A "MOLECULAR BIOLOGY" of REGIONAL INNOVATION SYSTEMS: A SUPERVENIENT APPROACH TO DEVELOPING TECHNOLOGY ENTREPRENEURSHIP[1]

INTRODUCTION

Policy makers for years have been trying to come up with means to increase economic growth. This is driven by the desire to increase employment and taxable income. While entrepreneurship and innovation are sources of economic growth and prosperity governmental policy makers have determined that they can promote venture creation and innovation on regional bases as a solution to unemployment or reduced tax revenues. The idea is new firms will generate a significant growth in higher salary employment – the modern version of a 'smokestack industry'. This perception also assumes that new firms employ lots of persons, and that technology based new firms also pay higher prevailing wages. The cold reality is quite different. Most would-be entrepreneurs never succeed in creating organizations, not even half of all potential founders succeed in creating an enterprise, most firms start small, are short-lived or at best remain small, change little, if at all (Aldrich & Auster, 1986). Only 3 percent grow beyond 100 persons (Duncan & Handler, 1994, Reynolds & White, 1997, Aldrich & Martinez, 2001) most never add any employees. In fact some entrepreneurs actually do not want to hire employees preferring often to outsource all but the most critical aspects of their operations.

Despite these not so encouraging numbers, policy makers continue to seek economic growth by endorsing entrepreneurship and innovation as one of the few viable alternatives available to them. Hence, to meet the policy maker's wishes to increase employment there is obviously a need to significantly increase entrepreneurial activity, which then calls for some kind of mechanism to 'engineer' the situation. This mechanism is known as an innovation system, which exists widely on regional and national levels (Saxenian, 1994).

In the entrepreneurship literature, particularly technology entrepreneurship, the word *entrepreneurship* has often been equated to *innovation*. This is not at all surprising as most researchers and practitioners hold Schumpeter (1934) as their intellectual father. Schumpeter's entrepreneur is an innovator who creates the new (often frame-breaking technology) thereby shifting the costs and revenues curve in the market. Drucker has defined

[1] For the full (and more recent) version of the paper, please contact the lead author.

entrepreneurship as the activity of purposeful innovation (Drucker, 1985, p. 17). Taking this notion to its extreme would mean that every scientist in a research laboratory is a potential entrepreneur in waiting. While seeking the means by which to engineer innovation and entrepreneurship activity on a national or regional level a fundamental problem seem to have been created simultaneously: "Where is the entrepreneur?" The critical *actor* in the process has been lost in the model. The actor being the entrepreneur or the innovator is taken for granted or magically appears. It seems to be assumed that ideas exist out there waiting to be identified and any entrepreneur will do. Therefore, if it is possible to create a system that will boost entrepreneurship and innovation, the ideas and the entrepreneur will just magnetically fall into the system.

This paper reports on a study based on in-depth case interviews among university researchers and start-up entrepreneurs within a well-established science park in southwest Finland. This study is part of a larger action research study aimed at developing a regional innovation system to increase technology venture development and growth. This science park was explicitly designed and organized under the triple helix metaphor. Results show that the entrepreneurs and the potential innovators (scientists and researchers) feel excluded or avoid involvement with governmental actors. Ideas do not emerge and firms are not created, suggesting significant limits to the triple helix model. We will conclude with a competing model that is better described as a true double helix, one that places the human actors (entrepreneurs and their champions) at center stage[2].

PREVIOUS RESEARCH: THE 'TRIPLE HELIX' METAPHOR ARISES

There is a wealth of research on innovation, innovation systems, national and regional innovations systems, and science parks (see, e.g., Acs & Audretsch, 1987; Dosi & Orseniego, 1988; Flynn, 1993; Saxenian, 1994; Etskowitz & Leyesdorff, 2000; Bathelt, 2001; Cooke, 2001, 2005; Lemarié et al, 2001; Thierstein & Wilhelm, 2001; Autio et al, 2004; Höyssä et al, 2004; Freeman, 2002; Motohashi, 2005). The interest towards the phenomena show no decrease with more than 200 regional innovation systems studies published between 1987 and 2002 and new papers published monthly (Cooke, 2005).

It is fair to say that this interest has been sparked by the initial success of Silicon Valley and Route 128 in the mid-1970s (Saxenian, 1994). Although both areas experienced a

[2] Consider, for example, CTI, Switzerland's successful technology commercialization effort.

slow down, from which Route 128 did not manage to recuperate from until much later, these two areas became role models for similar type of technology based agglomerations world wide. The other spark is certainly the consensus on that technology development, R&D, and innovations impact positively on national and regional wealth creation. An overwhelming characteristic of the research seems to be that most studies are on a macro level. Literature also shows the usefulness of national innovation systems (NIS) for *institutions* devoted to innovation (Niosi, 1991, 2002; Nelson, 1992; Freeman, 2002). Despite this massive body of research, a single definition of an innovation system seems to be missing (Niosi, 2002). The core of NIS is interrelated *institutions*, those *institutions* that produce, diffuse, and adapt new technological knowledge such as industrial firms, universities or government agencies.

Complementing research on NIS is another large body of research focusing on regional innovation systems. These studies again have studied why some firms choose certain locations and factors influencing the choice (see e.g., Flynn, 1993; Bathelt, 2001; Cooke, 2001; Lemarié et al, 2001; Thierstein & Wilhelm, 2001). The terminology includes 'science parks', 'research parks', 'technology centres', 'innovation centres', 'incubator centres', 'start-up initiatives', and 'business parks'. Typically, governmental agencies, the city itself and the surrounding municipalities as well as the universities are strong actors in setting up these institutions (Carsrud & Ellison, 1992). Some studies have suggested that the success of regional clusters depend on agglomeration and urbanization benefits to new firms rather than the proximity to universities and other small technology based firms (Westhead et al, 2000). Again, we see a focus on the critical institutions. This institutional approach is appealing to those who desire a top-down view of innovation systems. However, it need not address the functionalities of those institutions, particularly from the perspective of the individuals immersed – and presumably the intended beneficiaries of the innovation system.

Research by Zucker et al. (1998) and Zucker et al. (2002) showed that small firms emerging in close proximity to world-class science institutions are more successful. Interestingly their research also showed that top scientists working in close proximity to start-up technology firms become better scientists because they ask better questions early in their careers and become highly cited ones. Others argue that organizational patterns and manufacturing cultures embedded in socio-institutional traditions of a particular region are decisive (Bathelt, 2001). The effects of science parks on firm creation have also been perceived as some form of public sponsorship of entrepreneurial activity. The question remains if this effective use of public monies. With respect to sponsorship, questions have been raised in relation to a potential competitive imbalance relative to existing firms, and

how science parks will influence patterns of cooperation and effective use of resources. Westhead, et al. (2000) argued implicitly that this appears to be much more a policy makers' issue than actually a primary concern of small firms.

National and regional innovations systems are seen as learning systems of national economies (Niosi, 2002; Autio et al, 2004; Höyssä et al, 2004) and a large body of studies around firms ability to create, disseminate, and diffuse new knowledge also exist (Cohen & Levinthal, 1990; Carsrud & Ellison, 1992; Kogut et al, 1993; Teece et al, 1997; Deeds et al, 1999; McMillan et al, 2000; Deeds, 2001; Murray, 2002; Riccaboni & Pamolli, 2002). The striking characteristic of these studies is the institutionalization of the phenomena regardless of whether it is national or regional level. Most studies are on a macro level and rarely if ever discussions relating to *the entrepreneur* or *the innovator* mentioned. The wide range of terms deployed include: infrastructure, globalization, asymmetric knowledge, dynamics capability, innovation networks, knowledge spillovers, technology transfer, region, sector, national innovation policy, etc.

One well-publicized model of regional and national innovations systems that has gained increasing numbers of adherents is the *Triple Helix* perspective (Etzkowitz & Leyesdorff, 2000). Although criticized by Cooke (2005) to be on an extremely high level of abstraction, it is a model which many current innovation systems appear to be based on. For example, the Swedish national body for promoting innovation and technology VINNOVA openly declares that their system is based on the "Triple Helix" model. Triple Helix basically provides a model for integrating governmental institutions, universities and industry to boost innovative activities and technology development. The novel characteristic and apparently appealing characteristic is the integration of these parties which are perceived as important for economic wealth creation. Etzkowitz and Leyesdorff (2000) argue that the previous models are *passé*. The "*etatistic*" model assumes that innovation can be managed by governments (*état*) and the "*laissez-faire"* model allows for the parties too much freedom to ignore each other, thus rendering this approach ineffective and inefficient.

However, this model, as in previous models and studies ignore the *entrepreneur* and the *innovator*. One might argue that the concept of 'industry' includes the entrepreneurs and small firms. However, 'industry' most certainly also includes large organizations, i.e. 'industry' appears to refer to a cluster of firms, where larger firms mostly drive their agendas and smaller firms tend to tag along to benefit from potential spillovers. While a cluster indeed can be beneficial for small start-up firms, as the Finnish pharma cluster, we argue (needs re-

wording and change in sentence structure) the current models ignore actions at: **1)** the firm level and **2)** the entrepreneur(s) and the innovator(s) who create the firm and technology. This study shows the alienation of the entrepreneur(s) and a quite astonishing unwillingness to approach entrepreneurs although most parties appear to have acknowledged the fact that entrepreneurs feel left outside (Brännback, et al., 2001).

SUPERVENIENCE: "REVERSED" CAUSATION AND AN ALTERNATE VENTURE- AND ENTREPRENEUR-CENTRIC MODEL

Mereology and Supervenience

Traditionally, scholars have argued for a collective treatment of value and knowledge creation and only a tiny minority have taken the stand for the individual (Arrow, 1962, Simon, 1991, Zucker, et al, 1998, Felin & Hesterly, 2007). There may be a perfectly pragmatic explanation for this; it is simply far more convenient to study the whole (the organization, the firm, the department) than its parts (the individuals that make up the whole). Also it allows for statistical analysis which is the preferred way of communicating scientific results in social sciences as it, when done properly, allows for potential generalizations. However, in most cases generalizations have to be tagged with limitations thus nibbling the contours of credibility, but that seems a minor problem. Thus, most research are based on **downward** causation, i.e. by creating a conceptual framework or theory that explains the whole. It is assumed that the individual parts are understood and explained since it is *a priori* that the individual parts are homogeneous (Felin & Hesterly, 2007). Downward causation thus goes from macro to micro as in the case here from macro to another macro level, failing to address the micro. By anchoring our argument in *mereology* our discussion is given a solid foundation within the philosophy of science. Mereology is a stream in philosophy of science dealing with causal directionality and the relationship between parts and whole. The Triple Helix is indeed a powerful and timely metaphor given the global buzz about gene technology. However, applying mereology will show that the metaphor is in fact completely misplaced as used in previous research (see, for example, Etzkowitz & Leyesdorff, 2000).

The Triple Helix assumes that if these collective bodies are tightened, the individual actors entrepreneurs and innovators will magically appear as in the structure of DNA, yet the Triple Helix fails to resonate with the most vital individual part – the actor or the innovator or the entrepreneur. As our research shows, the entrepreneurs feel disconnected and some do not even want to be associated with the collective actors.

We argue for a reversed causation known as *supervenience* in the philosophy of science (Kim, 1993, Sawyer, 2001, Felin & Hesterly, 2007). Thus, supervenience provides the opposite prediction of part-whole relationship. The whole results from the parts and any change in a higher level are strictly a function of changes at a lower level. All collective outcomes can be explained with reference to individuals (Elster, 1989, Felin & Hesterly, 2007, p. 200). In other words, a nation's or a region's ability to innovate can only be determined by the individuals' ability to innovate. As we have already stated, we believe innovators innovate. Firms do not innovate because they are firms (collective constructs) but because they have individuals who do. Thus, firms can only be innovative. Entrepreneurs innovate, researchers innovate, and theoretically government officials can also innovate, but mostly they govern, i.e. maintain status quo!

The Triple Helix model was not intended to just be descriptive, but normative. However, the clever imagery has yet to be matched by empirical results. However, it has served a great purpose in directing the attention of researchers and government officials toward consideration of the complex interplay of the forces driving innovation and entrepreneurship. Nonetheless, the triple helix model inherently focuses on the bureaucratic/institutional components and not on the entrepreneurs, their allies and their ventures. Much as molecular biologists debated whether DNA was a single, double or triple helix, it should be useful to consider a double helix model that actually is a closer fit to best practice and fits the DNA metaphor more closely.

Idaho has embarked on an ambitious strategy to accelerate technology development, a strategy ominously reminiscent of that described above – except that they are operating under what is better described as a double helix (Krueger 2005). This model draws on the prior work suggested by SSTI (www.ssti.org), the national N2TEC organization (www.n2tec.org) and others (e.g., Lichtenstein & Lyons 2001, Pages 2001, Camp, 2005 and especially Sweeney 1987). We synthesize their common theme that posits that the key to true entrepreneurial economic development is to fully understand that an entrepreneurial economy has three types of critical assets:

1) **Innovation Assets** (stocks and flows of ideas),
2) **Entrepreneurial Assets** (stocks & flows of relevant human & organizational capital) – and, most importantly -
3) **Bridging Assets** (proactive persons & mechanisms to coordinate & encourage the interaction of entrepreneurs &d ideas; to proactively connect both with resources)

Visualize, if you will, the traditional picture of the DNA double helix: Two strands connected by links. In this case, the two strands are the Innovation Assets and the Entrepreneurial Assets, while the links are the connections forged between the two. However, the Bridging Assets need not be confined to the links; in fact, it is likely that the links are artifactual of the efforts of Bridging Assets. Sweeney (1987) proposed that the key element in local or regional entrepreneurial development was the existence of and support for the *liaison-animateur*. That is, the passionate professional described above serves a dual role. First, the *liaison-animateur* serves as a link between ideas (innovation assets) and people (entrepreneurial assets) and between both and external resources. However, this person also serves as more than *liaison*, but also as *animateur*. It is vital that this person proactively encourage linkages between ideas and people, between people and between ventures and resources. While Sweeney's term has not become popular (indeed, swamped by the clever metaphor of the triple helix) best practice in entrepreneurial development has proven the value of proactive, professional bridging assets (Camp 2005, Lichtenstein & Lyons, 2001, Pages 2001, SBA 2005).

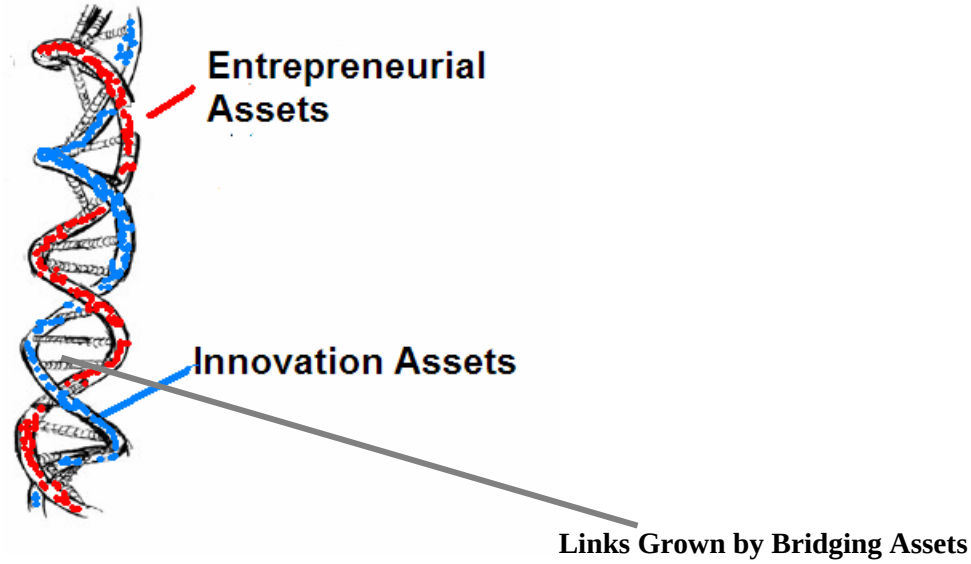

Figure 1. The Real Entrepreneurial "Helix"?

What Do Bridging Assets Do?

While stretching the DNA metaphor to its limit (or beyond), Bridging Assets could perhaps be thought of as a parallel to the mechanisms like RNA that are constantly forging new links, eliminating useless links and repairing damaged links. Some entities supporting the commercialization of technology is applying this bottom-up venture-centric double helix approach, identifying (and attempting to optimize) both Innovation Assets and

Entrepreneurial Assets, while acting as Bridging Assets and coordinating a wide array of other potential Bridging Assets. (needs to show the model) They perceive this as critical in helping nascent entrepreneurs through the early stage "Valley of Death" using an adaptation of the entrepreneur-centric Goldsmith model first deployed in Oklahoma and later in San Antonio. The bridging assets serve to assist the nascent entrepreneur through each stage, proactively connecting the entrepreneur with critical human, technical and financial resources. As such, proactive professionals are required; this cannot be left to the kind of bureaucratic mechanisms that the Triple Helix too often generates (as in Sweden, with VINNOVA or Finland with TEKES). The Swiss technology commercialization effort, CTI, is following a very similar model to Idaho's and should offer opportunities to collect data in parallel.

Note that the double helix model does not bury the entrepreneur, but instead makes the entrepreneur one of the key backbones of entrepreneurial development. But, it also visually emphasizes that ideas (innovations) are another backbone. It shows to those who would overemphasize Innovation Assets [e.g., the Finnish effort described above] that entrepreneurs are equally important. Moreover, this model demonstrates quite emphatically the critical long-term importance of Bridging Assets. We argue that the double helix places the entrepreneurs, the innovators and the "bridgers" at center stage in the entrepreneurial development process. As such, we propose to examine a regional innovation system that has embraced the triple helix model almost completely, one that appears to show little evidence of focus upon entrepreneurs, let alone bridging assets. Rather, it has fully embraced the focus upon funding the institutions, as the triple helix model would argue.

Key Findings

The findings were somewhat stunning, but not surprising. Most interviewees could not even define an innovation system. One entrepreneur gave his definition by asking if there were other systems than the US model, which is a capital and knowledge intensive *environment that generates knowledge intensive growth companies*. Another entrepreneur bluntly replied, *I don't know!* A large majority of the entrepreneurs feel left outside and resent the level of competencies and capabilities of government agencies to truly contribute to venture creation. The university researchers want to stay as far away from government agencies as possible. They perceive these governmental programs as time away from much more important things like research. The entrepreneurs described the innovation system in a way which best fits the *état-istic* [statist] model, whereas the researchers described the system

in a way which resembled the *laissez-faire* model. Regardless, here the entrepreneur portrayed him/herself as a very distant component.

DISCUSSION AND FUTURE RESEARCH DIRECTIONS

Despite an immense interest from both the research community and society at large towards innovation systems due to the above sketched rationale a fundamental problem seems to exist, one that is adequately addressed in research and literature on entrepreneurship – specifically what can be called the psychological school of thought, which argues that information about opportunities is insufficient to determine who becomes an entrepreneur and depends on a person's willingness, motivation, and ability to take action (one paragraph sentence—needs sentence structure) (Bird, 1988; Katz & Gartner, 1988; Carsrud, et al. 1989; Krueger, 1993, 2000; Shane, 2003).

Consider the central role of an entrepreneurship-friendly cognitive infrastructure. Entrepreneurial intentionality is driven by personally perceived desirability and feasibility. A national or regional innovation system, based on the research sited earlier, appear to focus primarily on feasibility, i.e. ensuring the existence of adequate resources and infrastructure. Entrepreneurial intentions to be realized into action require also perceived personal desirability. Therefore a national and regional innovation system that fails to increase perceived desirability will become ineffective and inefficient. Desirability again is dependent on personal attitude and social norms. Both of these are complex issues. Changes in social norms are slow and may take place over generations. Changes in desirability perceptions may require complicated interventions and education. It requires a supportive culture (includes the social/cultural norm that it is socially acceptable to become an entrepreneur) and a skillfully designed formal reward system that cannot be overridden by informal punishment.

We show here that regardless of whether there is a national or regional innovation system, this system has to deal with whether persons perceive entrepreneurship as desirable and feasible. This paper shows that scientists and researchers may have entirely different desires, and entrepreneurship is not their primary interest. Moreover, this paper shows that those who do become entrepreneurs do <u>not</u> perceive themselves as part of an innovation system, but instead as part of the <u>commercial</u> world. An innovation system is perceived as merely a state-run initiative and the idea that it would at all be possible to engineer entrepreneurship seems strange to inventors and entrepreneurs alike.

Therefore, we need to rethink models of innovation systems and we need models that start **from** people and ideas. In fact, we need research on innovation systems that focus on entrepreneurs and innovators, studies we have found to be relatively rare. We believe that one promising approach would be to compare incubators operated under the top-down Triple Helix assumptions versus a more bottom-up approach. Recall the Finnish entrepreneur who saw little change in the incubator over 10 years; in Idaho, what the incubator[3] offers is driven by the market (its current and prospective tenants).

In sum, we argue here for moving away from the so-called Triple Helix model, given the remarkable lack of support for its efficacy when carried to its logical conclusion as we see in Finland. A venture- and entrepreneur- centric double helix model appears preferable; we look forward to testing it. Entrepreneurship is a bottom-up process; so too should the mechanisms to nurture it.

[Authors' note: Please do not hesitate to contact us about this research; this a much-abbreviated version of the paper. We are eager to share our findings and to learn your ideas! - NK]

References available upon request from first author: Norris.krueger@gmail.com

[3] e.g., www.bsutecenter.com