6 Higher Education Spin-offs

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> *"The higher education so much needed today is not given in the school, is not to be bought in the market place, but it has to be wrought out in each one of us for himself..."*
>
> WILLIAM OSLER (1849–1919)

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Introduction

The last twenty years has witnessed a growing enthusiasm for entrepreneurs as catalysts for economic development and change, with increasing attention paid to the role of small technology-based companies as contributors to wealth creation, technological innovation and employment in high technology industries (Autio, 1997; Jones-Evans and Klofsten, 1997; Jones-Evans and Westhead, 1996; Shane, 2004). As a result, there has been considerable academic and policy interest in examining the process of entrepreneurship within such organisations, commonly known as "technical entrepreneurship".

Early studies into technical entrepreneurship identified the research-based academic environment – universities, non-profit research institutes and government research centres – as the predominant background from which technical entrepreneurs emerged (Schrage, 1965; Roberts and Wainer, 1966; Wainer and Rubin, 1969; Cooper, 1971). These individuals would form new businesses which have commonly become known as spin-offs (Carayannis et al. 1998).

However, spin-offs from universities are not a recent phenomenon (Nicolaou and Birley, 2003a&b). Historically, higher education spin-off enterprises can be traced to the 19th century when companies were set-up by academic researchers. Examples of these are the German chemist Heinrich Caro who contributed to the setting up of BASF, and two other academics taught by his master, von Liebig, who helped set-up Hoescht. In the nineteenth and twentieth centuries, many technical academics set up enterprises which have become large multinationals (Mustar, 1995; Mustar et al, 2006) including Werner von Siemens, Gerard Philips and Conrad Schlumberger.

The growth of Silicon Valley can be partly attributed to researchers who left academic and industrial laboratories. For example, William Schockley who was head of the research team at Bell Telephone set up a small company in Palo Alto in 1952 (Zagnoli, 1990), whilst Professor Frederick Terman convinced two of his students, Hewlett and Packard, to set up a new enterprise. In order to start producing an audio-oscillator designed by Hewlett, when writing his masters thesis, Terman lent them $538 which provided them their first employment and also a loan from a bank in Palo Alto.

Academic spinoffs have played a major role in the development of specific industries (Müller, 2008; Druilhe and Garnsey, 2004). The growth of the biotechnology industry is linked directly to the development of small enterprises set up by academic researchers who transferred basic research activities into innovations (Dodgson, 1993). During the 1970s, the biotechnology industry influenced universities to give more attention to control over intellectual property by their researchers and professors (Kennedy, 1986). Financing institutions, especially venture capital companies, became interested in academic research, and this led to a shift in the boundaries between non-commercial basic research and commercial research (Mansfield, 1991, 1995). As suggested by Rosenberg and Nelson (1994), commercialisation was possible, since funding in the biomedical field had created a reservoir of knowledge from which the biotechnology industry developed new products.

During the 1970s, participation by universities in commercialising biotechnology research not only led to new knowledge but also academics starting their own enterprises by maintaining or leaving their academic tenure. As a consequence, spin-off enterprises play a central role in the growth of new industrial sectors and the innovation process.

Academic entrepreneurs

The academics who form spin-off businesses have commonly become known as academic entrepreneurs (Knight, 1988; Klofsten *et al*, 1988; Samson and Gurdon, 1993; Jones-Evans, 1995; Meyer, 2003). They tend to be scientists whose primary occupation, prior to playing a role in the spin-off, and possibly concurrent with that process, was that of clinician, researcher or teacher, affiliated with a university, research institution and/or hospital. They do not include the industrial scientist who, during his/her industrial affiliation, had usually been exposed to corporate and managerial cultures.

This type of technical entrepreneur tend to have little exposure to either the business world or entrepreneurship. However, as Jones-Evans (1995) has recognised that, with the changing nature of academic careers, such individuals could, despite spending the majority of their career in an academic research position, have minor experience of a commercial organisational background, usually within a research department.

Previous research has recognised that the vast majority of the owner-managers of academic spin-offs have considerable technological competence (Mueller, 2006; Druilhe and Garnsey, 2004), from which the product or process which the business bases its competitive advantage is derived. However, there has also been considerable discussion regarding the often highly academic nature of the technological skill and creativity within this type of entrepreneur, leading to some scepticism regarding their ability to manage a commercial enterprise.

Many of the early studies found that technical entrepreneurs rarely possessed management expertise comparable to their technical skills (Cooper, 1971; Schrage, 1965) which was generally attributed to a lack of a formal business education, coupled with work experience which tended to be in the technical area.

More recent studies, such as Westhead and Storey (1994), have also found that the owner-managers of young technology-based firms had limited experience of specific functions such as marketing, finance and personnel. This orthodox view of technical entrepreneurs – having low management experience and high technological expertise – was originally associated with those emerging from a research-based academic environment (Schrage, 1965; Roberts and Wainer, 1966; Wainer and Rubin, 1969).

Studies of academic-based technical entrepreneurs frequently demonstrated that they had very little exposure to management skills and had very little concept of business (Klofsten *et al,* 1988; Samsom and Gurdon, 1990). Detailed research by Jones-Evans (1996a; 1996b) has supported this position, demonstrating that academic entrepreneurs had very little experience of management functions such as marketing or finance, even in the case of those with previous commercial positions.

Whilst academic entrepreneurs have little experience of formal management functions, many will gain 'soft' management skills such as team management and interpersonal skills. This is because academic entrepreneurs have had considerable experience of managing research and development projects, in many cases evolving from a purely technical role within academic research projects, to responsibility for other individuals working together as a team. The inter-personal skills developed during the supervision of small research teams may, in many cases, be directly transferable into the management of a small research-based new venture.

Whilst the lack of management skills and experience may not be a problem at start-up, this may change as the new venture develops. In the extreme case, this may lead to problems if the company grows to the stage where the management responsibilities increase to the point where strong leadership and delegation are needed, but the academic entrepreneurs no longer have sufficient management skills to run the business (Firnstahl, 1986; Greiner, 1972).

These problems could include the delegation of technical tasks to other employees (despite having the capability to do them quicker and better than the employee); shifting from the role of specialist to generalist; watching others achieving a technical competence within the organisation superior to one's own; and learning the new job of general manager (including the tasks of strategic planning, and human resource management).

This may prove very difficult to academic entrepreneurs who possess high technological expertise (Druilhe and Garnsey, 2004). Subsequently, if an entrepreneur with little management experience continues to lead the venture beyond the start-up phase, then the organisational performance of the company will suffer (Flamholtz, 1986). For example, research carried out by Rubenson and Gupta (1990) indicated that founders with scientific or engineering backgrounds remain in control of the companies they founded for shorter periods than do founders whose previous experience was in business.

As well as management skills, the high technological expertise of the individual academic entrepreneur may also lead to considerable problems as the business develops. The dependence of the business on academic entrepreneurs for its technological competence (on which the competitive advantage of the business is often based) can lead to significant problems as the small technology-based firm develops.

Whilst the academic entrepreneur can continue to be involved in product development whilst retaining control as managing director (Maidique, 1980), considerable difficulties may arise in maintaining technological advantage, as often the technical entrepreneur may be the only person within the organisation with the necessary skills and experience to make the relevant technical decisions. In many cases, delegation may be difficult for individuals possessing a high degree of technical expertise, not only because they fear reduced technical quality, but because they have a genuine desire to continue to be involved on the technology side of the business.

In a study of the transition from scientists to managers, Peck (1986) suggested that, for the business to succeed, the entrepreneur's relationship with the product must change from direct to indirect involvement, with a sharp departure from the "hands-on" orientation of the typical scientist. Such a change in roles may be difficult for entrepreneurs whose backgrounds are predominantly technological, despite indications that the future success of the small technology-based firm may rely on the ability of the entrepreneur to tie together the two strands of technical and management experience and expertise (Klofsten and Jones-Evan, 1996; Utterback *et al* 1988; Oakey, 1984).

Academic spin-offs

Academic spin-offs (Müller, 2008; Druilhe and Garnsey, 2004) have their roots in university research through at least one of the founders working in an academic research establishment before inception of a firm (Jones-Evans et al., 1998). These enterprises are established to commercialise a product or service developed in a university laboratory. An academic spin-off usually occurs when a new enterprise is formed by university scientists seeking to develop further the commercial possibilities of their research (Garvin, 1983).

In one of the first studies of small technology-based businesses, Schrage (1965) saw spin-offs as the establishment of a new venture by scientists emerging from their organisation, "Three physicists leave their position with a large corporation or leading university to establish their own company. They pool their funds, secure a research contract from the government, obtain a loan from a friendly bank, and a so-called R&D company is born.". Subsequent studies (Cooper, 1970, 1971; Roberts and Wainer, 1966, 1968; Litvak and Maule, 1971, 1972; Braden, 1977) related 'technical entrepreneurship' directly to founding ventures through spin-offs from university departments (Roberts, 1968; Lamont, 1972; Doutriaux, 1987; Samsom and Gurdon, 1990) or larger organisations (Cooper, 1971, Draheim, 1972).

However, defining academic spin-offs can be difficult. Most studies have related the development of academic spin-offs to two main criteria. First of all, the business must be related to technology developed at the university and secondly, the founder must be a former employee or student of the university who has worked on developing that technology. For example, Cooper (1971) defined high technology spin-off firms as those that have their roots in a research organisation i.e. at least one of the founders worked in a research establishment before starting the firm and was established to commercialise a product developed in a research organisation.

Olofsson and Wahlbin (1984) defined a university technology start-up firm as having at least one founder employed at the university when the company was formed and a business idea which is aimed at commercialising knowledge and technology developed at the university. Other Swedish researchers (McQueen, 1990; McQueen and Wallmark 1988) have referred to a spin-off firm as based on a product or service resulting from university research, and founded (or co-founded) by a person (or persons) from a university research group where the founder moved directly from the university to the spin-off firm (McQueen and Wallmark, 1985;1991). This definition has been adopted for this chapter.

However, this can leave a number of successful companies unaccounted for. For example, does the definition include academics who wish to form a partnership with non academics? For example, Van Tilburg (1990), in a study of spin-offs from the University of Twente, defined a university spin-off as university staff, students and alumni that start their own business, using the university know-how, as well as including individuals from outside the university, who start their own business with assistance and know-how from the University of Twente.

One must also consider the actual involvement of the academic in the business. In a study of academic entrepreneurship in Canadian universities, Doutriaux and Peterman (1982), indicated that all the full professors who started their own business were still employed by the university on either a full-time or part-time basis. Brown (1984) in a study of spin-offs from the University of Utah, showed that the faculty members' participation in a company varied from resigning an academic position and devoting full-time to the company, to following a passive role such as serving as a consultant and/or director of the company. Between these faculty members arranged part-time university appointments and spent the balance of their time with the company.

A wider definitional approach by Giannisis et al. (1991) considers three types of academic spin-off models which are based on the origins of the business itself. The first – the entrepreneurial model – is a newly start-up established as a result of a combination of the expertise and independent motivation that the entrepreneurial faculty member has brought to the commercialisation process. The second type – the traditional model – is where the commercialisation of a university-based technology is pursued by an outside business entity. Finally – the institutional model – is where the commercialisation process is managed by the university through an organisation such as the Industrial Liaison Office (ILO) or a wholly owned not-for-profit subsidiary of the university.

Therefore, whilst a definition may seem easy, in practice there are difficulties in formulating a common definition of an academic spin-off.

Economic importance of academic spin-offs

As we have demonstrated, various studies have recognised that a significant number of new technology-based businesses in both the USA (O'Shea et al, 2005) and Western Europe had been established by scientists emerging from different types of academic-based organisations, such as non-profit research institutes, government research centres and universities. However, despite the increasing interest in the development of spin-offs from academic research, there are only a few studies which have attempted to consider the economic impact of such organisations.

In the USA, a variety of studies have demonstrated how various regions have developed university spin-offs (Saxenian, 1994; Roberts, 1991) although these have tended to concentrate on Route 128 in Boston and Silicon Valley in California as the main examples for spin-off developments from universities such as MIT and Stanford. However, as Malecki (1991) points out, the presence of an outstanding university within a region in the USA does not necessarily lead to the development of an entrepreneurial climate in which high technology spin-offs are created. For example, universities such as Harvard, Columbia, Chicago, Berkeley and Caltech do not play a strong incubator role for such businesses.

In Europe, there are only a few studies which have examined this phenomenon, and only in limited regional settings. Linkoping – one of the fastest growing regions of Sweden – contains a strong high technology industrial environment, which includes the presence of Saab's Aircraft Division, Ericsson Radio and the Swedish Defence Research Establishment, and is at the forefront in the creation and development of new technology-based firms in Sweden. Academics and students from Linkoping University have played a leading role in this. To date, over 450 small technology-based spin-offs have emerged directly from academic research activities at the institution (Klofsten and Jones-Evans, 1996), with a high number of the others using or developing university research findings as the basis for their products or services.

A French study by Mustar (1988, 1995) reported that, from the early 1980s, several hundred French researchers developed high technology enterprises (biotechnology, artificial intelligence and robotics). In an analysis of more than two hundred enterprises, founded by researchers, about one third of all new high technology enterprises were created by public sector researchers. More importantly, academic spin-off enterprises generated three times more employment than other industry and service sectors over the same period. In addition, the failure rate for this type of enterprise was about twenty five percent in the first five years, less than the fifty percent average in the rest of French services and industry.

Italian work on academic spin-off enterprises has been undertaken by Piccaluga (1991; 1992), Amendola (1992) and Bellini and Zolla (1997). The studies found spin-off enterprises to be relatively scarce in Italy although there was growing involvement of universities in entrepreneurial development activities. Amendola (1992) reported that the factor that most influenced the formation of spin-off companies was the quality and status of the academic researcher. According to Chiesa and Piccaluga (1998) it appears that Italian academic status contributes to influencing researchers to choose "soft" entrepreneurial solutions, instead of abandonment of university research centres – a more popular option in other academic systems, especially in America.

In the UK, the most famous study of academic spin-off activity is that of the 'Cambridge Phenomenon', which found that nearly all of the 350 high technology businesses in the area had ultimately been generated from Cambridge University, especially the departments of physics, engineering and computing (Segal, 1986; Segal Quince, 1995, 2000). Similar clusters have been identified at the universities of Heriot Watt and Aston, although these have not been developed to the same extent, and the research on successful spin-outs is quite sparse.

Despite this, the increased recognition of the potential of spin-off businesses to the economy, both in terms of diffusion of university knowledge and high skill employment opportunities, led to a positive policy decision by the UK Government, in 1999, to create more start-ups on campuses (Di Gregorio and Shane, 2003) through the establishment of a £50M University Challenge competition. The programme aimed at establishing venture (seed) capital funds and management support for potential start-ups in the winning universities. These policy aims of the UK Government have been taken on-board by the Higher Education Funding Council for England (HEFCE) and also by the Higher Education Funding Council for Wales (HEFCW) and the Scottish Funding Council.

In Wales, the articulation of policy has been through initiatives such as TOPSPIN and the Wales Spinout programme, although it needs to be recognised that since Wales has a low proportion of companies per head of the population (Wales has 7.51 firms with more than five employees per 1,000 population while England has a figure of 9.60 per 1,000 population) the emphasis on spin-off activity will need to relate to this difference. In Scotland, as enunciated in a report by Scottish Enterprise (1996) and a study by Downes and Eadie (1997; 1998), the Scottish case is different again. Following analysis of twenty five companies, the report maintained that universities were involved in all cases. This shows that the recognition of the importance of spin-offs took place at an earlier time in Scotland than in many other parts of the UK.

In order to encourage more university-based staff with innovative ideas and "know-how" to start their own businesses, the UK Government also provided £25M for eight new enterprise centres in universities (particularly in science and engineering areas). This included a reach-out fund of £20M a year to reward universities for strategies and activities that enhanced interaction with business and promoted technology transfer.

Whether these approaches are the right way to develop entrepreneurial businesses is still open to debate. The role of universities in creating these milieux of innovative firms (Elco van Burg et al, 2008) within different regions has led to a proactive approach by universities, usually supported by regional or national government, in adopting direct entrepreneurial roles. However, these can range from the establishment of university-owned holding companies to the promotion of fledgling academic entrepreneurs (Gibson and Smilor, 1991) to the development of specific centres of research and training which promote and assist the process of spin-off of academic research into a network of industrial firms and business ventures (Klofsten and Jones-Evans, 1996).

Although there is no recommended model for the creation of spin-off businesses on UK university campuses, there are individual university models and this has resulted in the establishment of a variety of commercial infrastructures on campuses, often alongside the development of incubators and science/technology parks.

In the Netherlands, the Twente regional economy was almost destroyed in the 1960s with the demise of its textile industry, and the loss of fifty thousand jobs. The Technical University, established about this time, had by the late 1970s implemented a spin-off policy for graduates and others to form their own technology-based companies in the area. The scheme, formalised as the TOP programme in 1983, has since then supported the creation of more than one thousand five hundred quality jobs, developing a dynamic young firm community forming the centre of self-sustaining regional regeneration. Following this, the Twente team guided the UNISPIN Innovation Programme's project, for other EU regions to develop similar schemes (Innovation and Technology Transfer, 1997).

Brett et al. (1991) and Roberts (1991) describe the American case which appears to be more dynamic and structured than in Europe, due to the different institutional nature of universities in America. Here there are several environments in which spin-off enterprises can be set up (including incubators and science parks). Universities are also good at commercialising research. For example, the Bank of Boston reported that MIT spin-off enterprises contributed around ten billion dollars a year and three hundred thousand jobs to the Massachusetts economy.

Conclusions

Perhaps one of the real barriers to the development of university spin-off businesses is the culture within the university sector towards entrepreneurship. Whilst the UK government's programmes are aimed at breaking this down and making involvement with industry easier, the traditional academic culture does not encourage the development of links with small-scale industry.

As Louis et al (1989) suggest, universities are not traditionally viewed as leaders in entrepreneurship. In fact, they suggest that there is often a tendency to distinguish between the search for truth in science – which is considered a legitimate function of the university – and the search for invention – which is considered an inappropriate focus on ideas that have potential commercial or practical applicability via spin-off activity. Indeed, it has been indicated that many academics are concerned that research collaboration with industry is against the central ethics of universities, which should focus on fundamental research and the education of students, and that links with industry not only detract from this but could, in some cases, restrict the free flow of information between academics and institutions (Charles and Howells, 1992).

In addition, another problem may be the role of suitable role models for academics to follow (Stankiewicz, 1986; 1994). Most academics are driven to becoming teachers and scholars and therefore tend to perceive other roles with scepticism and even open hostility. As a result, an academic who aspires to become an entrepreneur finds himself in an environment where he is regarded as an oddity. This is an issue which universities need to seriously address through making the 'third role' – interaction with industry – as important as teaching or research.

Recommended Reading

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