Technology-based entrepreneurship education

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Abstract

This case study introduces high growth, technology-based entrepreneurship education (TEE) as a special strand of entrepreneurship education (EE) and demonstrates its implementation in the Business School at Loughborough University. Based on an educational programme for technology evaluation and commercialisation (TEC) originally developed jointly by the Colleges of Engineering and Management at North Carolina State University (NSCU), the so-called 'TEC Algorithm' – now taught to Loughborough MBA students - facilitates the evaluation and commercialisation of new platform technologies by exploring the interaction between technology, products and markets.

Background

The UK Government's 'Third Mission' for Higher Education (DTI, 2000) urged universities to extend their mission beyond teaching and research to forge links with local industry and communities and to encourage the transfer of science and technology from universities to the business sector. This wide-ranging agenda has developed over time but the core philosophy has been retained. In particular the 'Mission' encouraged UK universities to:

- teach enterprise and entrepreneurship to STEM students (those studying science, technology, engineering and mathematics)
- promote the growth of new businesses by supporting start-ups, including spin-out companies based on innovative ideas developed by students and faculty.

In line with these twin aims, Loughborough University launched a TEE programme that built on its existing portfolio of entrepreneurship teaching and exploited the university's traditional strengths, especially the research activity conducted in its renowned engineering departments.

One particular challenge in developing high technology products is the so-called 'Valley of Death' that falls between universities' research activities and commercial needs (Markham et al., 2002, p 169) - see Figure 1.

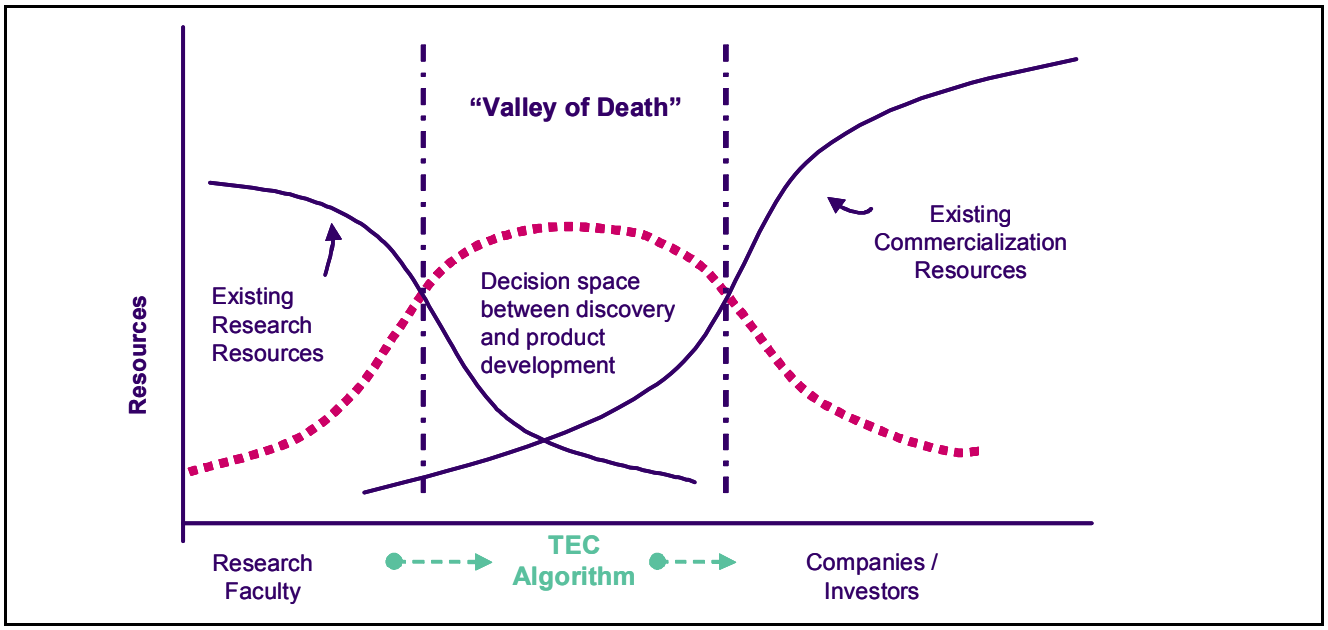

Figure 1: The Valley of Death

Individuals or teams engaged in scientific or technical research in the UK are usually funded by official bodies that support academic research. The researchers often lack the skills, resources or

time to develop product ideas, conduct market research or write business plans that would appeal to companies and/or investors. This creates the need for a systematic process of technology evaluation to bridge the Valley of Death and thus enable the researchers to speak the same language as commercial companies and/or investors.

In this context, the authors suggest that TEE programmes could, or indeed should, be structured differently, especially when taught to STEM students (see also Galloway and Keogh, 2006).

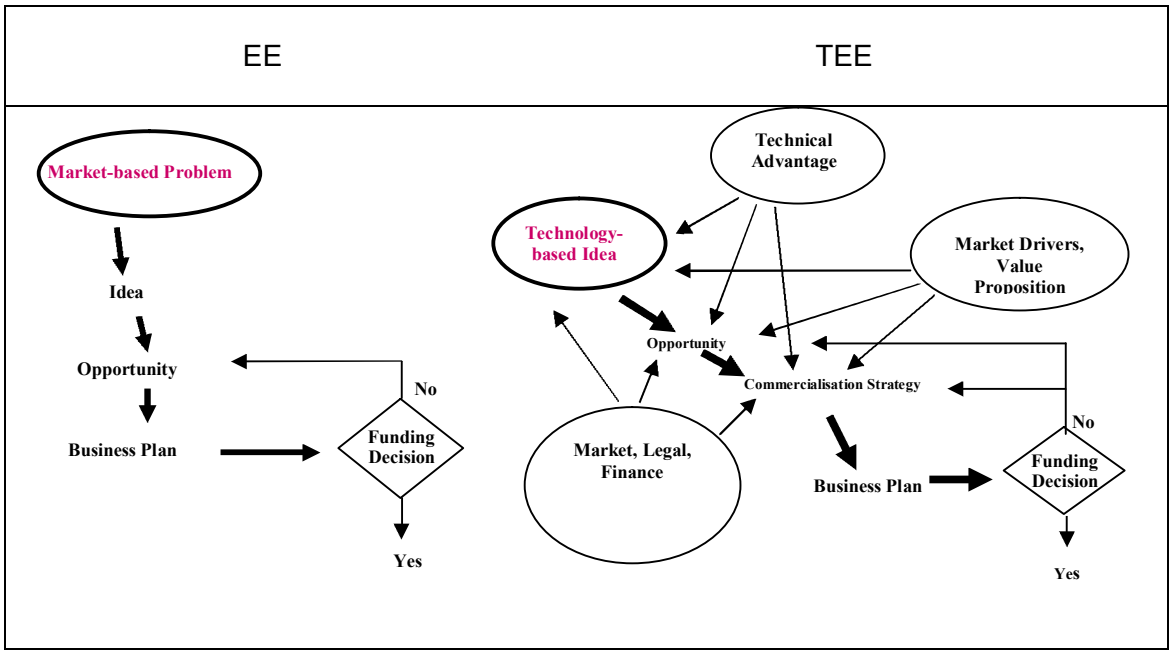

Figure 2. Comparison of 'traditional' EE and TEE (based on Kingon et al., 2002)

A key difference between EE delivered management and/or business schools and TEE is the switch of emphasis from a market-based to a technology/product orientation (Figure 2).

Structure and content of the programme

The 'TEC Algorithm' (henceforth Algorithm) is a framework for crossing the Valley of Death (Figure 1). It gives multi-disciplinary teams a structured process to assess the potential of 'real' technologies developed in universities and/or by local/regional companies. The focus is on high technology, high growth businesses. Implementing the TEE approach illustrated in Figure 2, the Algorithm starts from a technology-driven rather than market-driven perspective.

The Algorithm comprises the following phases:

- *'Search and Ideation' Phase (Idea Generation)* during which platform technologies with high growth potential are identified.
- During *Phases 'Assessment'* and *'Analysis'* a product's potential commercial viability is assessed in relation to a number of functional areas, including legal, marketing and so on. As a result 'fatal flaws' may be discovered, for example: inability to protect the intellectual property (IP), or a market with limited growth potential. Product ideas with fatal flaws are eliminated. At the end of the Analysis Phase a sound product concept should be generated on which the team can build a commercialisation strategy.
- In the *'Commercialisation Strategy' Phase* a route to commercialisation (licensing, manufacturing and selling, joint venturing, etc.) has to be chosen and a range of issues addressed, notably senior management availability and access to capital. At the end of this phase - the final phase taught at Loughborough - the student groups will put together a dossier which will contain a complete business proposal and documentation providing evidence for the decisions taken in previous phases.

- In the US, where the amount of time spent on the Algorithm is double that currently at Loughborough, the groups complete the framework with the *'Commercialisation Implementation' Phase*. This has resulted in the formation of a number of businesses, dependent on the ability to attract investors.

An overview of the structure of the programme is shown in the fact sheet at the end of this case study. For a more detailed description of each of the phases of the Algorithm see Markham et al. (2000) and Boocock and Warren (2005).

Issues

The issues faced when introducing and running the Algorithm as part of the graduate (MBA) programme are grouped around the key resources required. Broadly speaking these are the selection of technologies, human resources and time.

It is crucial to secure sufficient technologies and preferably platform technologies with high growth potential. At one extreme, the technology cannot be too 'blue sky' nor, at the other extreme, should it be too focused on a single product that is already very close to market.

The Algorithm works best with business to business manufacturing technologies. It is less suitable for businesses involved with consumer goods, services or 'lifestyle' offerings. At Loughborough, the technologies have been drawn from the fields of telecommunications, medical monitoring, semiconductors, solar power and sports technology.

The assessment of the IP of an invention, particularly within a university, is sometimes subject to dispute. Although generally the IP remains with the company and all participants on the MBA programme have to sign Non-Disclosure Agreements, technologists are sometimes reluctant to allow the teams to access key clients on the grounds of confidentiality or because they do not want to raise market expectations while products are still under development.

The time commitment of running the entire TEC Algorithm is immense for both students (just under 200 hours) and academic staff (for recruiting the technologies and delivering the module). There is a perceived conflict, particularly in research-orientated HEIs, between research (as a priority) and enterprise education (as a time-consuming activity). Career paths are perceived to be limited for young academics concentrating on enterprise education (Botham and Mason, 2007, p 98).

Objectives and benefits of the programme

The primary commercial objective of the programme is to create viable business concepts that generate wealth for all stakeholders. The primary educational objectives focus on:

- Subject-related knowledge:
  - Understanding of academic knowledge underpinning the Algorithm
  - Generation of technology-based product ideas
  - Development and application of business concepts to technologies
  - Selection of appropriate commercialisation strategies
  - Creation of viable business plans from technology sources
- Transferable skills:
  - Problem solving and critical thinking
  - Communication, team work and project management.

On an educational level, the students benefit from working with 'live' technologies and real companies. The integrative nature of this particular MBA module is pedagogically beneficial and appreciated by students. Students recognise, some for the first time, the extent to which marketing and other business concepts and factors determine the commercial viability of a technology and hence product development.

On a business level, the technologists and/or companies receive (for a minimal outlay) a comprehensive business proposal to strengthen existing business plans or to suggest alternative product development strategies. It should be stressed that not only *new* business ventures benefit from the application of the Algorithm but also large (established) organisations which need to fend off competition, develop new ideas, change the way things are done to meet customer needs and so forth.

On a macro level, the local and regional economy can benefit from the implementation of the Algorithm. In North Carolina more than 250 jobs have been created as a direct result of new venture creation following the Algorithm. These businesses have attracted more than US$120m venture capital. As the TEC programme has only run twice in the UK, and to a (so far) much more limited audience than in the US, the economic impact here is yet to be determined.

For specific benefits voiced by participating students and technologists see Boocock, Frank and Warren (2008).

Evidence of success

Student feedback has been excellent. One student "found the algorithm extremely helpful and can see opportunities to use it in [my] own entrepreneurial future." Another student has "already taken the opportunity to suggest ways in which [his] present company might improve their competitive position in the automotive industry. The TEC module has helped in this process."

This feedback has been gathered via university standard module feedback as well as via interviews with a selection of students from each cohort. In-depth interviews have been held with all technologists involved. This will form a database for future evaluation studies.

This module is fundamental to the accreditation of the Loughborough MBA. It represents an important element of the curriculum. In a context where entrepreneurship education is high on everybody's agenda – from UK government to universities – this particular module will become a compulsory module for all MBA students at Loughborough from 2007/08.

How can other academics reproduce this?

Other teachers/instructors can reproduce this technique. To be successful, they need to invest considerable time (around three months plus) getting to know the Algorithm in detail. It is beneficial if they fully apply it at least once in, for example, a short course. In the past, 'training for trainers' has largely been provided by NCSU staff. This might change in the near future once TECNet, an international network of TEC Algorithm users, is fully established.

Although the TEC Algorithm can be adapted in many ways to suit the users' needs, it works best when not just partly taught within another module, but when run as a full, separate course, especially to make use of the hands-on, full application of the Algorithm into real life technologies. Potential participants can be any STEM and/or management postgraduate students and researchers and/or staff involved in the commercialisation of university IP. However, the success of any programme requires participants to put in the necessary time commitment.

Reflections

Generally speaking, the TEC Algorithm fits well with the technology focus of Loughborough University and benefits from the university's strong links with industry and a desire to make an economic impact in the region. It should be noted that a number of other universities in the East Midlands have shown an interest in running their technological innovations through the Algorithm.

To make full use of the potential of this framework for technology evaluation and commercialisation it has to be backed by university-wide commitment (i.e. not driven solely by a Business School in conjunction with the university's IP office). Top level endorsement from the Vice Chancellor(s) to all

Heads of Department and more publicity across the university will secure the number, range and quality of platform technologies to make use of the Algorithm as a route to commercialise research.

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Background information

Discipline	*Generic: Business Studies* *Specific: "High technology evaluation and commercialisation"* *Also relevant to those teaching entrepreneurship to engineers*
Participants	*Currently: optional double module (20 of 180 MBA credits)* *No. of students: ca. 16 p.a.; lecturers:1 or 2; mentors: 4 (e.g. experts in intellectual property, private equity); technologists: 4* *In future (tbc): core module* *No. of students: ca. 30 p.a.; lecturers: 2; mentors: 4 (e.g. experts in intellectual property, private equity); technologists: 6*
Level	*Postgraduate/MBA*
Pedagogical approach	*Deep learning by experiential learning/action learning (Kolb, 1984)* *Development of critical thinking* *Enabling students to cope with unstructured and uncertain situations (as Solomon et al., 2002)* *Transformative (rather than transmissive) methodology for teaching and learning (as Lourenço and Jones, 2006)*
Teaching methods	*Double module: 48h class contact time, split into 24h lectures and 24h collaborative work, tutorials, discussions* *Additionally, 150h student effort outside classroom (self-study and research, mix of individual and group activities)*
Materials required	*Break-through technologies (1x/student group)* *Handouts: HiTEC workbook* *Literature: Mullins' Business Road Test; and others* *Software: HiTEC software* *Web-resources: Access to university library system and internet*
Assessment used	***Written (75% of total mark):*** *Group coursework: business proposal, documentation of decision-making process and underlying evidence.* ***Oral (25% of total mark):*** *Group presentation of business concept to invited panel consisting of staff and appropriate guests such as technologists and business experts as well as fellow class members. Assessment by module lecturers and small element of peer assessment.*
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