value of multilateral, transatlantic cooperation in the project

Two primary factors underlie the added value of developing this collaborative network rather than working independently, namely: the education and continuing support of globally-competent students; and, the unique opportunity for research on educational intervention.

The education and continuing support of globally-competent students

Much of current business school and engineering graduate training in TEE relies heavily on anecdotal evidence and on narratives of exemplary outcomes that students are urged to emulate. One of the primary and highly distinctive benefits of the TEC pedagogy is that students follow a well-structured but flexible approach, grounded in scholarly research and taught through experiential learning on real projects. However, the current single-nation approach to delivering TEC (whether in the U.S., England or Portugal) is deficient in one crucial respect; when dealing with the growing importance of global markets, lecturers utilize the same sorts of traditional tools that this pedagogy more generally avoids i.e., we urge students to behave in a globally-informed and sensitive manner yet rely upon examples and narratives of others’ success to put this point across.

It is therefore imperative that we expand our pedagogy and the projects through which it is implemented to include a process-based approach to identifying and developing opportunities, technologies and resources of all kinds from anywhere on the globe. Students must learn how to access international markets, to attract extra-regional risk capital, and to utilize world-class
industry and technology expertise no matter where they are doing business. They must also be exposed to diverse business practices, political environments and cultures. Our collaborative network will support this by permitting us to create transnational projects and teams, and also by allowing us to study and compare lessons from across various regions – both those now part of the network and those we recruit to join it (described in section VIII) – and to integrate these lessons into our pedagogy.

The unique opportunity for research on educational intervention

Emerging streams of scholarly research have contributed to our attempts to “globalize” our students’ educational experiences. However, to our knowledge, very little work addresses effectively addresses what processes can be structured and taught to provide students with the ability to engage in entrepreneurship and technology commercialization across traditional national boundaries. An important element of TECnet will therefore be to engage in high quality, cross-national comparative research that focuses on what teachable processes deliver the best outcomes in relation to entrepreneurship and technology commercialization across a wide variety of environments.

VII. Expected results and outcomes of the project

As described in our objectives above, the primary results and outcomes of the project will be: the creation of a network (TECnet) of educators utilizing and promoting a structured, process-based, replicable form of TEE; the creation and development of a web-based repository of information and contacts, as a means to capture and disseminate lessons learned across all TECnet locations; the emergence of a cadre of “global citizens” prepared to build high growth technology-based ventures demanding international co-operation and engagement; and, the systematic gathering of data to conduct research on best practices for process-based TEE, and the dissemination of those results.

VIII. Potential impact of the project for a wider group of institutions

TEC was developed and first implemented at NCSU; it has been made available to, and adopted by, a variety of organizations, including the founding members of TECnet and other organizations in the U.S., Europe and Asia. The TEC process, as locally adapted, has proved at least equally effective beyond NCSU, both within the U.S. and in Europe.

In this project we propose to establish that TECnet is viable and sustainable, and then open the network to many more members. The common platform and repository we will create as part of this project will make TEC more accessible and scalable across a much larger group of nations and organizations.

Our goal is to promulgate and develop the process-based teaching approach both within the countries of the current members and well beyond these nations. This project will help provide the tools to make this happen.

IX. Plans for evaluation, promotion and dissemination of the project results

Evaluation

In line with our objectives, our evaluation of this project will focus on: student impact; and, the effectiveness of TECnet as a network (especially as more members adopt the TEC pedagogy).
We will measure two primary elements of student impact. First, we will track the number of students who receive cross-national training/team experiences enabled by TECnet; our initial goal will be for this number to increase by at least 20% annually. Second, we will track five primary elements of student outcomes: i. student satisfaction with the training/experience they have received; ii. changes in skill levels in relation to fundamental tasks of technology commercialization and entrepreneurship; iii. changes in students’ goals and cognitive orientations toward valuing the creation of innovation through application of emerging science and technology; iv. the number and percentage of students engaging in the creation of new technology-based venture; and v. the number and percentage of students engaged in jobs involving technology commercialization in existing firms. Our goal is have a statistically and substantively significant annual improvement in each of five areas; each of these student outcomes will be investigated in our research programme.

For TECnet as a network, we will measure success first by its size and second by its effectiveness in relation to student learning and project support.

First, a primary goal of TECnet will be to disseminate the TEC pedagogy and add further members to the network. This is essential for both increasing the impact of the project and for our long-term sustainability. Our goal will be to add a minimum of three new members during the course of this project, effectively almost doubling the founding size of the network.

Second, we will measure the effectiveness of TECnet as a mechanism for learning from each member’s experiences of using the TEC approach. The web platform we develop will allow us to provide version control and periodic releases of changes to the core forms, readings, and other documents that support the pedagogy. These releases will be based directly on feedback and records of successes and problems documented by TECnet members. Our goal, therefore, is that we will capture and incorporate at least two changes from each member of TECnet for each major version release. Finally, an essential characteristic of TECnet will be the network of affiliated individuals and firms who have supported student projects and who are willing and eager to engage with additional projects. We will closely track, map, and manage the network of active supporters who become affiliated with TECnet, with a goal of at least 50 additional supporters distributed across TECnet locations by the end of the project.

Promotion and Dissemination

Promotion and dissemination of the results of this project will occur in three primary ways: promotion of student successes; presentation and publication of related research; and, active support for new members of TECnet.

First, as our students start new firms or commercialize new technologies for existing firms, we will use a variety of inexpensive means of celebrating these student successes, including (but not limited to) press coverage, use of “Web 2.0” mechanisms, and encouraging the firms themselves to make note of the role played by TECnet in their success. Second, the processes and intended outcomes of TECnet activities are primary research targets of several of the founding members of TECnet. We will actively pursue opportunities to present our research at international entrepreneurship, commercialization, management, and engineering conferences, and will also seek to publish related research in both academic and practitioner outlets. Third and finally, we will support new members of TECnet by assembling international teams to “train the trainers” and more generally support quick and effective implementation of the TEC pedagogy at each new member’s location.

Sustainability

Our sustainability model is simple and direct. The current project will provide an adaptable platform that will permit cost-effective expansion of TECnet. Thereafter, each new member of TECnet will be expected to fund the costs of implementation of the pedagogy at their locations.
In addition, each TECnet member will pay annual fees for membership and will commit to funding at least one representative’s travel to the annual TECnet workshop to be hosted at a member institution.

**BIBLIOGRAPHIC REFERENCES**


COSEPUP: Committee on Science, Engineering, and Public Policy of the National Academy of Sciences (1995) Reshaping the graduate education of scientists and engineers, National Academy of Sciences, Washington DC.


