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# New Trends in Technology Management Education: A View From Europe

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***In the nineties, postgraduate technology management education was mainly concentrated upon structuring the product development cycle and positioning technology strategy within the overall strategy of the company. Today it encompasses a much wider range of capabilities to address contemporary challenges such as globalization, open innovation, and the need for corporate renewal and venturing. To gain insight into the implications of this change, we conducted a number of exploratory interviews with leaders from both the demand and supply sides in Europe based in higher education institutes, the corporate sector, and public institutes. Our interviews highlight a dynamic field moving from traditional MBA-focused programs toward more entrepreneurial "boot camps," from a case study-oriented teaching style toward a mentoring approach, and from an emphasis upon general business toward working across disciplines yet being sensitive to underlying technologies. We found important implications for technology management education with respect to its location within universities and identified opportunities for business schools to provide technology entrepreneurship and commercialization skills.***



Almost 2 decades ago, innovation and technology management education in graduate and postgraduate programs was focused upon structuring the product development cycle, creating technology roadmaps, and positioning the technology strategy within the overall strategy of the company (Wheelwright & Clark, 1991). A decade ago, Mallick and Chaudhury (2000) found little change when exploring the content and process of technology management education in MBA programs in the United States. They found general agreement between academics and practitioners that knowledge of business strategy and competition, the strategic role of technology in business, new product development, and the understanding of issues related to the implementation of new technology were important. They defined the emerging field of technology management accordingly, thereby making a clear distinction with the management of engineering, which is broader and more explicitly focuses on the management of engineering processes. Building on Mallick and Chaudhury's findings, Nambisan and Willemon (2003) have described the field of the management of technology as trying to answer the question of how "organizations can maximize gains from the technological assets within the company." We believe that this definition—although it encompasses a broad spectrum of activities—is insufficient. Technology management should also be able to address contemporary challenges, such as globalization, open innovation, and the need for corporate renewal and venturing. As Chesbrough (2003) described in his book, *Open Innovation*, companies are increasingly seeking new paradigms for creating and exploiting ideas, from being open to new ideas generated outside the organization to leveraging their research capability into new markets. In this line of logic, the

management of technology, therefore, should also include the "innovation and entrepreneurship" component more explicitly than before. The maximization of gains is no longer limited to the boundaries of the company; it also includes taking entrepreneurial initiatives that can result in commercialization (for a time) outside the company's boundaries. This emerging trend will be considered further below. As scientific research into the topic is still very limited, we chose an explorative methodological approach. Thus, our work here should be seen as an opinion piece that can instigate further research.

We chose cases that reflect the extreme situations and polar types in which the process of interest is "transparently observable" (Eisenhardt, 1989). In line with Pettigrew (1988), we interviewed representatives of technology management education who have created new programs to exploit emerging opportunities within the sector. First, we identified institutes that are positioned among the best in their respective fields. We label these institutes and their respondents "leaders." In the second round, we asked these leaders to refer to institutes that might not be considered leaders, but have created novel initiatives in the field. We label these "pioneers." Our article complements the paper by Hang, Ang, Wong, and Subramanian (this issue), which focuses on the university context in Singapore.

We present the leaders' reflections upon the historical developments within technology management education and their explanations of how they have modified their programs and experimented with new offers to meet the changing demands of an increasingly fragmented market. From our interviews we observed two common themes regarding the evolution of the market. First, the leaders observed a change in demand for more specific technology management skills, such as technology evaluation and business planning. Second, they propose a change in the anticipated outcomes of education programs toward organizational renewal and new-venture creation. Using these themes we develop a typology of four types of education programs and present the voices of pioneers from within each category, as identified by the leaders. These pioneers, from both the public and private sectors, explain how they have created novel programs to meet emerging demands and share their thoughts of the future needs of the market.

We conclude by considering the limiters and enablers for organizations that wish to capitalize upon nascent trends and discuss the challenges for business schools aiming to exploit the inherent opportunities.

## INTERVIEW METHOD AND QUESTIONS

Our initial approach involved considering the diversity of technology management education providers in Europe, encompassing a variety of types of suppliers exhibiting innovations in education provision. Since the innovation and entrepreneurship component is of great interest to us, this was the principal criterion for the selection of interviewees. We conducted a first round of interviews with six organizations that were actively responding to changes in technologies and markets within Europe. Two of these organizations were within the higher education sector: Vlerick Management School in Belgium and Nottingham University Business School in the United Kingdom. Vlerick Management School was chosen because it is representative of the group of autonomous business schools in Europe, including London Business School, INSEAD, IESE, TIAS, and so forth. It is ranked 10th in the *Financial Times* (2008), thereby belonging to the league of major business schools in Europe concentrating on executive and MBA teaching. Nottingham University Business School is a research-driven business school that is still part of a university, thus following the rules of that university. As these research driven-business schools predominantly put emphasis on research rankings, they tend to appear lower in the *Financial Times* rankings but higher in research rankings. Nottingham is a top-10 business school overall in the research ranking of the United Kingdom and among the top 5 in the world in terms of its innovation and entrepreneurship research. Both schools focus on innovation and entrepreneurship to provide a comparative advantage over rival management schools; however, the supply side has changed significantly and now also includes new players, such as corporates, consultants, and research organizations (Friga, Bettis, & Sullivan, 2003).

Within the corporate sector we chose Qinetiq and Rolls Royce from the United Kindgom, as organizations facing drastic changes in their supply chains, technology acquisitions, and development strategies due to globalization. Rolls Royce and Qinetiq are both within the top-10 R&D spenders in the United Kingdom within the aerospace and defense sectors (Department for Innovation, Universities & Skills, 2009). The final two organizations were selected from the public nonprofit sector. The Interdisciplinary Institute for Broadband Technology (IBBT) in Belgium and Biotechnology Yes in the United Kingdom are tasked with developing the capability to exploit nascent technologies within two of the fastest moving

markets, information and communication technology and biotechnology. IBBT is representative of large public research organizations in Europe, as they employ almost 500 researchers and have a public funding of 25 million Euro annually, matched with 10–25 million in revenues from industry. Biotechnology Yes and IBBT share a number of challenges, not least the transition from business models based on proprietary technologies toward those based on open innovation.

We conducted in-person and telephone interviews with the senior people responsible for the provision of technology management education. The interviews were typically conducted by two of the authors, and each lasted between one and two hours. The interviews were conducted during the period from April to August, 2008. All interviews were transcribed.

Our interview schedule covered a range of topics and considered the education programs provided, the skills provided by the programs, whether the programs were delivered on- or off-site, the pedagogical approach, the nature of the faculty providers (i.e., in-house, consultants, business school faculty), the topical focus of the programs, and the expected outcomes and the changes taking place within the programs. A summary of the responses can be seen in Table 1.

Based upon the initial interviews, we developed a preliminary view on how technology management education has evolved along different dimensions. Two important trends were identified: A change in demand for more specific technology management skills and an evolution in the anticipated outcomes of education programs toward organizational renewal and venturing. Based upon these findings, we developed a typology of four types of education programs. We then asked our respondents which organizations they considered as "pioneers" in developing new projects or approaches in the field of technology management education. If an organization was mentioned by at least half of our respondents, we considered it to be relevant and included it as a showcase in our sample. From this snowballing approach, we were able to identify "pioneers" in each of the four distinct areas. These exemplar organizations included Finmeccanica (Italy) for its specific in-house FHINK, master's in international business engineering; CREAX for its specialized and adapted TRIZ methodology, which is used in creativity training; Alcatel-Lucent for its "entrepreneurial boot camps" providing entrepreneurial skills for technologists; and Judge Business School at Cambridge University in the United Kingdom for its master's in technology and innovation management. We subsequently interviewed key individuals at each of these organizations to compare and contrast their approaches to those of the initial organizations examined. Details of these organizations and the characteristics of their programs can be seen in Exhibits 1 through 4.

We sent transcripts of the interviews to the respondents in order to check for accuracy and clarity, but requested no changes to the underlying responses. Details of all respondents can be seen in Table 2. In the following, we present the thoughts of the respondents, grouped thematically.

### Skills Provision: Generic and Specific Skills

Skills provision can be represented by a continuum ranging from generic to specific skills (Clucas, 2004; Wright, Piva, Mosey, & Lockett, 2008). Within the context of technology management education, respondents considered generic skills to be those provided by "MBA-type" courses designed for technologists. Commonly quoted examples include courses in strategy, marketing, organizational behavior, finance, project management, and operations management. These courses are characterized by their emphasis upon theory, abstracted from any single industry or technology. By contrast, according to the respondents, in specific skills courses the emphasis is on skills development rooted within the industry or technology context where the technologists are based. These tend to be delivered by consultants. Commonly cited examples include creative problem solving, new technology evaluation, business plan development, and cross-disciplinary communication. To deliver such courses credibly, providers are required to demonstrate in-depth industrial experience. Inevitably there is no clear delineation between these two areas. However, within the different organizations examined, we observed a shift of emphasis from generic toward more specific skills.

The large corporations interviewed had a "university" or "education department," which closely collaborates with the business units, R&D, and HR. They oversee either a short-term course organized internally or a partial sponsoring of employees to enroll in an open (executive) MBA at a business school.

> *" . . . Our Middle Management has the opportunity to do an MBA. Formal training is a very big issue for us. In terms of budgeting, we would normally budget something in the range of 4 or 5 man days per year for this purpose. This is in the context of about 200 days per person being available to work on customer projects, after subtracting holidays etc. . . ."*
>
> —Andrew Middleton, Qinetiq

**TABLE 1**
**Characteristics of Proactive Technology Management Education Programs**

| | Corporations | | Public Nonprofit Institutes | | Higher Education Institutes | |
|---|---|---|---|---|---|---|
| **Characteristics** | **Rolls Royce** | **Qinetiq** | **IBBT** | **Biotechnology YES** | **Vlerick Leuven Gent Management School** | **Nottingham University Business School** |
| ***Forms of Management Training*** | Specific (e.g. TRIZ) Creative Problem Solving | Open MBA Specific Training (mostly technical); Short Management courses | Project Management and Negotiation. Entrepreneurial Skills | Business Plan Creation for new ventures in biotechnology | Executive Training (innovation management is standard module) One dedicated course in MBA specific programs on R&D Management | Master's between Business School and other Faculties E.g., Computer Science and Entrepreneurship |
| ***Enrollment*** | Facilitated within projects ~100 users per year | Five days per employee is standard | ~100 in project management and generic skills 25 in *i*Bootcamp | 350 postgraduate researchers per year | 350 MBAs per year 15 Exec Master Class Innovation >300 in open programs | 60 full time Master's students per year |
| ***Providers*** | Consultants for specific (e.g. TRIZ) Five in-house lead users | In company University Business Schools for open MBA Consultants | Consultants for specifics Business School for *i*Bootcamp | Technology Entrepreneurs Industry practitioners Business School faculty | 85% enterprises through exec. education | Business/Science/ Engineering Faculty and Technology Entrepreneurs |
| ***Identified Gap*** | Entrepreneurial skills among design engineers | More structured support needed to develop business cases | Technical Specific MBA skills | Lack of technology/ industry knowledge by Business School faculty | Lack of technology/ industry knowledge by Business School faculty | Lack of technology/ industry knowledge by Business School faculty |

**TABLE 2**
**Details of Respondents**

| Respondent | Organization | Position |
|---|---|---|
| Geoff Kirk | Rolls Royce Aerospace | Former Chief Designer<br>Visiting Professor of Innovation<br>University of Nottingham |
| Andrew Middleton | Qinetiq | Director Defense Science Strategy |
| Marie-Claire Van de Velde | IBBT | Director Valorization & Business Development |
| John Peberdy | Biotechnology YES | Emeritus Professor Microbiology, University of Nottingham<br>Founder Biotechnology Yes |
| Kristi Valentine | Vlerick Leuven Gent Management School | International Business Development Manager |
| Stijn De Zutter | | Scientific Coordinator of the Executive Master Class in Innovation & Entrepreneurship |
| David Garner | University of Nottingham | Emeritus Professor Chemistry<br>Chairman, Royal Society of Chemistry |
| Andrea Prencipe | Finmeccanica | Scientific Director FHINK Program |
| Simon Dewulf | CREAX | Managing Director |
| Boudewijn De la Fortry | Alcatel-Lucent | Boot Camp Project Manager |
| Arnoud De Meyer | Judge Business School, Cambridge | Director of Judge Business School |

This quote illustrates that the development of generic skills remains significant in large companies (2.5% of the time goes to generic skill development). However, although these university-led programs seem to satisfy the general need for skill development over the long term, a number of shorter term needs have arisen. For instance, the need for openness in the innovation process creates a need for skills to manage IP in a very sophisticated way (Chesbrough, 2003) and to manage the innovation process systematically. Further, increased globalization creates the necessity to be able to function in multicultural teams that are not necessarily located together (Doz, 2007). This is compounded by the pressure on R&D departments to better demonstrate their value. It appears no longer sufficient to refer to industry benchmarks as the main rationale for spending a percentage of turnover on R&D. Instead, R&D departments have to show commercially viable results immediately, and therefore, enter into venturing initiatives, which in turn require researchers to have specific entrepreneurial skills (O'Connor, 2006). In response to these trends, organizations from both public and private sectors are making use of specialized consultants that offer tailored programs based on their immediate needs.

Actors interviewed from the supply side also experienced an increased need for specific skills. Here, a large number of open programs are offered in which scientists and engineers participate from different functions in the organization. This is complemented by short-term programs covering an increasing number of specific topics and organized by a mix of academics and practitioners:

> *" . . . Next to our open programs in which innovation management is included as a core module, we offer a specific number of short-term programs on specific needs such as open innovation. These programs are provided by our faculty in close cooperation with the leading industry experts in these areas. Whereas in a typical MBA program the ratio of internal faculty versus guest lecturers from industry would be 80:20%, in specific programs, this ratio is 50:50 or even 20:80 . . ."*
>
> —Stijn De Zutter, Vlerick Leuven Gent Management School

This quote illustrates how specific skills provision differs from that of generic skills. This trend is also observed among the supply side of technology graduates. For example, at Nottingham University Business School in the United Kingdom, six new master's programs have been created between 2004 and 2008 to meet the ever-increasing demand for graduate technologists to gain specific entrepreneurial skills, such as creative problem solving, entrepreneurial marketing, venture finance, and intellectual property protection. Master's in computer science and entrepreneurship, sustainable energy and entrepreneurship, crop biotechnology and entrepreneurship, chemistry and entrepreneurship, and electronic and electrical engineering and entrepreneurship were developed through the business school working together with the appropriate science and engineering schools and involve different industry experts and faculty with an industry background. Technology

graduates on these courses learn to apply business school frameworks within their own technology context to meet emerging industry needs.

> *" . . . One group of master's students had to evaluate the commercial potential of a novel chemical compound that offered enhanced storage properties for hydrogen. They found commercial opportunities for hydrogen powered cars, domestic heating and even container ships as part of their fieldwork . . ."*
> —David Garner, University of Nottingham

This quote illustrates that the results from specific skills provision can be immediately applied in practice. It also illustrates the way in which specific skills training differs from general skills education: The emphasis on field work and the use of coaching or mentoring appears a central part of the learning process.

### Topical Focus and Expected Outcomes: From Career Development to Corporate Renewal

Our interviews revealed that the demand for training differs according to the need for specific versus generic skills. Moreover, there is a major difference between training oriented toward the development of individual participant's careers and goals-oriented training with tangible business outcomes. The former has the classic objective of job enrichment; the latter has an immediate corporate objective, such as increasing entrepreneurial initiatives that might result in new venture creation.

***[T]here is a major difference between training oriented toward the development of individual participant's careers and goals-oriented training with tangible business outcomes. The former has the classic objective of job enrichment; the latter has an immediate corporate objective, such as increasing entrepreneurial initiatives that might result in new venture creation.***

To clarify the first type of technology management education one can refer to the corporate organizations, Rolls Royce and Qinetiq, which are more focused on adapting their programs to enhance the individual development of their employees. By contrast, in line with the second type of technology management education, both IBBT and Biotechnology Yes organize industry-specific training in which the participants have to turn a project into a potential business case. Both organizations insist that training providers focus upon business development within their specific industry context, namely ICT and biotechnology.

> *" . . . We have strongly emphasized in the start-up of our collaboration that cases and examples should as much as possible be about the ICT-sector, so not the usual Coca Cola examples or cases . . ."*
> —Marie-Claire Van de Velde, IBBT

They do so in order to increase the likelihood of a realistic outcome at the end of the training. By tailoring the offer specifically to the biotechnology and the broadband technology industry, respectively, these programs attract technology entrepreneurs from industry to share insights with researchers from public research organizations and higher education institutes with entrepreneurial aspirations. Despite the single industry focus, these researchers span a number of technology domains, such as medicine, chemistry, biology, electronic engineering, social sciences, and computer science. It could reasonably be argued that industries such as biotechnology and telecommunications have grown in part due to cross-fertilization from very different technology domains. Recent examples are developments in pharmacogenomics, the computer modeling of proteins in biotechnology, and artificial intelligence and usability research in telecommunications.

> *" . . . There are some ideas that stem from research with real research going on around them, others just come up with a new idea and they think it has commercial value. A classic one we had was this idea of developing genetically modified grass that would not need to be cut . . ."*
> —John Peberdy, Biotechnology YES

The above quote demonstrates how corporate goals and tangible outcomes are increasingly emphasized by the demand site for technology management programs.

Most providers collected summative feedback from participants to capture their views on the outcomes of the training. In the main, this was reported as positive for MBA-type programs. Here a clear connection between learning objectives, content delivery, and outcomes was apparent to the participants. However, for corporate renewal-type delivery, this type of feedback was more mixed.

For instance, following an early IBBT venture camp, participants were disappointed that the business idea they had generated was not considered worthy of further development. Participants were seen to evaluate the outcome in terms of the idea they generated rather than the skills they may have developed. An analogous situation was observed with Biotechnology Yes. Here an independent reviewer contacted researchers between one and five years following their participation (Mosey, Hassall-Jones, Ucbasaran, & Lockett, 2005). By comparing the feedback received after the researchers' careers had developed with their feedback immediately after the event, an interesting difference was observed. In the main, researchers realized the value of the training and the skills they had developed when they were seeking a new career, or working on a new business opportunity. The realization that they were better able to recognize opportunities only became apparent some time after taking part in the program.

We can conclude that when the objective of the program is individual career development, the expectations of the participants are much lower than if corporate objectives are to be reached. In the latter case, the success of the outcome will determine to a large extent the general satisfaction level.

## AN INTEGRATED FRAMEWORK FOR TECHNOLOGY MANAGEMENT EDUCATION

From the observed trends in skills provision and anticipated outcomes, we derived an integrated framework as presented in Figure 1.

In this framework, we suggest that the aspects by which training programs seem to differ can be represented by way of two axes: a generic versus specific skill axis and an individual career versus corporate objectives axis. This line of reasoning introduces a framework of four quadrants.

The first, lower-left quadrant is one in which generic skill development is combined with an individual focus. This is the home territory of business schools and universities offering MBAs and executive training. These educational programs are oriented toward the pedagogical development of specific employees and serve a long-term objective of retaining employees and even attracting new employees in the company.

*" . . . Each of our engineers has got a training packet of 5 days to spend. As business units we have to sponsor and even fill in these training days at the start of their career. The specific content of the offer is made of course by the Qinetiq university*



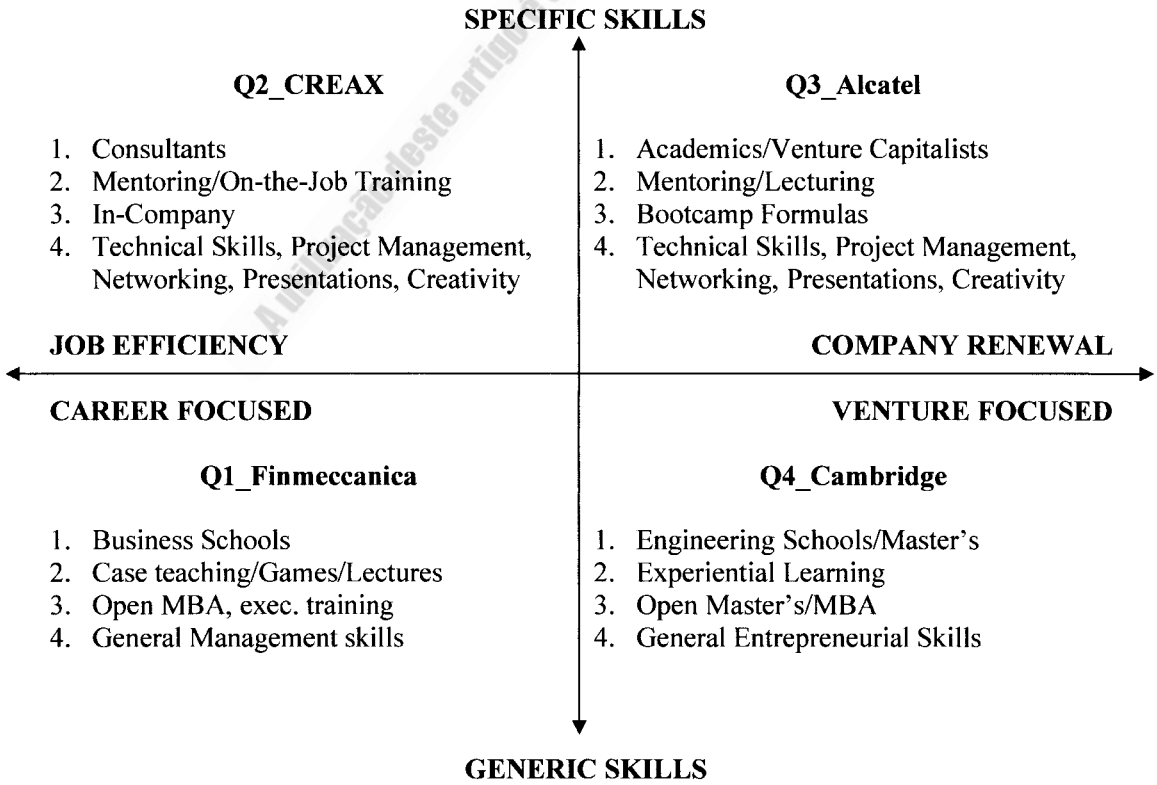


**FIGURE 1**
**Skills Provided by Technology Management Education Programs**

*people who determine a program in collaboration with the various Business Schools we have agreements with . . ."*
—Andrew Middleton, Qinetiq

It is important to note that generic skill provision seems to have become a standard focus of most companies which, as a result, have deployed rather large departments to organize and partly teach this form of training. Career development and long-term objectives are key here, in addition to recruitment and retention.

By contrast, quadrant 2 (upper left) combines those programs that are oriented toward individual objectives with a very specific focus, such as social networking. Such programs were found in each of the corporate organizations we studied, in addition to the public nonprofit institutes such as IBBT. They satisfy a need for specific training in order to be more efficient in the workplace. However, the results are not expected immediately but are rather seen over the longer term. It is remarkable that the universities we included in this investigation did not emphasize these kinds of programs. A common complaint from corporations was a lack of competent faculty within business schools to provide the soft skills required to develop current technologies and serve current markets. Different organizations were seen to address this shortfall in different ways. Corporations such as Rolls Royce used external consultants for specific training needs, such as creative problem solving and networking. They then invested in developing this capability within the company and leveraged the capability to make it more relevant to their specific needs. For example, at Rolls Royce, Chief Designer Geoff Kirk identified a lack of creative problem-solving skills among designers as a critical gap. He responded by employing training consultants to provide a creative problem-solving training (TRIZ), tailored to the needs of the company. Geoff explained how the consultants customized this training so the process could be systematized across the firm:

*" . . . We then had roundabout 25 facilitators around the company who were trained to a higher standard who were available to the designers . . . They would then facilitate the half-day or one day session. Then there were five lead users who were the real experts in it who would go on the course and keep up to date with the latest trends. . . . So we set-up a hierarchy . . ."*
—Geoff Kirk, Rolls Royce

The third quadrant includes a more novel area of specific skills provision such as those required to create new ventures utilizing novel technologies, combine technologies from disparate domains, or create new business models. Here it was proposed by organizations such as IBBT that these skills could be best inculcated within a "boot camp," an intensive event in a neutral venue with a focus on identifying and developing business opportunities within a specific industry sector and utilizing proprietary technologies.

The specific objectives of these boot camps go beyond the training and personal development observed within the previous two quadrants. Here concrete expectations are formulated in terms of starting new ventures and the program is seen as a facilitator to reach such objectives.

*" . . . The goal was set by the Innovation Board to create new business within three to five years worth 50 to 100 million Euros. In order to achieve this goal, the Entrepreneurial Boot Camp was introduced at Alcatel-Lucent . . ."*
—Boudewijn De la Fortry, Alcatel-Lucent

In the final quadrant, we observe a combination of generic skill development with concrete objectives. An example of this is the Executive Master Class in Innovation and Entrepreneurship, which is offered at the Vlerick Leuven Ghent Management School. This master class aims to develop entrepreneurial skills among its participants and, in addition, requires them to write a full business plan. The objectives of the program are clearly stated by its coordinator, Stijn De Zutter:

*" . . . The reason why the participants of the executive master class take part in this program and are paid by their companies to participate in it is not because its teachers are so well-known or because the program has an extra-ordinary content, it is especially the extensive coaching they receive in order to finish a business plan which really offers value added . . ."*
—Stijn De Zutter, Vlerick Leuven Ghent Management School

This kind of program provides four sessions of 4 hours mentoring, in addition to its traditional curriculum of 144 contact hours. The mentoring is not only provided by the professors at the business school but also by industry experts that act as "privileged witnesses" (Vanaelst et al., 2006). They

have a broad industry overview and mentor specific groups of people, categorized by industry sector. Alumni of this master class are subsequently recruited as mentors for the future versions, as they are familiar with the methodology behind the master class and have a specific industry expertise. The business cases delivered at the end of this master class often result into new ventures when the participants return to the workplace.

As the four quadrants in Figure 1 emerged as distinct practices, we subsequently selected four additional cases, following a snowball approach. To achieve this, we asked the participants in round one to recommend "pioneers" as exemplar suppliers within each specific area. Four different organizations were selected for their unique contributions in each quadrant. Each example and the success factors of their specific programs/products are described below.

## ANALYSIS OF LEADERS IN EACH EDUCATIONAL QUADRANT

### Quadrant 1. Generic Skills, Individual Objectives: The Case of Finmeccanica

The first pioneer identified was Finmeccanica for its in-house FHINK, Master's in International Business Engineering with a focus on innovation and technology management. This serves as both a training method for young engineers in the company and an excellent recruitment vehicle as described in Exhibit 1.

**EXHIBIT 1:**
**Finmeccanica—Master's in International Business Engineering**

The Finmeccanica Group is a world leader excelling in the design, development, and manufacturing of state-of-the-art technologies. The company is a key player in defense, aeronautics, helicopters, space, and security. Innovation is at the core of their activities; consequently, the Group invests a great deal in research and technological innovation, yet the company also recognizes the importance of their human capital. Finmeccanica has training strategies for its employees at different levels: Induction courses for new graduate recruits, training and the development of skills for middle-management, and managerial training for executives with identified leadership potential. The Group also invests heavily to attract talent from overseas by organizing the FHINK, the master's in international business engineering. It was adopted by the Finmeccanica Board on May 11, 2006, and initiated its first edition on November 15, 2006.

**EXHIBIT 1:**
***(Continued)***

The master's program enables high-potential graduates to become professionals in an international business engineering environment in the areas of project management, project planning & control, innovation management, operation & technology management, business development, and international sales. The master's is delivered over 12 months. The participants initially take basic courses and then continue their training in more specialized ones. Once successfully completed, the students participate in an internship in a Finmeccanica operating company.

The FHINK is a unique 1-year program and is designed to forge a link between academic institutions and industry. Talented graduates from around the world are invited to apply for the master's program. Figures show it to be very successful and a truly international initiative. The first cohort in 2007 attracted 3,500 applications from 40 different countries. The second cohort attracted 5,100 graduates from 105 different countries.

There are several reasons attributed for the success of this program. Depending upon the student's final graduation scores and the skills they have acquired, Finmeccanica will offer them a job opportunity within the Group. Furthermore, Finmeccanica offers financial support to all participants to cover tuition fees, accommodation, and living expenses.



### Quadrant 2. Specific Skills, Individual Objectives: The case of CREAX' TRIZ Methodology

In the earlier section, we explained how Rolls Royce provided TRIZ training in-company, with engineers calling for team problem-solving facilitation as and when it was required. Here the focus was upon more efficiently developing technologies within existing business models.

> *" . . . We only selected 3 or 4 techniques from TRIZ as the main runners. In total, there are forty principles but we said for our business there is probably only 5/6 or 7 which are really applicable or really going to be useful to us . . ."*
> —Geoff Kirk, Rolls Royce

The TRIZ training is argued to be exemplary, as its specialized courses are used by many leading companies. The offering is diverse, ranging from technology evaluation toward softer skills such as social network analysis, communication and presentation techniques, project management, and problem-solving tools. Although a wide variety of consultants provide this kind of training, within the area of creativity CREAX was argued by respondents to be one of the most remarkable. Its training method is described in Exhibit 2.

**EXHIBIT 2:**
**CREAX—TRIZ Methodology**

TRIZ is a method that was developed by the Russian Genrich Altschuller. It's an acronym for *"Teoriya Resheniya Izobreatatelskikh Zadatch*," freely translated as "a theory to solve problems in an inventive way." It offers a process to identify and solve any possible problem.

The problem can be technical or not. It can be a new project or a heavily limited challenge. It is used for gradual continuous improvement programs in addition to undertaking radical innovation steps. The basic idea is to transfer knowledge across domains through abstraction. CREAX selected TRIZ and added new aspects to the traditional TRIZ method to improve existing products and develop new ones.

First, CREAX focused upon patents. Patents describe solutions to problems, a significant part of which are consumer related. CREAX created a method to distil this consumer data from patents. They found when patents are analyzed linguistically, the DNA of the underlying system can be extracted. The DNA refers to the systems' properties and their functions. Once the DNA is known, similar systems can be traced alongside properties that associate or differentiate these systems.

CREAX also uses "the 9 Windows Tool" to visualize a product in time and space. Here two questions are asked: "This product exists /is part of (what)?" and "What came before/comes after this product?" The final novelty CREAX added to the TRIZ-methodology is related to the changes of a product over time. An effective way to gain insights into the evolutions in a certain domain is to track the changes linguistically, looking for keywords such as *increasing*, *decreasing*, and *changing* or *stabilizing*.

CREAX organizes 2-day workshops predominately aimed at technical staff, product developers, engineers, and innovation managers who can make practical use of the TRIZ methodology. The workshop introduces the most important TRIZ problem-solving tools, the benefits, and the effects. Participants can bring their own projects to the workshop and subject them to the TRIZ methodology. Each theoretical insight is immediately put into practice in the form of interactive exercises, group assignments, and simulations.

### Quadrant 3. Specific Skills, Company Objectives: The Case of Alcatel's Boot Camps

An exemplar within quadrant 3 provision is Alcatel-Lucent's boot camp initiative (see Exhibit 3 below for a description). This program was organized by Alcatel-Lucent's Innovation Board and was established with specific venture creation objectives.

*" . . . And so we measure activities that we can see are—in one way or another—related to one of the projects of the boot camp. Today we have two internal ventures. One was established the first of March this year. They recruited people and the general manager. So they are now in operation . . ."*
—Boudewijn De la Fortry, Alcatel-Lucent

**EXHIBIT 3:**
**Alcatel-Lucent—Entrepreneurial Boot Camp**

In 2002, Alcatel-Lucent was restructured. The new goals for the Belgium-based organization were to stay at the forefront of the industry as an innovation powerhouse, to keep generating breakthrough innovations, and finally, to make innovation the responsibility of every employee. The formation of an innovation board was the first step to realizing these objectives. The goal was set by the latter to create new business within 3–5 years, worth 50–100 million Euros.

In order to achieve this ambitious goal, the entrepreneurial boot camp (EBC) was created by Alcatel-Lucent University Antwerp in collaboration with Research & Innovation, Alcatel-Lucent Technical Academy, and Flanders Business School, thereby bringing together people and ideas. The aim is to develop and defend a business opportunity plan (BOP) to venture capitalists. The premise is that the organization has many talented people, ideas, and silos scattered across real and virtual space. If connected, these should generate unique innovations. During the first phase ideas are gathered on the Innovation Web Site (see www.inceptum.be).

Approximately 20 ideas are proposed at launch. These ideas are presented to an internal audience and 5 or 6 arouse attention. Then, the "right ideas" are connected to the "right people" during a dating event. The right people can be the idea owners themselves, or high-potential employees, or possibly MBA students. Participants can originate from anywhere in the company: R&D, Finance, Marketing, Sales. Any employee with a great idea and with an entrepreneurial mentality can join the Boot Camp. The Boot Camp is a means to connect committed and talented people with multidisciplinary/complementary skills and expertise across the boundaries of the organization.

At the dating event, five teams are formed, each consisting of five members. These teams are then engaged in the Entrepreneurial Boot Camp. The boot camp takes place over a 3-weekend residential learning program where the teams are supplemented with selected senior managers and external experts—mostly faculty and venture capitalists. The latter investigate each case thoroughly and ask critical questions. Each weekend deals with a specific subject. The first weekend evolves around the following concepts: "How to Develop a Successful Business Plan," "New Venture Creation," and "Opportunity Development." The second weekend elaborates on "Entrepreneurial Marketing" and "Principles of New Product Growth."

During the final weekend the participants learn more about "Entrepreneurial Finance," "Legal Aspects," and "Intellectual Property Rights." Between weekends teams are asked to further optimise the business case. Finally, the participants have to present and sell their business opportunity plan to a jury of experts. The jury consists of venture capitalists, business school professors and the CEO, CTO, and CFO of Alcatel-Lucent, Belgium. In a final phase the venture council decides which business plans should lead to the launch of a new venture or project.

As described in Exhibit 3, the remit of this program goes beyond the mere development of skills, which are generic and only indirectly related to possible company objectives. Instead, the objectives are to speed up the communication flows within the company and target very specific company objectives:

> *" . . . Every other organization and Alcatel also consists of silos for R&D and another silo for Marketing. And the pressure today is so high that it is hardly possible to organize any activity across silos. This program is a unique program in the sense that it brings together people with different competences and different skills from different parts of the organization which normally—in daily life—never talk to each other . . ."*
> —Boudewijn De la Fortry, Alcatel-Lucent

The return on investment of the program seems to be positive, as 10 of 12 projects resulted in new ventures, two of which are external ventures cofinanced by the venture capitalists from the judging panel. Also of interest, in terms of the degree of innovation, three projects targeted existing markets with new technologies; four targeted new markets with existing technologies, and only three projects or ventures were real radical innovations in the sense that they both targeted new markets with new technologies. In other words, boot camps do not *only* result in exotic ventures that have nothing to do with the parent company. Rather, they tend to result in new projects in familiar markets or with familiar technologies in adjacent markets, and only 1 of 5 seems to result in an external venture in which venture capitalists play a major role.

***Also of interest, in terms of the degree of innovation, three projects targeted existing markets with new technologies; four targeted new markets with existing technologies, and only three projects or ventures were real radical innovations in the sense that they both targeted new markets with new technologies.***

### Quadrant 4. Generic Skills, Company Objectives: The Case of Judge Business School at Cambridge University, UK

Cambridge University in close collaboration with its Judge Business School delivers technology commercialization by way of more standard classroom case study and lecturing approaches. In addition, they also deliver project-based learning at the end of the year-long course where teams of students work with a high-technology company to solve their industry specific problem. In this way a pedagogical approach analogous to the boot camp business development phase is achieved (see Exhibit 4):

> *" . . . It's a combined master's program and the participants fill it in according to their own sector like 'Nano' or 'Biosciences'. They pursue a master's programme in technological area but in the first two terms—so in Fall and Winter—they get eight courses in Management in Economics, Finance, and Commercialization of Innovation and so on . . ."*
> —Arnoud De Meyer, Dean Judge Business School at Cambridge University

**EXHIBIT 4:**
**Judge Business School—MSc in Innovation and Technology Management**

What is now Judge Business School began life in 1954 as part of the engineering department of the University of Cambridge. It is now one of the top business schools in the world. Since 2000 Cambridge University has a collaborative venture with Massachusetts Institute of Technology (MIT) called the Cambridge-MIT Institute (CMI). CMI conducts joint, overseas teaching and research. One of the focal points is the encouragement of the entrepreneurial spirit in higher education. The activities in Judge Business School are central to the development of such commercial spin-offs from academic innovation.

In 2000 and 2001 the Cambridge-MIT Institute found that MIT—as opposed to Cambridge University—had a pervasively interdisciplinary nature. Learning from each other across boundaries helped individuals to deal with innovation. As a result, MIT investigated the 1-year MPhil degree at Cambridge with the aim of providing a more interdisciplinary approach. The resulting offer was a master's-level degree aimed at enterprising young scientists and engineers. The typical student in such courses is younger, more research-oriented and less experienced in industry than their MIT counterparts. Consequently, the Cambridge-MIT Institute developed and delivered six new MPhils at Cambridge University. The MPhil degrees are established in the following areas: Advanced Chemical Engineering, Bioscience Enterprise, Computational Biology, Engineering for Sustainable Development, Micro- and Nanotechnology Enterprise, and Technology Policy. These programs offer students the latest teaching in their field and a central module in the management of technology and innovation, otherwise known as MoTI.

MoTI introduces the students to the pathways by which new technologies can reach the marketplace. The students receive a grounding in core management principles, including strategy, marketing, organizational behavior, finance and accounting, decision theory, and

**EXHIBIT 4:**
***(Continued)***

microeconomics. The aim is to equip the students with the organizational and managerial competence to convert ideas and opportunities into commercially viable products and services. In addition to the taught MoTI components, in the last term students have the opportunity to work on a real company consultancy problem.

As mentioned, the MoTI course is shared by all MPhil programs, and therefore, offers a unique opportunity for students to mix with graduates from other disciplines. It also represents cost savings realized by sharing the development of this series of modules. Director of Judge Business School Arnoud De Meyer amplifies: "*. . . They pursue a master's program in a technological area but in the first two terms—so in Fall and Winter—they get several courses in management. These are rather short courses of eight hours in economics, finance, and commercialization of innovation and so on. So we bring people together from six different areas which means it's a relatively big group working and studying together. Those courses are aimed at people who want to work as a Technology Manager. In general, people who follow this program have a technological background and they don't want to escape technology. They don't regret being an engineer. They just want to understand the management aspects better. Especially the discussions between the six different areas are very interesting . . .*"

The experience gained by this MoTI program seems to be paying off for the students. In 2 of the past 3 years, students from these programs have won the Cambridge University Entrepreneurs competition and have gone on to launch their own companies commercially. By the end of the 2005/2006 academic year, 381 students had worked on team projects with over 60 companies and public sector organizations, ranging from BT to tiny start-ups.

## IMPLICATIONS AND CONCLUSIONS FOR TECHNOLOGY MANAGEMENT EDUCATION

Two trends can be drawn from Figure 1. First, we clearly observe within each quadrant a trend. Within quadrant 1, providing generic skills and individual objectives, there is a trend toward using this kind of education both to retain and recruit people. Finmeccanica is a rather extreme example of this, where a master's in international business engineering is organized in-house to attract potential candidates. The enormous success in number of applications for this program indicates that in sectors where the labor market is constrained, the selection of good candidates happens before the MBA rather than afterward. Here business schools face the challenge of preventing their best professors teaching on an individual basis in these programs. Although business schools seem to be best suited to provide education in generic skills, it is remarkable that corporations are successfully moving into this area.

Within quadrant 2, we observe an increasing trend toward specialized on-the-job training provided by a variety of consultants. Universities and higher education institutes seem to be less suited for this, as the transfer of specific skills tends to include the transfer of tacit knowledge through providing on the job training (Dawes, Bennett, Cunningham, & Cunningham, 1996). Although recent research by Clinebell and Clinebell (2008) suggests that the use of executive professors in business schools might increase the possibility of transferring tacit knowledge, as of now, this seems to be only an emerging trend of which the results are unclear. So far, specialist consultants tend to dominate this quadrant. CREAX is an excellent example of the degree of professionalism and depth that these consultants can offer companies. In addition to providing specific skills, they can also offer insights gained through working across different industry sectors and cultures (Skogstad, Currano, & Leifer, 2008). CREAX does not only use the TRIZ methodology, it also further developed and updated this methodology using 1.5 million Euro seed capital that was invested in the company. In doing so, they have become the expert in specific on-the-job training, thereby outcompeting business schools and universities in that segment. This is congruent with other segments such as supply-chain management and operations management, where dedicated consultants have raised money on the stock market to fine tune the six sigma methodology. Collaboration with business schools in these areas is seen to be limited to dedicated consultants who give guest presentations during executive programs to gain participants for these programs.

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Within quadrant 3, providing more specific skills and company-focused objectives, there is a clear

trend toward internal boot camp-type programs where success is measured by financial targets, such as new ventures created. Moreover, the sponsor is not the HR department but the R&D department or the innovation board, which consequently sets the objectives to be consistent with those of their own department. The teaching style also changes from being business case-oriented toward a mentor-led approach. Artificial, exemplary cases from different industries are less important than project coaching with clear target results. The barriers for business schools to deliver these kind of programs appears high, as their faculty is expected to have in-depth industry knowledge and be able to give pointed feedback as opposed to teaching purely conceptual models. It is a clear example of where executive professors with a rich business experience can collaborate with and complement the academically trained professors.

Finally, within quadrant 4, focusing upon providing generic skills and company specific objectives, there is a clear trend toward embedding generic skills into technology-specific programs, thereby emphasizing industry-specific needs. Judge Business School's connection with its faculty programs enables an open boot camp-type of education, which seems to be its major source of entrepreneurial activity. The integration of the business school with the scientific and engineering faculties is path breaking and, again, poses significant challenges to other business schools that aim to excel in technology management and entrepreneurial skill development. Most business schools are not closely connected to the faculties of their universities, and some are independent from the university as is the case for Europe's leading business schools, such as INSEAD. This trend offers opportunities for embedded business schools and provides significant challenges for those that are not embedded.

Across the quadrants, there seems to be a trend from the left to the right side of Figure 1. We clearly see a trend toward the development of boot camps and other programs that offer a clear result beyond the personal development of the individual trainee. This means that the internal customer in the company is the R&D department rather than the traditional HR function. The success of boot camps is not measured against individual achievements, although these are undoubtedly one outcome. Instead, the overall commercial achievements of the program are important. Even in open programs for example the Judge Business School, concrete objectives, such as the creation of new ventures appear significant.

In addition to the overall trends and their implications, we observed the following limiters and enablers for organizations concerned with providing technology management education research.

### Coaching or Mentoring as an Educational Style in Addition to Classroom Teaching and/or Case Study Teaching

Within boot camps, respondents argued that technologists needed to see the relevance of entrepreneurial skills to their own industry sector. A common pedagogical method to achieve this objective was to encourage technologists to develop new venture ideas within their industry using proprietary technologies. Central to the success of this approach was the use of coaching or mentoring to guide teams through the process:

> *" . . . We tried to coach during the boot camp. Not just before, but also during the boot camp. We tried coaching on a marketing level and an Alcatel coach who tries to provide the network inside the company to solve some problems . . ."*
> —Boudewijn De la Fortry, Alcatel-Lucent

Business Schools were seen to be similarly lacking in a critical mass of faculty to develop entrepreneurial skills within boot camps. This was illustrated by Biotechnology Yes who experimented with practitioners rather than business school faculty to meet their needs. It seems that business schools were seen to be lacking in terms of the domain-specific knowledge required to gain credibility with technologists:

> *" . . . and I know I am being critical of academics but I think to understand some of the issues you really need people who have done it and naturally held that innate knowledge from actually doing it. I mean understanding things like the commercialization process and licensing deals, how these operate and what's involved . . ."*
> —John Peberdy, Biotechnology YES

Similarly, the Alcatel-Lucent boot camp and the IBBT boot camp made use of a mix of practitioners and academics to deliver the mentoring considered critical to successfully organize these programs. In each case, the boot camps were a close collaboration between academics from leading business schools, who were able to provide the academic and theoretical methodology, and practitioners who could provide experience and industry-specific knowledge. This introduction of practitioner-oriented professors has more recently been

adopted by business schools that make use of "executive professors" to teach in their programs (Clinebell & Clinebell, 2008). Here the challenge for business schools is how to include these professors in the more traditionally structured MBA programs. By contrast, their integration as mentors in close cooperation with the professors seems to be more straightforward.

> *" . . . Some mentors have a business development background, again to reinforce intellectual property, to reinforce understanding financial plans, managing finance, understanding licensing deals and all those sort of issues which are quite complicated really, to a student who has no knowledge whatsoever. They all say their learning curve is phenomenal . . ."*
> —John Peberdy, Biotechnology YES

Researchers attending such programs were able to relate to the entrepreneurs, as they had to make the transition from researcher to entrepreneur. Moreover, the providers of business development skills such as finance and marketing were also drawn from industry. They had started their careers as researchers, and consequently, gained similar credibility and impact with the attending researchers:

> *" . . . knowing about commercialization opened their eyes. Widening their career opportunity, I admit when I started this way almost 20 years back, I was quite surprised to find that the VCs may have a PhD in microbiology and people working for the big accountancy firms have a science background. So it is meeting those sorts of people I think that gave the students inspiration."*
> —John Peberdy, Biotechnology YES

Without exception, each organization interviewed argued for the ever-increasing need for entrepreneurial skills among technologists. They also agreed that the methods to deliver these skills are different from those utilized in the past and that the expertise required to do so was scarce (De Graff & Kolmos, 2003). It appears that boot camp-type initiatives can be effective ways to provide opportunity identification skills. However, these need to be built on with more formal, yet relevant, classroom methods to deliver business development skills in finance, marketing, and innovation commercialization. All organizations observed were moving, but the direction was subtly different. It appears that selected corporations are more focused toward sustainability through new venture creation. Other corporations see sustainability as more creatively leveraging current and new technologies within their existing value chain. Yet a new consensus is emerging around the concept of technology entrepreneurship. Here entrepreneurial skills are employed within the context of business model or organizational innovation. Selected higher education institutes and network organizations are beginning to cater for this nascent need and are finding that the demand is growing but that the expectations are unclear. This remains a challenge for training providers and corporations alike (Skogstad et al., 2008).

### Emphasis on Training Embedded in the Business-Specific Context or Technological Environment of the Company

Our interviews suggest that whereas open MBA programs were in demand in the nineties and at the beginning of the 21st century, today's companies require very specific training, either embedded within company-specific projects (e.g., creativity and social skills) or within the technology-specific context in which the company operates. This demand stretches the knowledge of academics at business schools that do not tend to have the in-depth knowledge of a training consultant or the technological expertise, both of which are relevant to technology-based companies. Armstrong (2005), for instance, argues that most business schools tend to form students who can talk about practice rather than people who are competent practitioners. He refers to theoretical arguments that suggest that most learning occurs on the job as tacit knowledge—usually a product of learning of experience in real-world settings—and it is exactly this kind of knowledge that is the most valuable.

These developments in technology management education pose further challenges to the relevance of business schools, both generally (Pfeffer & Fong, 2002, 2004) and in Europe (Starkey, Hatchuel, & Tempest, 2004), and are exacerbated by the current financial crisis. The development of more technology-specific management education, eventually with an entrepreneurial component, suggests an opportunity for business schools to become the new kind of knowledge space envisaged by Starkey et al. (2004), where different stakeholders and disciplines interact and learn from each other. Yet, this development raises important challenges for business schools that are free-standing or not connected to science and engineering schools. Increasingly, business schools may need to be linked to technology schools either by being lo-

cated within them or through the development of strong links with *boundary spanners*, individuals with experience across domains (Singh 1993).

For instance Cambridge has transcended the traditional school structure with its cross-faculty master's programs and also circumvented the recruitment paradigm by employing faculty with industry knowledge rather than research expertise per se. Similarly Biotechnology YES, although managed by Nottingham University Business School and the BBSRC (Biotechnology and Biological Sciences Research Council), has leveraged training expertise from the biotechnology industry. Business school faculty provide pedagogical guidance and networking support, but most classroom delivery and coaching is from outside. This has only been possible due to the quasi autonomous structure of the organization, which owes its longevity due to the support of the industry it services and the government and charitable support it subsequently leverages. This unique value proposition has survived due to the focus upon the biotech industry, where open innovation is supported by a corporate need and a strong appropriability regime. However, it takes only a little imagination for a similar initiative to be developed within the ICT or nanotechnology sectors (Cambridge has already started to move in this direction):

> *" . . . The main advantage of a business school who's embedded in a technology university—and you must know that the core of my strategy is to be really at the heart of Cambridge University—is that we approach problems from a multidisciplinary perspective, e.g. issues like global warming. The fact that we are well integrated is extremely interesting because it allows us to address issues in a way that would be very difficult otherwise. For 'Health Management' for instance we work together with local hospitals. It's more difficult with a stand alone business school, because it takes a lot more time to integrate different views . . ."*
> —Arnoud De Meyer, Dean, Judge Business School at Cambridge University

### From Team Learning in Open-MBA Programs Toward Open Innovation-Oriented Boot Camps

Our study suggests that the increasing demand for technology entrepreneurship may provide an opportunity for business schools. This is due to the nature of the dynamics of supply and demand. First it appears that private sector organizations, such as corporations or training consultants, are constrained in meeting the increasing demand for entrepreneurial skills for technologists. Corporations appear restricted by their organizational structure and current capabilities. Consultants appear constrained by historical demands for classroom-based delivery in traditional "MBA-type" management skills.

Boot camp initiatives, such as the one presented by Alcatel-Lucent are an ideal type of program to stimulate the kind of entrepreneurial skills that engineers seem to lack. Currently, boot camps are organized by consultants in close collaboration with individual professors, who provide the methodological background to test the assumptions behind a business case. In addition venture capitalists give feedback on the presentations in return for a first view of potential investment opportunities.

However, although these boot camps appear successful, their success relies on the availability of creative ideas within the organization, a typically closed innovation mode. The innovation management literature has argued that this kind of innovation does not deliver the optimum results. An increasing number of scholars have, therefore, analyzed the possible benefits of open-innovation programs (Cassiman & Veugelers, 2002; Gann, 2005; Helfat & Quinn, 2006). Their studies converge on the idea that openness has its advantages, especially in the early stages of the innovation process when new opportunities need to be recognized from a technological and market perspective (Laursen & Salter, 2006). This premise is supported by the case of the Alcatel-Lucent type of boot camp. Here it appears that cross-industry teams working together to generate new ideas are increasingly in demand:

> *" . . . I think it will be easier for Alcatel-Lucent to start up open innovation activities in the sense that we expect that business school to organize these activities for various companies. The interfacing, the networking, the coming together, the coming together with people from other companies might be a very interesting opportunity to go in the direction of open innovation . . ."*
> —Boudewijn De la Fortry, Alcatel-Lucent

## CHALLENGES FOR BUSINESS SCHOOLS

An emerging challenge of the move to more entrepreneurially oriented programs such as boot camps is the need for faculty with the expertise to provide this material. Corporations that may traditionally have provided in-house courses now see

increased reliance on outside consultants. Notwithstanding the major increase in entrepreneurship programs in business schools, traditional business school academics likely do not possess the appropriate skills (Wright, Piva, Mosey, & Lockett, 2008). Specifically, traditional business school faculty typically do not possess the necessary context-specific business creation skills that are increasingly demanded as a central part of technology management education. A solution might be to include more executive professors in the business school as suggested by Clinebell and Clinebell (2008). However, this also introduces a number of management challenges for the business school. General business schools tend to concentrate on the traditional generic skill development to be found in open MBAs and repackaged for companies in short-term executive education programs. Entrepreneurial marketing, discovery-based planning, entrepreneurial finance and business planning in general do not show up on their core curricula.

Even more worrying for the general business schools is the lack of the specific technology skills and industry knowledge demanded by an increasing number of companies. This is not something easily solved by introducing executive professors with a business background. We observe that it is no longer sufficient to provide a general MBA education in isolation. More is needed. Business education needs to be embedded in the specificities of the technology and industry, which means that the academics who teach also need to have very specific technology or industry knowledge in order to be successful. However, in general business schools, it is very unusual for professors to have a technology background or have in-depth technology knowledge. This offers opportunities to business schools, such as Judge Business School associated with the University of Cambridge, which is a very highly regarded technical university. In line with this, we see that the business school does not only consider its traditional FT MBA program as a flagship program, as most business schools tend to do. It also puts its MSc organized in close collaboration with the engineering faculties and technical faculties as a series of core flagship programs, delivering the most entrepreneurship award winners among graduate students. Business schools need to decide between being autonomous from their universities, which gives them the flexibility to price and grade their own MBA programs, and being embedded in a university, which gives them the flexibility to interact with technology and engineering schools to capture the opportunities inherent in the development of the knowledge-based economy.

Finally, master's programs within engineering and science faculties that are embedded in the technical courses of the faculties themselves seem to have become increasingly important in technology management and, more broadly, entrepreneurship education. Business schools that have strived to become independent institutes, usually to avoid the rigidity of a typical university decision-making process, will have to reconsider their role in educating professors and researchers and training postgraduate students who might now choose an industry or technology-specific master's education instead of a traditional MBA. The flagship of many leading business schools, the MBA, appears to be an offer that is rapidly moving away from the needs of this market.



## REFERENCES


Armstrong, S. 2005. Postgraduate management education in the UK: Lessons from or lessons for the US model? ***Academy of Learning and Education,*** 4(2): 229–234.

Cassiman, B., & Veugelers, R. 2002. Spillovers and R&D cooperation: Some empirical evidence for Belgium. ***American Economic Review,*** 92(4): 1169–1184.

Chesbrough, H. 2003. ***Open innovation. A new imperative for managing innovation.*** Harvard Business School Press.

Clinebell, S. K., & Clinebell, J. M. 2008. The tension in business education between academic rigor and real-world relevance: The role of executive professors. ***Academy of Learning and Education,*** 7(1): 99–107.

Clucas, E. 2004. ***The structure of training courses for knowledge transfer practitioners.*** Discussion paper. Institute for Social and Economic Research, University of Essex, U.K.

Dawes, G., Bennett, B., Cunningham, C., & Cunningham, I. 1996. ***Learning and development in organisations.*** St. Albans: Strategic Developments.

Doz, Y. 2007. ***The globalisation of R&D.*** OECD TIP Working Group.

De Graaf, E., & Kolmos, A. 2003. Characteristics of problem based learning. ***International Journal of Engineering Education,*** 19(5): 657–662.

Department for Innovation, Universities & Skills. 2009. The 2008 R&D Scoreboard. ***Department for Innovation, Universities & Skills*** (DIUS) in collaboration with the ***Department for Business, Enterprise & Regulatory Reform*** (BERR), London, UK. URN 145-08-IN/B.

Eisenhardt, K. M. 1989. Building theories from case study research. ***Academy of Management Review,*** 14(4): 532–550.

Friga, P. N., Bettis, R. A., & Sullivan, R. S. 2003. Changes in graduate management education and new business school strategies for the 21st century. ***Academy of Management Learning and Education,*** 2(3): 233–249.

Gann, D. M. 2005. Open Innovation: The new imperative for creating and profiting from technology. ***Research Policy,*** 34(1): 122–123.

Helfat, C. E., & Quinn, J. B. 2006. Open innovation. The new

imperative for creating and profiting from technology. ***Academy of Management Perspectives,*** 20(1): 86–88.

Laursen, K., & Salter, A. 2006. Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. ***Strategic Management Journal,*** 27(2): 131–150.

Mallick, D., & Chaudhury, A. 2000. Technology management education in MBA programs: A comparative study of knowledge and skill requirements. ***Journal of Engineering and Technology Management,*** 17: 153–173.

Mosey, S., Hassall-Jones, T., Ucbasaran, D., & Lockett, A. 2005. Investigation of Biotechnology YES past participants career aspirations and destinations (1997–2004), ***BBSRC Report,*** UK.

Nambisan, S., Willemon, D. 2003. A global study of graduate management of technology programmes. ***Technovation,*** 23: 949–962.

O'Connor, G. 2006. Organizing for radical innovation: An exploratory study of the structural aspects of RI management systems in large established firms. ***Journal of Product Innovation Management,*** 23: 475–497.

Pettigrew, A. 1988. Longitudinal field research on change: Theory and practice. Paper presented at the National Science Foundation Conference on Longitudinal Research Methods in Organizations, Austin, TX.

Pfeffer, J., & Fong, C.T. 2002. The end of business schools? Less success than meets the eye. ***Academy of Management Learning and Education,*** 1(1): 78–95.

Pfeffer, J., & Fong, C.T. 2004. The business school "business": Some lessons from the U.S. experience. ***Journal of Management Studies,*** 41(8): 1501–1520.

Singh, J. 1993. Boundary role ambiguity: Facets, determinants, and impacts. ***Journal of Marketing***, 57: 11–31.

Skogstad, P. L., Currano, R. M., & Leifer, L. 2008. An experiment in design pedagogy: Transfer across cultures and disciplines. ***International Journal of Engineering Education,*** 24(2): 367–376.

Starkey, K., Hatchuel, A., & Tempest, S. 2004. Rethinking the business school. ***Journal of Management Studies,*** 41(8): 1521–1532.

Vanaelst, I., Clarysse, B., Wright, M., Lockett, A., Moray, N., & S'Jegers, R. 2006. Entrepreneurial team development in academic spin-outs: An examination of team heterogeneity. ***Entrepreneurship Theory and Practice,*** 30: 249–272.

Wheelwright & Clark 1991. ***Revolutionizing new product development.*** Harvard Business School Press.

Wright, M., Piva, E., Mosey, S., & Lockett, A. 2008. ***Academic entrepreneurship and business schools.*** Oslo: The Changing Role of Universities in Innovation Systems Conference.

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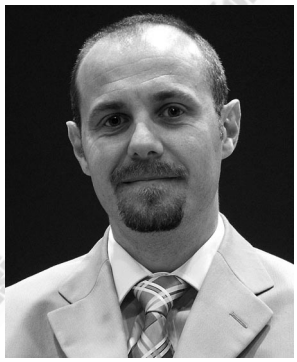

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