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## Original Article

# Academic entrepreneurship, entrepreneurial universities and biotechnology

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**ABSTRACT** There are various definitions of an entrepreneurial university, yet there is a lack of agreement about its core components. This article defines the five key characteristics of an entrepreneurial university based on examples of successful bio-clusters in the United States and Europe, and suggests an agenda for stakeholders.

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## INTRODUCTION

Global social change, economic volatility, environmental challenges and an evolving international knowledge-based economy require creative, innovative, entrepreneurial solutions. To that end, both developed and developing entrepreneurial economies need to encourage entrepreneurial activity. In part as a result of these efforts, global technology clusters, including bio-clusters, continue to grow. Yet, evidence suggests that a favorable external environment alone is not sufficient for biotech firms' survival and growth;<sup>1</sup> the characteristics of universities and their internal processes are considered pivotal to the trajectory of a local, high-tech economy.

Indeed, the core of every bioscience industry cluster in the United States and United Kingdom consists of notable universities.<sup>2</sup>

Several international governmental and private agencies in developed countries have created roadmaps and outlined strategies and action items to create more entrepreneurial universities.<sup>3</sup> Despite these efforts, however, it is not clear what constitutes an entrepreneurial university. There are various definitions of an entrepreneurial university,<sup>4,5</sup> but a lack of agreement about its core components. Whereas some universities have created a trans-disciplinary culture of entrepreneurship, others have focused on relatively narrow technology-based licensing, spin-out or other technology transfer metrics, or delegated the task to specialized programs in their business or engineering schools.

In this article, we reconcile different definitions of an entrepreneurial university to

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propose five core elements of such an entity: (i) top-down vision, strategy and leadership, (ii) clearly defined entrepreneurship learning objectives that drive the curriculum, (iii) robust internal and external networks, (iv) a culture of innovation, and (v) experiential learning and knowledge transfer opportunities. We focus on the area of biotechnology and draw upon examples of successful bio-clusters in the United States and United Kingdom to argue that institutions of higher learning should embed entrepreneurship education into their programs, infrastructure and processes as a facilitating technology that permeates the entire curriculum.

The structure of the remainder of this article is as follows. The next section defines the concept of academic entrepreneurship and outlines the reasons why universities need to embrace academic entrepreneurship. This is followed by a discussion of the significance of academic entrepreneurship in the area of biotechnology and the economic impact of such activity emanating from bio-clusters. The following section then outlines the core components of our proposed model of an entrepreneurial university. The final section identifies an action plan for moving toward an entrepreneurial university.

## WHAT IS ACADEMIC ENTREPRENEURSHIP?

It is essential to establish an understanding of entrepreneurship before defining academic entrepreneurship. Entrepreneurship has many definitions. For the purpose of this article, entrepreneurship is the process of creating customer-defined value by innovating and exploiting resources beyond our control. This definition incorporates several concepts. First, entrepreneurship is a process, an action-oriented undertaking that requires doing, executing and adjusting to changing conditions. Although planning is an important part of the process, learning by trial and error, early prototyping and taking advantage of a closing window of opportunity is a core concept. There is a definite bias to action.

Entrepreneurs triumph over bureaucrats and managers whose primary purpose is to manage resources and protect the *status quo*. As noted by Clayton Christensen in his best-selling book, 'The Innovator's Dilemma', the failure of large companies is attributed to their failure to 'kill the cash cow', that is, these companies did all the right management things but failed to capitalize on disruptive innovations that were game changers, like laptops, mobile phones and online brokerage firms.

Second, entrepreneurship is a means toward an end: creating value as defined in the mind of the customer. Value is the difference between tangible and intangible benefits versus tangible and intangible costs. Different customers or stakeholders will define value in different ways. To an entrepreneur, value might be defined by the market value of her company, the number of jobs created or the size of a new tax base created in the community. To a commercial customer, value might be defined in terms of product features and benefits, service or customer experience. Economic development authorities might define the value of entrepreneurial activities in terms of jobs created in the community. Academic administrators might measure value by the number of grant dollars generated, new programs or courses offered, or improving educational and skills outcomes in their students. In every instance, value is defined and validated by a customer willing to pay for a product or service.

Third, entrepreneurs identify and exploit resources beyond their control.<sup>6</sup> Bootstrapping, skunk works, garage works or work-arounds are core competencies. They are experts at exploiting protected resources – be it time, equipment, money or talent. Finally, entrepreneurs innovate. They create new products, processes, services and business models to satisfy customers' wants and needs.

Academic entrepreneurship refers to the variety of ways in which academics go beyond the production of potentially useful knowledge.<sup>7</sup> They undertake a range of

initiatives to facilitate the commercialization of that knowledge, or become participants in designing new marketable products and assume a leadership role in ensuring successful commercialization of these products.

Academic entrepreneurship is different from both entrepreneurship education and entrepreneurship training.<sup>8</sup> Entrepreneurship education is usually defined in broad terms as the building of knowledge and skills 'about' or 'for the purpose of' entrepreneurship generally, as part of recognized education programs at primary, secondary or tertiary-level educational institutions; entrepreneurship training is interpreted as the building of knowledge and skills in preparation for starting a business.

Academic entrepreneurship, in contrast, is a feature of universities that do much more than impart entrepreneurship education and training, or excel at technology transfer practice and metrics. Based on the US and European experience, universities may be considered entrepreneurial when they are not afraid to maximize the potential for commercialization of their ideas and create value in society without seeing this as a threat to academic values.<sup>9</sup> They create a culture of innovation on their campuses and attempt to instill an entrepreneurial mindset in every graduate and faculty member by building the structure and processes designed for stimulating innovation and value in the marketplace.

We argue that academic entrepreneurship is of value to universities, to their faculty and students, and to the various other stakeholders that they serve. In particular, there are several reasons why institutions of higher education should embrace entrepreneurship as a core value:

1. Because it helps universities put teeth into their innovation mission.
2. Because it is a way for universities to demonstrate to their stakeholders that they are adding value and creating an impact beyond their walls.

3. Because it expands commercialization revenues and fills the technology transfer pipeline beyond traditional technology-based ideas, inventions and discoveries.
4. Because it creates a competitive advantage in attracting highly talented faculty and students.
5. Because it provides students with the knowledge, skills and abilities they need to succeed, regardless of their career choice or place of employment.
6. Because it meets a market need.
7. Because it fosters creative thinking about how universities should satisfy their multiple missions.

The following section outlines the significance of academic entrepreneurship and the economic impact of such activity in the area of biotechnology.

## ACADEMIC ENTREPRENEURSHIP AND BIOTECHNOLOGY

Biotechnology is defined as 'any technique that uses living organisms, or substances from those organisms, to make or modify a product, to improve plants or animals, or to develop micro-organisms for specific uses'.<sup>10</sup> Academic entrepreneurship is especially significant in the area of biotechnology. This is because biotechnology firms have special features that necessitate their reliance on universities more than other types of high-technology firm. Unlike computer hardware and software firms, for instance, biotechnology firms have specific capital infrastructure requirements. They are also information intensive and require people with formal educational credentials, often from leading graduate programs. A large proportion of innovations, as for instance in the field of medical biotechnology, comes directly from university labs. The universities then enter into licensing agreements with private firms for commercialization, a process that generally requires complex face-to-face interaction between university researchers and staff of these firms.

Several bio-clusters in the United States and United Kingdom cite the central role of universities in their emergence and development. Key among these are Stanford, Purdue and the Massachusetts Institute of Technology (MIT) in the United States, and Cambridge in the United Kingdom that have been particularly successful in nurturing start-ups. Since its inception, Stanford University, for example, has played a key role in the transformation of the Silicon Valley. Because of the university's commitment to the entrepreneurial spirit, the valley became a haven for high-technology companies.<sup>11</sup> The university established a stimulating environment that encouraged the proliferation of new start-up companies, and continues to effect the local economy by spawning new and creative ideas, dreams and ambition.

The most interesting feature of the Massachusetts biotechnology cluster, likewise, is the central role of MIT.<sup>10</sup> Of the 280 biotech firms in Massachusetts 23 per cent are located in Cambridge. One of the key factors underlying the tight clustering of firms in the Boston Metropolitan area is access to university research labs; unlike firms in other regions of the country, Massachusetts-based firms rank proximity to MIT ahead of cost in choosing to set up business in the state.<sup>12</sup>

Bio-tech clusters bring various benefits to both the universities and the economies that surround them. The universities gain rewards from the clusters in the form of research finance, practical experience for students and access to expensive equipment for their technology contributions.<sup>10</sup> The economic impact of entrepreneurial activity emanating from universities in clusters can be measured through several indicators, as for example, the number of companies founded by graduates, the total number of people that these companies employ or the number of patents based on university research. As one of Indiana's largest employers, Purdue University, for instance, contributes US\$2.2

billion to the state's economy annually.<sup>13</sup> The discovery park, an innovative interdisciplinary research complex at the university, employs 3000 people in 157 companies, including 90 technology-based firms. Since the inception of the discovery park, the university has launched 30 companies and generated 40 patents based on university research, created 165 jobs and developed strategic collaborations with more than 25 regional, national and global companies, foundations and research institutions. In the life sciences field, the collaboration of the university with Indiana is expected to bring \$25 million to the state over the next few years to improve the process through which lab discoveries are transformed into new medical treatments and products.

MIT alumni-founded companies have a disproportionate importance to their local economies as they sell to both national and world markets. A recent MIT report shows that MIT graduates have founded an estimated 6900 companies (including manufacturing, software, consulting and biotech firms) creating more than a million jobs worldwide and generating annual sales of approximately \$232 billion.<sup>12</sup> According to a study on the entrepreneurial impact of MIT, which analyzes the economic effect of MIT alumni-founded companies and its entrepreneurial ecosystem, if the active companies founded by MIT graduates formed an independent nation, their revenues would make that nation at least the 17th-largest economy in the world. Globally, a less conservative estimate of their annual world sales would equal \$2 trillion, producing the equivalent of the 11th-largest economy in the world.

In summary, the significant economic impact of these universities provides an important model for other universities interested in helping their students become more effective entrepreneurs. Therefore, based on this discussion, we define the core components of an entrepreneurial university in the following section.

## CORE COMPONENTS OF AN ENTREPRENEURIAL UNIVERSITY

Academic entrepreneurship augurs well for the host institution and for its external environment. But what constitutes an entrepreneurial university? There are several views on what constitutes an entrepreneurial university, yet a lack of agreement about its core components. Thorp and Goldstein<sup>4</sup> suggest that an entrepreneurial university is one that embraces a culture of entrepreneurship and instills an entrepreneurial mindset in every graduate, 'no matter what their interests, dreams and values happen to be'. According to them, an entrepreneurial university has five key characteristics: (i) it recognizes that liberal arts education has fueled American innovation; (ii) it thrives on big problems; (iii) it values both innovation and execution; (iv) it places culture ahead of structure; (v) it encourages partnerships between academics and entrepreneurs.

Zhou and Etzkowitz<sup>5</sup> state three primary characteristics of an entrepreneurial university: (i) entrepreneurship activities are accepted and supported systematically; (ii) there are interface mechanisms, for example a technology transfer office, such as Office of Technology License and corresponding achievements; (iii) there are significant numbers of staff members to form firms.

Another contribution to defining the key features of an entrepreneurial university is a recent NESTA report, which suggests that an entrepreneurial university has the following attributes:<sup>14</sup>

1. A free-standing subject-focused module aimed at delivering knowledge and skills for and about entrepreneurship that permeates the entire university curriculum.
2. The learning within these courses is part of the core curriculum. Learning outcomes are developed in practice-based modules.
3. Entrepreneurial behaviors, attributes and skills are developed through direct engagement with industry. The form

of the engagement is wide ranging and may include work placement, contributions to curriculum delivery and assessment, and industry-based assignments by industry professionals.

4. Pedagogies and faculty development that support deep-learning approaches by focusing on situated and project-based learning and have high currency for students.
5. Recruitment, development and retention policies that accommodate entrepreneurial faculty and supplement other more standard policies that focus on research or clinical productivity and which seek to recruit applicants with broad industry experience.
6. Promotion and tenure policies, key performance indicators and other performance measurements that reward faculty entrepreneurial accomplishments with the same weight given to other accomplishments in research, clinical productivity or teaching.
7. A culture that rewards the scholarship, teaching and practice of entrepreneurship in all disciplines, not just in isolated units within the university, like technical disciplines or the business school.

Although much has been written about entrepreneurial universities over the past decade, it has not been possible to extract an agreed comprehensive model as to what constitutes such an entity.<sup>9</sup> In this section, we propose a model of an entrepreneurial university drawing upon examples of universities central to some of the most successful bio-clusters in the United States and United Kingdom as discussed above, and that we believe have successfully embraced academic entrepreneurship in the context of biotechnology. In our view, an entrepreneurial university has the following five attributes:

1. *Top-down vision, strategy and leadership.* University Presidents/Vice-Chancellors at entrepreneurial universities have a

responsibility to champion enterprise and entrepreneurship education with a vision, purpose and strategy that supports a cross-campus opportunity available to all students and academic faculty and that delivers clear entrepreneurial outcomes both inside and outside the university.<sup>3</sup> The original mission of the university at MIT, for example, which focused on the development and practical application of science in connection with agriculture and commerce, provided the foundation stone for the entrepreneurial spirit to flourish from the outset.<sup>15</sup>

2. *Clearly defined entrepreneurship learning objectives that drive the curriculum.*

Core learning objectives at entrepreneurial universities are clearly defined and drive curriculum development and design.<sup>9</sup> These include the development of entrepreneurial behavior, attitude and skills; creation of empathy with the entrepreneurial life-world; encouragement of self-employment as a career; inculcation of the processes of business entry, 'how-tos' and business survival; development of generic entrepreneurship competencies; and the management of one's self and relationships. The overarching goal of the curriculum is to build the level and rate of human capital investment at the university level and increase the relative pay-off to becoming an entrepreneur.<sup>7</sup>

At the University of Cambridge in the United Kingdom, for instance, a key part of the curriculum is the training to turn scientists into entrepreneurs.<sup>16</sup> The Cambridge-MIT institute offers a variety of interdisciplinary training opportunities aimed at training a new breed of innovators and business leaders in areas such as bio-enterprise, technology policy and managing innovation strategically. The courses are intended to provide the skills required to take 'innovation from the lab to the market', and draw on the experience of seasoned entrepreneurs to motivate and inspire future entrepreneurs.

3. *Robust internal and external networks.*

Robust internal and external networks are a critical success factor for entrepreneurial universities. The goal is to create an infrastructure and systems that facilitate interaction and information flow to the disparate members of the cluster and stakeholders. In addition, strong networks are the backbone of serendipitous discovery. Most universities rely on creating a maximally efficient and effective 'technology push-market pull' model striving to find the right customer for the right technology discovered or invented by their faculty. Others provide a range of networks and support services that supports 'structured serendipity'.<sup>17</sup> Personal networking using social networking tools, and extending one's reach beyond core areas of expertise, are core entrepreneurial skills that should be facilitated and nurtured in faculty and students. MIT is a key example where over a long period of time, the university has been successful at developing informal internal and external networks between government, industry and academia.<sup>15</sup> These networks have increased and leveraged research funding and allowed for the sharing of knowledge, which has in turn helped to stimulate high-tech entrepreneurship.

4. *A culture of innovation.*

Davies noted that entrepreneurial academic cultures exhibit the following characteristics: (i) university-level strategic thinking; (ii) open and quick decision-making; (iii) open communication and frankness; (iv) ability to take risks and learn from mistakes.<sup>18</sup> They cheer their champions and celebrate success through internal and external communications. One of the core elements of spin-off activity at MIT, for example, is the culture within the university, referred to as the 'Entrepreneurial Orientation' that champions commercialization activity and direct exposure to role models that have successfully commercialized research.<sup>15</sup>

The University of Oxford in the United Kingdom, as one of the world's leading centers of entrepreneurship in the biomedical field, is another instance where a commercialization organization that embodies norms of an entrepreneurial system complements a favorable national institutional environment. It is such a system that has significantly changed the internal selection environment of the university and increased the capacity of its star scientists to spin out biotech firms.<sup>1</sup> The lack of an entrepreneurial culture in Swedish universities, in contrast, is the major explanation for the limited importance of academic entrepreneurship compared to other countries.<sup>7</sup>

5. *Experiential learning and knowledge-transfer opportunities.*

Entrepreneurial universities are led by someone with some industry experience. Entrepreneurs learn best by doing and working on projects that are relevant to their interests and lives. Educational and training programs should thus include such endeavors as internships, knowledge exchange schemes, faculty–industry exchange mechanisms and industry sabbatical opportunities as a way to cross-fertilize industry with academe. Students should be offered the opportunity to work on project-based assignments addressing real-world entrepreneurial challenges.

MIT has supplemented a rigorous engineering curriculum with formal and experiential education in entrepreneurship, drawing on the local alumni base and faculty role models.<sup>15</sup> Along with providing early-stage and seed funding, and management support and guidance, the Emerging Innovations Fund at Purdue University, similarly, provides entrepreneurial faculty, staff, students and Purdue Research Park start-up companies with practical business knowledge of critical junctures in a new technology's life cycle with a view to fast tracking the development of Purdue-related technologies and hence

increasing the number of commercial successes.<sup>19</sup>

## TOWARDS A MORE ENTREPRENEURIAL UNIVERSITY

Based on examples of successful bio-clusters in the United States and United Kingdom, we have outlined what we believe are the key elements of an entrepreneurial university. However, universities evolve from a state of entrepreneurial naïveté to a fully integrated and embedded entrepreneurial learning organization, each with its own set of features and benefits.<sup>3</sup> Several factors influence this evolution. Many of these such as history or embeddedness in a local context cannot be replicated or emulated.<sup>15</sup> What can be changed is organization culture. Although not easy, culture change is a necessary requirement if universities are to realize the tremendous personal, economic and creative impact they can have on societies. We propose the following action plan to make this cultural change and hence move towards an entrepreneurial university:

1. Recruit star faculty: Key to creating an entrepreneurial culture is the recruitment of appropriate faculty engaged in activities far beyond the purview of normal research and teaching. 'Classical' academic entrepreneurs are those who possess publication and citation records, command a position in the university hierarchy, cite the existence of a role model and possess business education and experience.<sup>19</sup> University recruitment efforts thus need to emphasize these characteristics. Over the last decade, Purdue University, for example, has demonstrated an unprecedented commitment to recruiting and supporting a robust research community, especially through external funds and endowments that ignite the ambitions and efforts of Purdue researchers and help commercialize new technologies.<sup>20</sup>

2. Develop links with industry: Developing a university–industry interface is especially critical in a scenario where a large share of research is carried out at universities.<sup>7</sup> The interface can take many forms such as research projects sponsored by an outside agent; industry consulting by industry personnel; the set up of firms for commercial exploitation of research; financial and advisory aid to research-based firms and to individual researchers to facilitate the patenting, licensing or direct commercial exploitation of knowledge and research results originating from universities. The key is to devise this interaction at the university level, independent of government engagement and involvement.
3. Create an appropriate incentive structure: Systems run the organization; however, people run the systems. It is imperative, therefore, that apart from awareness and education campaigns, success is celebrated and appropriate rewards and incentives are in place in order to motivate faculty and students to network and connect. It is important to adjust lines of study and allocate research budgets to demand in the private sector and to facilitate faculty bridging of the gap between academia and the industrial sector.<sup>7</sup> Sweden is a stark example where the pertinent incentive structures have not rewarded entrepreneurial behavior to any great extent in comparison with the United States, resulting in the lack of an entrepreneurial culture and hence academic entrepreneurship.

At the same time as we advocate the above specific actions, it is important to remember that all stakeholders, including university leadership, faculty, students, entrepreneurship educators and entrepreneurs have a distinct role to play in contributing to the creation of entrepreneurial institutions of higher education. It is also vital to develop a framework for the monitoring of fundamental institutional change so that progress can be tracked over time.<sup>9</sup> Finally, although beyond the scope of this

article, the role of other factors outside of the university, such as a conducive legal and regulatory framework, and the presence of a vibrant VC industry, also cannot be ignored.

## REFERENCES

1. Smith, H.L., Romeo, S. and Bagchi-Sen, S. (2008) Oxfordshire biomedical university spin-offs: An evolving system. *Cambridge Journal of Regions, Economy and Society* 1(2): 303–319.
2. Mehta, S. (2004) The emerging role of academia in commercializing innovation. *Nature Biotechnology* 22: 21–24.
3. NESTA. (2008) Developing entrepreneurial graduates, [http://www.ncge.org.uk/publication/developing\\_entrepreneurial\\_graduates.pdf](http://www.ncge.org.uk/publication/developing_entrepreneurial_graduates.pdf), accessed 1 July 2011.
4. Thorp and Goldstein (2010) *Engines of Innovation: The Entrepreneurial University in the Twenty-first Century*. Chapel Hill, NC: The University of North Carolina Press.
5. Zhou, C. and Etzkowitz, H. (2006) The entrepreneurial university and the future of higher education in China, <http://www.iked.org/ethiopia/web/paper/Pre%20conference%20Paper%20-%20Zhou,%20Chunyan%20&%20Etzkowitz,%20Henry.pdf>, accessed 1 July 2011.
6. Pfeffer, J. and Salanick, G.R. (2003) *The External Control of Organizations: A Resource Dependence Perspective*. Stanford, CA: Stanford University Press.
7. Henrekson, M. and Rosenberg, N. (2000) Incentives for Academic Entrepreneurship and Economic Performance: Sweden and the United States. Working paper for the Center for Business and Policy Studies (SNS), Stockholm.
8. NESTA. (2007) *Entrepreneurial Education for the Creative Industries, Policy Briefing*. London: NESTA.
9. Gibb, A. (2005) Towards the Entrepreneurial University: Entrepreneurship Education as a Lever for Change. National Council for Graduate Entrepreneurship Policy Paper #003, Birmingham.
10. Breznitz, S.M. and Anderson, W. (2005) Boston metropolitan area biotechnology cluster. *Canadian Journal of Regional Science* 28(2): 249–264.
11. Tajnai, C. (1996) From the valley of heart's delight to the Silicon Valley: A study of Stanford University's role in the transformation. Stanford Computer Forum, Stanford University, Stanford, December 1996, [http://forum.stanford.edu/carolyn/valley\\_of\\_hearts](http://forum.stanford.edu/carolyn/valley_of_hearts).
12. MIT News. (1999) Impact of universities in Boston area illustrated by Harvard report and MIT's 1997 report, <http://web.mit.edu/newsoffice/1999/impact.html>.

13. (2011) Transforming the scientific vision of today into the reality of tomorrow. Visions of discovery, Discovery Park, Purdue University, June, <http://www.purdue.edu/discoverypark/viewbook/delivery>.
14. The Higher Education Academy Art Design Media Subject Centre and the National Endowment for Science, Technology and the Arts. (2007) <http://www.nesta.co.uk>.
15. O'Shea, R.P. and Allen, T.J. (2005) Creating the entrepreneurial university: The case of MIT. Presented at the Academy of Management Conference, Hawaii.
16. The Cambridge Biotechnology Cluster. Science Careers from the journal Science, <http://sciencecarers.sciencemag.org>.
17. NESTA. The Connected University: Driving Recovery and Growth in the UK Economy. NESTA Research Report, April 2009, <http://www.nesta.co.uk>.
18. Davies, J. (2001) The emergence of entrepreneurial cultures in European universities. *Higher Education Management* 13(2): 25–42.
19. Erdos, K. and Varga, A. (2010) The Academic Entrepreneur: Myth or Reality for Increased Regional Growth in Europe? Working paper IAREG WP1/03g.
20. Purdue's Emerging Innovations Fund. Money, people ideas, <http://emerginginnovationsfund.org/faculty.php>.