

## EXPLORING THE LINKAGES BETWEEN UNIVERSITY TECHNOLOGY TRANSFER AND ENTREPRENEURSHIP EDUCATION PROGRAMS: ATTITUDES AND PERCEPTIONS AMONGST ENTREPRENEURSHIP ACADEMICS

*Peter Moroz: University Of Regina, Saskatoon, Canada*

*Kevin Hindle: Australian Graduate School Of Entrepreneurship, Hawthorn, Australia*

*Robert Anderson: University Of Regina, Regina, Canada*

~

**Contact:** Robert Anderson, University of Regina, University of Regina, SK S4S 0A2 Regina, Canada, (T) 1-306-585-4728, (F) 1-306-585-5361, Email: Robert.Anderson@uregina.ca

### **Abstract**

As the University Spin Out (USO) has become a highly desirable outcome for commercialization efforts, the development of entrepreneurial capacity within the university system becomes increasingly more important. We hypothesize that entrepreneurship education (EE) programs (*ceteris paribus*) may play a role in developing this capacity. This paper examines the attitudes and perceptions of academics who are directly involved in the field of EE with four research goals in mind: to determine whether or not there are (1) perceived advantages to collaboration between EE programs and technology transfer offices (TTO) in spinning out technology, (2) identifiable university specific variables that influence these perceptions, (3) perceived barriers to collaboration, and (4) to identify whether these collaborations may already exist in some form.

### **Introduction**

A sizeable body of literature has been developed on the University Spin Out (USO). The reasons for this growing interest in knowledge transfer within the university system are manifold. Recent studies of the phenomenon point to the prevalence of three factors that contribute to the burgeoning curiosity around the entire USO process: 1) empirical evidence that ties the generation of new knowledge to sustainable economic growth, 2) the centrality of the university research environment in developing new knowledge into patent worthy intellectual property (IP), and 3) the pressing need for converting IP into tangible financial benefits for the university in terms of revenues and the external community in terms of high paying jobs/wealth creation; specifically through the vehicle of high growth, new technology ventures (Etkowitz, 1998). Identifying the many complex variables and processes that stimulate the proliferation and success of the USO is thus of utmost concern for all stakeholders involved.

For the modern university, the challenges accompanying this paradigm shift in thinking require a complete re-assessment of the traditional organizational goals long held. No longer are knowledge creation and its unfettered dissemination the exclusive mandate of academia. Universities are being compelled to embrace an onrushing market head on, as a voracious global economy thirsty for new technology demands both greater levels of research output, and rapid commercialization of the fruits of this effort. Paradoxically, the university system has become ensnarled within the Schumpeterian vortex that was once comfortably observed from afar. In order to survive, the modern university must

evolve as an institution. Clark (1998) believes that this can only be accomplished through creating, among other things, new entrepreneurial pathways.

What is crucial to this transformation is the reconciliation of the traditional mandates of the university within a new interpretive scheme that is inclusive of these new realities and sensitive to institutional heterogeneity. Each institution is unique in terms of the culture and resources available for enacting change. For many schools and colleges within the university system, fostering an environment that is friendly to innovation and commercialization is often difficult. Cultures must be broken down and slowly altered in order to accommodate a new socially integrated role in regional development. The educational requirements and transitional tools necessary for this massive up taking will require both time and money. Most importantly, leadership must be cultivated internally, and kindled wherever it emerges.

Within the field of entrepreneurship research, these changes within the university system are fundamentally important to many streams of current and future theoretical development (Shane and Venkataraman, 2000). The activity of opportunity identification and exploitation, especially in unfriendly environments such as the academic institution, offer a wealth of information on the process of entrepreneurship, on both a micro and macro foundational level. The prominence of the USO as a prime strategy for commercialization of new knowledge and the resulting obligation to build capacity around this activity provides an excellent foundation for entrepreneurship research.

More importantly, approaching this problem from the perspective of the academic field of entrepreneurship may provide for insight that is extremely valuable to the overall challenges faced by universities. For instance, knowledge spillover is theorized to be responsible for technological diffusion, as it is understood that latent entrepreneurial activity surfaces wherever opportunities abound (Audretsch, 2004). But the barriers between new knowledge and new *economic* knowledge must be fully identified and understood before effective implementation of the “fourth mandate” of the university is fully engaged. Entrepreneurship theory may better help to map and explain these relationships.

As well, entrepreneurship education research and the application of entrepreneurship programming may be important in determining what skills, experience and behavioral cues are necessary to help bridge the gaps that exist between the codified knowledge of the research world, and the tacit knowledge important to navigating commercial markets (Yencken, 2002). An extensive body of literature detailing both the ability and efficacy of “teaching” entrepreneurship as a discipline (Gartner, 1994; McMullen, 1998; Kuratko, 1993; Kolvereid, 1997; Menzies, 2002; etc.) provides ample argument for its heightened role in closing this gap. The human resource skills necessary for launching USO’s as well as creating the environment where USO’s are an expected outcome of research trajectories must be developed somehow.

One might be so bold as to suggest that the dividing line between protecting the right of researchers to perform basic “social good” research and enabling researchers to develop research that can be readily commercialized may be more easily negotiated through the establishment of proper social cues rather than through elaborate incentive systems. Entrepreneurship research and pedagogy may contribute to the comprehension and establishment of network externalities by simply providing a greater diffusion of entrepreneurial skill sets and through the consequent outcomes of having more and more people practice entrepreneurship, and recognizing/reacting to opportunity (Minniti, 2004).

This is especially so for faculty scientists, graduate students, engineers, and the staff of technology transfer offices. These groups are pivotal players in the generation and commercialization of university IP. Entrepreneurship education has been empirically proven to increase the propensity of students and faculty to create new ventures and increase success rates (Menzies, 2002). Technology transfer officers involved in USO’s may benefit from skills, experience and network associations delivered through these programs.

There are other more direct methods of culture and capacity building that help to promote and enable commercialization processes and high tech spinouts. Technology entrepreneurship programs are quickly being adopted within top ranked entrepreneurship schools (Kauffman Foundation, 2006). Not only do the curricula developed for these programs help in the new venture creation process, they also provide experience, information and skills that are unique to starting USO’s. The mandates of

entrepreneurship schools continue to grow and add other services and resources to the mix, such as links to investors, internal startup financing funds, and other support infrastructure such as mentorship (Finkle, 2006). In many respects, the priorities and strengths requisite within entrepreneurship schools and centers is highly compatible with the IP identification and patenting end of TTO's. Some overlap does exist as well, especially in the area of infrastructure development and support for new ventures, such as incubators, and professional/business consulting services.

This inevitably leads to the question as to whether or not entrepreneurship centers and programs should be taking a more central role in the USO process. It also begs the question as to whether or not TTO functions would be better served if integrated administratively with entrepreneurship centers, specifically if the focus of commercialization efforts is to spin out technology into potential high growth ventures. Until now, the main vehicle for university commercialization efforts has evolved around the technology transfer/industry liaison model. The efficacy of this model, like any model, should constantly be evaluated and assessed, especially against shifting goals. Are there perhaps other models or paradigms that may better serve the university in terms of its ability to more effectively spin out technology produced from academic research?

As the majority of studies on the USO are derived from the perspective of technology transfer offices, scientist entrepreneurs, administrators and venture capitalist/angel investors, finding new areas of interpretation and examination may provide new insight. This paper takes a look at the problems, challenges and potential opportunities inherent to university knowledge transfer and high tech spinouts from the perspective of academics involved in the teaching, research and program development of academic entrepreneurship programs. Through this study, we intend to delve deeper into the entrepreneurial elements of university commercialization from a new and perhaps different viewpoint. In doing so, we challenge the traditional models currently being used and lay the groundwork for the investigation of new ways of innovative thinking around the question at hand: "how do we increase the potential for university derived IP to be commercialized in order to realize the maximum benefits to both the university and society as a whole?"

### **Theoretical Construction**

There is an obvious linkage between innovation and entrepreneurship (Hindle, 2001). Those universities that develop expertise, and support policies to stimulate technology transfer are often ascribed an "entrepreneurial culture". In Europe, entrepreneurial factors are cited as critical in a university's ability to spin out technology (Clark, 1998). This follows the general theory that in the absence of entrepreneurial capacity, the potential commercial value to a university of any new knowledge is close to zero (Hindle, 2001; Ropke, 1998). With the billions of dollars being injected into public research institutions around the world, perhaps the burning problem to be addressed is the notion of a lack of entrepreneurial capacity and culture within the university system.

This capacity gap exists on two overlapping levels: the lack of talented individuals who understand the process of turning innovation into enterprise, and the deficiency of organizational structures and environments that do not properly understand how to cultivate entrepreneurial activity. These two levels presented here are extremely broad in their countenance. For a deeper understanding, an examination of the subsets that exist within the micro foundational and macro foundational aspects of these assumptions is required.

Focusing on the creators of IP, DiGreggerio and Shane (2003) assessed the determinants of USO's and conclude that the skills and abilities of faculty were heavily significant. Scientists, who are incapable of identifying or exploiting the commercial value of their work, tend to not disclose research findings to technology transfer offices. As well, the seed of most research being performed within universities is not commercially motivated. Even if disclosure is made, the scientist must brave the gauntlet of a potentially daunting peer environment (Bercovitz, 2004). Considering that the direct involvement of the scientist throughout the early stages of the spinout process is positively correlated with higher levels of commercialization (Zucker, 2000; Thursby, 2005), considerable institutional disincentives may exist to dissuade their participation. Issues such as lack of time, recognition, motivation and business sense may also cause scientist to retract from such endeavors. Organizational rigidities, a dearth of resources and the complexities of the USO process itself all act as barriers to scientists spinning out technologies (Witt, 2004).

Since the commercialization of technology is basically an entrepreneurial process, understanding the nature of IP exploitation demands that scientists and students must turn themselves into entrepreneurs (Ropke, 1998), or at the very least, be familiar with and willing to accept entrepreneurial activities as a norm (Lenoir, 2004). Technology entrepreneurship programs attempt to fill the void of knowledge, skill and experience requisite of faculty and students to successfully maneuver between the world of research and the world of business. There are many examples of technology and new venture creation programs targeted at students and faculty (Kauffman Institute, 2006).

In a study performed by Kolvereid and Moen (1997), graduates with an entrepreneurship major were found to be more apt to start new businesses and have stronger entrepreneurial intentions than other graduates. Menzies (2004) found that engineers who had taken entrepreneurship courses had higher propensities to venture and better success rates in starting new businesses. Specifically to technology Yencken (2002) finds that training in entrepreneurship and technology management familiarizes innovators with the processes and requirements for successful USO's. Many examples of technology transfer and technology entrepreneurship programs have thus sprung up around North America and Europe based on this premise with a variety of outcomes (Marshall, 2006; Thursby, 2004; Binks, 2006).

In analyzing the effectiveness of university technology transfer, Siegel and Phan (2004) state that entrepreneurship curricula must be embedded throughout the university to maximize the effectiveness of commercialization efforts. This contention is based on considerable evidence that entrepreneurs with a good education (delivered through academic programs) tend to be more successful than those without (Vesper, 1990). As entrepreneurship education is itself a non-linear process, it is more closely aligned with innovation than the linear and often bureaucratic nature of technology transfer (Nelson, Byers, 2005). Therefore technology entrepreneurs who have received education, training and experience will generate better results than those who have not.

*Hyp1: Technology entrepreneurship programs and courses will be highly significant with USO creation.*

Although this may seem to be an obvious hypothesis, it is unknown as to the prevalence of technology entrepreneurship programs. Those unfamiliar with technology transfer and entrepreneurship programs in this area may not be as likely to cite this as an important factor out of sheer lack of hands on experience or involvement.

Lockett and Wright (2005) examine the creation of the USO from a macro foundational level and ask two pertinent questions: 1) what are the most important stocks of resource inputs and 2) what are the most important capabilities and routines? Among other things, business development and experience in spin outs were more important than the actual number of years that technology transfer offices had been in operation at a university. Routines that reinforce existing cultures of innovation through organizational norms, policies and procedures were as important as the actual stocks of IP being generated. Markman (1999) reinforces this theory and extends it by stating that value chains consisting of scientists, TTO's, university administration and external linkages to investors/industry must be put in place and work in tandem with the proper incentives to encourage spinning out technology.

Top levels of university administration must adopt this strategic approach (Siegal, 2004). Spinning out IP also requires routines where selectivity is practiced, as not all IP is created equally. Innovations will often have divergences in market appeal and growth potential (Powers, 2005). Some of these strategies may be aligned with cluster development, incubators, research parks, research chairs and other broad based policies that allow for long-term commitments. An understanding of the time that knowledge innovation takes to bring to a state of profitability, its unpredictability in outcomes and a tolerance for failures (Drucker, 1985) frames some of the requirements for a positive culture. Universities must also modify policies for the heterogeneity of USO types, sizes and growth rates.

Franklin (2005) posits that entrepreneurial routines and incentives may not be grown as rapidly as needed within the university through entrepreneurship programs. Thus surrogate entrepreneurs may help to provide the necessary capacity to accelerate the growth of commercial experience. External entrepreneurs can be the catalyst required for bringing USO's out of nascent stages through the

structural coupling of the university and regional resources into entrepreneurial patterns. Historical success follows an external environment where entrepreneurial activity is strong and universities cultivate ties with the business world (Blumenthal, 1996).

As these functions require a good degree of organizational coordination, administrative support, and the commitment of resources, entrepreneurship programs would most likely be more beneficial when directly tied into commercialization processes.

*Hyp2: Direct linkages between entrepreneurship education programs and commercialization strategies involving TTO's will be significant in the creation of USO's.*

This leads to a further hypothesis that states:

*Hyp3: There may be considerable advantages from integrating technology transfer offices and entrepreneurship programs under one single administrative unit.*

This hypothesis engages the consideration of paradigm shifts or evolutionary patterns in models that may contribute to the effective transfer of technology through the USO. As the suggested structural model is atypical of current configurations, it may serve as an introduction to analysis on its merits. Roberts (1996) looked at various selectivity and support configurations and concluded that weak entrepreneurial environments (both external and internal to the university) may require more rigid policies to enhance commercialization, while universities with past success, well established social cues and an environment rich with entrepreneurial capabilities and routines may not. Degroof (2004) agrees by stating that direct administrative control and rigid policies promoting entrepreneurial activity around commercialization efforts is better for underdeveloped environments.

Not all examinations of organizational control as a factor for USO creation are in agreement. Moray (2005) warns that increasing top down control on the venture process may discourage efforts to spin out technology. Regarding the specific collaboration of entrepreneurship programs and technology transfer offices, the differences between the two activities may limit the amount of direct interface between them, as their functions may warrant an autonomous relationship for realizing greater commercialization outcomes (Nelson, 2005).

All in all, the complexities involved with USO's are grand in their totality. This paper does not attempt to delve deep into the various factors and their relationships that either positively or negatively impact the proliferation of technology spinouts within a university setting. We offer insight of the understanding of the phenomenon from the perspective of entrepreneurship academics that may at best have tangential contact or understanding. We believe that analysis and comparison of the attitudes, views and beliefs of this rarely tapped population may offer some interesting discussion to current theoretical posturing on the subject.

## **Methodology**

In order to obtain the data presented in this paper, an invitation to participate in a self-administered web survey was emailed to Canadian entrepreneurship academics. The sample frame consisted of all academics and/or entrepreneurship center directors that were actively involved in administration, teaching, or research within or in conjunction to a university (such as an entrepreneurship center). The sample frame represents 95% of all Canadian Universities, disregarding regional colleges or affiliates of the main institution. Technical and trade schools were not represented in this sample frame. The sample population consisted of 67 entrepreneurship educators and was drawn from various sources: subscription lists to the Journal of Small Business and Entrepreneurship, an exhaustive internet search through faculty web pages and by the process of asking respondents to refer the survey to colleagues that fit the above sample frame. This last method is well documented in its application and is often referred to as snowballing (Heckathorn, 1997).

The first section of the survey asked respondents to identify several institution specific structural issues to help gauge the depth, breadth and focus of entrepreneurship education programs within their schools. This information was gathered by asking a series of partly closed questions that allowed for respondents to choose from a list of coded responses that included a category for "other" responses.

Respondents were asked to elaborate on “other” responses through follow up open ended questions in order to allow for a full range of responses to be collected. Information on research funding, research chairs, and endowments was also collected.

Part two of the survey involved asking respondents their opinion on issues involving the collaboration of entrepreneurship education programs and technology transfer offices. Answers were coded via a closed four point scale (Bradburn, 2004) assessing the strength of their agreement or disagreement with several questions. A middle point was left out of the scale in order to better gauge the leanings of the respondents. In order to avoid satisficing, a “don’t know” response was added at the end of each question’s response choices. This technique reflects the respondent’s ability to answer the questions with some authority, and allows them the option to answer based on a closed set of responses. It is likely that some entrepreneurship educators were not familiar with technology transfer and the commercialization aspects of the USO (Kalton, 1980).

The final part of the survey was modeled as two part questions to illicit responses on attitudes and perceptions of entrepreneurship academics, independent of whether or not the questions corresponded to their schools. This method was decided upon in order to mitigate the association of responses within an environmental context and to ensure that academic perceptions of what “should be” were not anchored with what actually may be happening within the program or school. Questions were designed to be as specific as possible to help filter the attitudinal characteristics of the responses (Bradburn, 2004).

Responses to opinion and attitude questions were measured by using a mean percentage to evaluate the level of the respondent’s agreement on a cumulative basis. The resulting scores were then used to assess the issue addressed in the question on a positive scale. Responses coded as “don’t know” were included in the aggregate percentages.

A second level of analysis involved parametric tests on dummy variables created for structural, resource variables and environmental variables and then compared with attitudinal variables. Pearson bi-variate tests were performed to identify the strength and significance of any pertinent correlations between the coded responses. Due to the reporting system used in the online survey, opinion and attitude questions were ranked in descending order of strength so that “1” was considered a strong positive result. As “don’t know” responses were coded as “5”, they were assigned as missing variables and dropped from the dataset.

## Results

Of the sample population of 67 respondents, there was a completion rate of 53% (n=36). The population of Canadian universities according to the Association of Universities and Colleges of Canada (AUCC, 2006) is currently 89. As the survey was designed as a non-probability purposive study of entrepreneurship academics within Canadian universities, the sample population of 67 consists of those targeted universities that have entrepreneurship education courses or programs of some kind. Of the 89 universities in the AUCC population, 19 were either affiliates of larger institutions or did not have a full representation of programs (art schools, design schools, and liberal arts colleges) and thus did not fit the requirements of the survey population. Thus the survey population of universities within the scope of this study is 70. Using standard sampling error techniques, with a sample error of +/-3%, the sample size drawn ensures a confidence level of 95% (Judd, 1981).

Breaking the respondent list down geographically, 19 eastern, 6 maritime, and 9 western universities were represented in this survey. There were two universities that provided dual reports from 4 individuals, for a total of n=36. Of the 36 respondents, 9 were female and 27 were male. Each province had at least one university respondent reporting.

In regards to university infrastructure and programs, the following results were obtained and are tabulated in Table 1. The vast majority of universities delivered entrepreneurship education programming from the business school (97.2%), while engineering schools reported 52.8%, arts schools 16.7% and medical schools 5.6%. The preeminence of the business school in delivering entrepreneurship education programs is typical of most nations and on the whole an obvious statistic.

The growth in entrepreneurship programs being delivered from engineering schools is a growing trend (Menzies, 2002), but the absence of entrepreneurship programming in other schools and colleges is not (Finkle, 2006).

Only 8.3% of respondents surveyed reported a PhD program in entrepreneurship, while graduate degrees and undergraduate degrees were 13.9% and 27.8%. This signals a supply chain shortage of trained academics within the Canadian system. Combined with the growing demand and undersupply of entrepreneurship academics within the US (Finkle, 2006), this statistic offers some critical insight into the state of growth in the field. As well, the limited availability of graduate and undergraduate programs speaks to the developmental stage that entrepreneurship education still exists within. Full-fledged programs offered through undergraduate and graduate degrees that are multi-dimensional in scope, offer experiential learning, social capital building, and a multitude of other pedagogical techniques required of the unique field of entrepreneurship education are theoretically and empirically superior to courses or skills building classes (Hindle, 1999; Finkle, 2006).

*Table 1. University entrepreneurship education infrastructure and programs*

Variable Type	Frequency n=36	%
Undergraduate degree in EE offered	10	27.8
Graduate degree in EE offered	5	13.9
PhD in EE offered	3	8.3
Business School EE programs/course	35	97.2
Engineering School EE programs/course	19	52.8
Arts School EE programs/course	6	16.7
Medical School programs/course	2	5.6
Startup Assistance within University	20	55.6
Entrepreneurship Education Endowment	17	47.2
Entrepreneurship Research Chairs	5	13.9
Entrepreneurship Center	20	55.6
Technology entrepreneurship courses	12	33.3

Further interesting results indicate that over half of the respondents (55.6%) were aware of an entrepreneurship center existing at the university. Typically, an entrepreneurship center will provide a teaching, research and an internal/external outreach component, and will be attached directly or indirectly to the University, or through a school or college (Menzies, 2002). Although this basic framework provides an idea as to what an entrepreneurship center does, there is little homogeneity around how it gets done. Budgets, administration, mandates and actual program delivery and curricula can be highly divergent or even unique from center to center, and ranking their efficacy can be difficult (Finkle, 2006).

Consequently, the number of research chairs in entrepreneurship (13.9%) and endowments to entrepreneurship programs or centers (47.2%) are often directly related to the operation and success of entrepreneurship programs within a university. Once again, the low number of research chairs represented when combined with world data that illustrates a high number of vacancies within university research chairs in entrepreneurship suggests an under capacity within the university system (Vesper, 1999). These numbers can also be interpreted in the light of empirical evidence that points out that ranked entrepreneurship centers have three times as many endowed research chairs than non-ranked centers (Finkle, 2006).

Reporting on technology entrepreneurship courses uncovered 12 universities (33.3%) that focused directly on high tech startups. As the survey did not prompt for further investigation into the level, program depth and history of these courses and programs, the significance of this variable at face value is ambiguous. Nonetheless, due to this variable being a possible nexus point in the examination of linkages between entrepreneurship education and USO creation, it is of considerable importance to this study (Blais, 1997).

Opinion based and attitude/belief questions were posed to entrepreneurship academics on a series of issues exploring the linkages between commercialization processes and entrepreneurship education programs. These results are highlighted in Table 2. The first three questions were related to what is happening at the respondent's university, and how it is happening. Responses were limited to an

attitudinal measurement scale of “strongly agree, agree somewhat, disagree somewhat, and strongly disagree”. Questions that elicited an unusually high number of “don’t know” responses are highlighted for analysis.

Table 2. Entrepreneurship Academics Survey Results

Survey Questions	Percentage*	Mean
1.) There are direct administrative linkages/programs between entrepreneurship faculty/programs and technology transfer officers/staff/program that are focused on commercialization activities (opportunity identification, selectivity, marketing, business plan, financing, startup launch, etc) at this institution.	58.3	2.61
2.) There are indirect linkages/personal networks/consulting (predicated upon social interaction without formal administrative structures) between entrepreneurship faculty and technology transfer officers/staff that are focused on commercialization activities (opportunity identification, selectivity, marketing, business plan, financing, start up launch, etc) at this institution.	83.3	2.11
3.) Entrepreneurship Faculty/Students participate/have participated in the commercialization of University derived Intellectual Property through the creation a startup company(s) at this institution.	58.3 /19.4**	2.69
4.) There are significant advantages that can be derived from greater collaboration between Technology Transfer Offices and Entrepreneurship Programs.	86.1	1.56
5.) The involvement of top university administration has more influence over commercialization success than Entrepreneurship Programs.	36.1	3.0
6.) Administrative barriers exist that serve to limit the collaboration between entrepreneurship programs and the commercialization of University research.	47.2	2.86
7.) The potential of commercialization outcomes could be improved if Entrepreneurship Centers and Technology Transfer Offices were merged into a single administrative unit responsible for research, teaching, outreach and University IP management.	30.6/22.2**	3.28
8.) Entrepreneurship programs developed specifically for faculty scientists, engineers and graduate students would increase the commercialization success of University derived research, ceterus paribus.	83.3	2.00
9.) Entrepreneurship and IP commercialization Programs are created or evolve independent of each other.	47.2	2.28
10.) Entrepreneurship Programs and IP commercialization Programs are created dependently, with one program arising from the other.	5.6/25.0**	3.53

\*cumulative of “strongly agree” and “agree somewhat”

\*\*”don’t know” responses that are unusually high

The first two questions attempt to draw from respondents the nature of collaborative activities that are taking place between entrepreneurship education programs and technology transfer processes within the university from the perspective of the entrepreneurship side. Although 58.3% believed that there were direct administrative linkages between the two, there appears to be an overwhelming emphasis on indirect and less formal processes that exist within the institutional environment that contributes to collaboration between entrepreneurship programs and university commercialization of IP. This supports the theory that latent entrepreneurship arises in an environment that is rich in IP (opportunity) and that these networks exist as local group norms outside of formal administrative structures (Siegel, 2004).

Balancing the above with question three, (whether students and or faculty have participated in USO’s), once again, 58.3% were aware of or believed that this activity took place within their university. As the respondents who answered, “don’t know” were unusually high, further analysis is necessary to understand the fully complexity of the responses. It is possible that informal networks that exist as posited by the responses in question 2 (indirect linkages) highlight asymmetric information issues that are concomitant with these activities. There may also be disconnects between activities that are carried out within the purview of university commercialization processes, indicating a bureaucratically stove piped relationship. Lastly, the prevalence of USO’s within some universities is highly rare. Administrative mandates within the university may be more in line with licensing technology than spinning it out (AUTM, 2005).

The remaining seven questions administered in the survey strove to capture the attitudes and perceptions of entrepreneurship academics with relation to entrepreneurship programs and technology transfer. Fully 86.1% of respondents agreed, or strongly agreed with question four: “there are advantages to collaboration between the two processes”. Of interest, there were no “strongly disagree” responses instigated by this question. Evidence from this paper thus corroborates a large body of

literature that acknowledges the significance of entrepreneurship education in the USO process (Shane, 2004; Etkowitz, 2001; Boni, 2005, Fitzsimmons, 2004; Siegel, 2004; Audretsch, 2004).

University top administration is referred to in question five with only 36.1% of respondents indicating that they believed it was not as important as entrepreneurship education in the success of USO's. This result may be limited in its explanatory power as the question is written as to bias entrepreneurship academics. Siegel and Phan (2004) believe that the highest levels of university administration must direct the strategic processes that impact upon the spin out process, while Pries and Guild (2004) require a comprehensive framework around university commercialization activities that reflect a variety of substantial approaches to technology transfer. In contrast, question six pertaining to administrative barriers preventing collaboration reveals that entrepreneurship academics believe or have experienced institutional bureaucracy in a more negative than constructive light (47.2%).

A paradigm shift is presented in question seven that queries whether or not integration of technology transfer processes with entrepreneurship programs would lead to a more constructive vehicle for spinning out university research. The positive responses to this question were very low (30.6%) and also resulted in a large "don't know" category (22.2%). Several assumptions can be made about this outcome. First, although entrepreneurship education and technology transfer programs have overlapping areas of concern, it is possible that the differences between them warrant maintenance of autonomy (Nelson, 2005). Secondly, the large "don't know" response reflects the reality of the lack of current models that attempt to incorporate the two. As well, there may be a simple aversion from respondents in considering this question, as well as a lack of depth of knowledge, experience, salience and motivation to analyze the question thoroughly.

Development of student and faculty entrepreneurship programs (question 8) received an overwhelmingly positive response from entrepreneurship academics (83.3%). As graduate students and faculty researchers involved in engineering and science are an empirically significant factor in the USO process, the idea of providing entrepreneurship education in order to propagate higher propensities to spinout within these groups is understandably appealing and in character with respondents (Witt, 2005). The debate as to whether or not entrepreneurship can be taught has long been put to rest, and that education can both motivate and contribute to greater success in starting a new venture is a fundamental theory within the field (McMullen, 1987; Low, 1988; Vesper, 1999; Kuratko, 2005).

The last two questions are designed to detect deeper foundational connections between the emergence of entrepreneurship and technology transfer programs within the modern university system. Both of these processes are relatively new, sharing a history of evolution that are closely paralleled in their growth and significance (AUTM, 2005; Kauffman Center, 2001). In question nine, respondents are asked whether or not they agree with the statement that entrepreneurship and technology transfer programs are created or evolve independently of each other. Question ten posits the reverse: that these two processes were created or evolved dependent upon the other. Perhaps due to context effects in terms of question order, the second question drew only a meager 5.6% positive response rate while the former evoked a halfway 47.2% for independent evolution. The large "don't know" response in the latter question of 25% perhaps allows one to intimate some confusion in understanding the question. Undeniably, the results are highly negative to any dependency upon evolutionary pathways between entrepreneurship and commercialization structures and programs. What is unclear is whether or not the question imposes an administrative foundation within the mind of the respondent, or if the two processes have reached an evolutionary stage where they are thereby universally perceived and defined as autonomous and independent structures.

Multivariate testing was used to help further analyze the data. Dummy variables were created from structural, resource and program information provided by respondents and then compared again ordinal data resulting from expert opinions and attitudes of entrepreneurship academics. Variables that demonstrated significant correlations on either a 0.05 or 0.01 level are tabulated below.

Table 3. Significant correlations between survey variables

Correlations	Tech Entship Courses/	Entship Program Endowm	Research Chairs	EE programs created	Student /Faculty participat	Case Studies of USO	Admin Barriers to Coll.	EE evolve independ
--------------	-----------------------	------------------------	-----------------	---------------------	-----------------------------	---------------------	-------------------------	--------------------

ENTREPRENEURSHIP EDUCATION

	program s	ents		depend w/ TTO	ed in USO			ent of TTO
Indirect EE/TT	.419*	.372*			-.395*	-.440*	.371*	.409
Student/ Faculty participa ted in USO	.375*			.429*	X			
USO case studies	.488*					X		
EE Centers		.622**						
Direct EE/TT		.506**	.353*					
Program Level		.363*	.413*					
Integrate TT / EE				-.450*				

\* Correlation is significant at the 0.05 level (2-tailed).

\*\* Correlation is significant at the 0.01 level (2-tailed).

Of critical interest to this paper is to interpret and define variables that may offer some insight into possible linkages between entrepreneurship education programs and the university commercialization process. Therefore, entrepreneurship programs that specifically focus on technology startups are highly important to this study and provide an obvious starting point for investigation. Pearson tests reveal weak correlations at the 0.05 level between those institutions that have technology entrepreneurship courses/programs and three opinion/attitude responses: 1) Indirect networks for EE and TT programs 2) Student/Faculty participation in USO's, and 3) USO Case Studies. The last two results are explainable through the involvement of students within technology entrepreneurship programs utilizing case studies on USO's and experiential education (participation in USO's). Correlation between indirect networks and technology entrepreneurship programs suggest that there is a heavy reliance on informal networks over direct administrative linkages, even within formal EE programs focused specifically on high technology venture creation.

The variable "entrepreneurship endowments" signifies the presence of external funding given to a university or school with the mandate of funding and developing entrepreneurship programs. As budgets have been identified in previous studies as a key factor in developing and implementing successful EE programs, schools with endowment money, ceterus paribus, should have a significant advantage in resources over those schools that do not (Finkle, 2006). Correlations with several other variables confirm this fact. Endowments are strongly correlated with the presence of EE centers and higher levels of Entrepreneurship education programming (PhD and graduate programs). Simply put, you get more "bang" from big bucks.

More interesting is the fact that endowments are strongly correlated with "direct" linkages to EE and TT, while "indirect" linkages are significant, but at a weaker 0.05 level. Implications from this result may be that entrepreneurship programs that are well funded have the resources to catalyze formal collaborative structures with technology transfer components residing within a university. Ensley (2005) has theorized that the university subscribes to aspects of institutional isomorphism, but that formal coercive pressures within an environment can play a role in guiding culture. Extending this theory, it is logical to assume that a strong enough core of entrepreneurship programming may ultimately create reverse mimetic behaviors that are exported into other areas of the university. Greater amounts of resources available to manage collaboration between the two may thus leverage the creation of formal pathways between tech transfer and entrepreneurship programs.

Reinforcement of this resource theory is further extended by significant correlations between research chairs, direct support for linkages between TT and EE programs and program levels. Once again, funding provided through research chairs (a resource wealth) generates greater amounts of formal activities that could be put to use in bridging information/process gaps between commercialization and educational programs that accommodate/promote this activity.

Two further significant correlations are considered. Entrepreneurship academics beliefs that EE and TT programs are created and evolve dependently with other correlate positively with "faculty and

student participation in USO's" and negatively with "advantages to integrated EE and TT". A solvent translation of the correlations could be constructed as academics involved in EE programs involve faculty and student participation in USO's believe there is dependency between the evolution of the two programs. This is a simple extrapolation but a logical assumption considering other results and extant literature on the subject. Universities where their students and faculty actively participate in the USO are cogent of the interdependencies between the technology transfer programs and educational (experiential) curriculum developed from the entrepreneurship program. This may also signify the belief that further evolution must better work to evolve these processes in a collaborative manner. The negative response to an integrated structure involving both EE and TT functions reflects the theoretical development posited by Nelson (2005) that they are different enough to still warrant autonomy.

The last variable to be examined is the "Indirect EE and TT linkages exist" line within Table 3. Although this variable has been analyzed before through other comparisons, the significance of generating so many correlations with other variables warrants further consideration as to the interpretation of these results. The correlations with "administrative barriers to collaboration" and "EE programs evolve independently" could thus be reconciled as barriers do exist, and that the two functions should be /or mostly are independent. Reviewing the rest of the correlates supports this interpretation of the data. Negative with "USO case studies" and "student faculty participation in USO's" suggest that these activities do not take place in environments heavily dependent upon indirect linkages. As referred to above previously, "indirect linkages between TTO and EE" can be positively correlated with technology entrepreneurship courses, and endowments as well.

This resulting high level of explanatory power emanating from the variable "indirect linkages between TT and EE programs" is not a surprising outcome. Further attention to this variable and its empirical implications will be covered in depth in the next section.

## Discussion

There appears to be a considerable amount of discrepancy from entrepreneurship academics on the levels and types of collaboration that exist or should be implemented between entrepreneurship programs and technology transfer offices. Technology entrepreneurship correlating weakly with indirect linkages to collaboration suggests many things: 1) that there are currently not many effective strategies in place that allow for constructive direct linkages between the two functions, 2) the majority of the impact derived from technology entrepreneurship programs are indirectly facilitated outside of direct administrative linkages and are more individually driven, 3) and that student and faculty participation may stem from the indirect application of new knowledge, skills and experience gained through these programs. As the support for hypothesis one is mainly opinion driven, there may be merit in comparing the efficacies of these programs with actual USO outcomes.

Little support for hypothesis 2 is generated, but the significance of direct linkages and resources such as endowments and research chairs is significantly correlated. As well, both endowments and research chairs are correlated with higher levels of entrepreneurship programs such as those that deliver PhD's. These results confirm other studies that state resources are an important in building top ranked programs. This offers little into the examination of linkages between EE programs and TTO's but the statistical reassurance of these results offers them as credible control variables.

There is low support for hypothesis three as only 33% of respondents felt that there were significant advantages to be derived from the integration of EE and TTO programs under one roof, although there was a considerable amount of "don't know" responses. As well, nowhere was this variable significant with others. Yet over 86% of respondents viewed collaboration between TTO and EE programs as extremely important to the USO process. Once again, this may signal the effects of a larger contingent of activities that are indirectly attributed to network externalities and the overall growth of entrepreneurial capacity, routines and experience in the USO process. Those academics that responded strongly to indirect linkages also felt that there were administrative barriers to greater collaboration. It is also shown that correlation exists between indirect linkages and TTO's and EE programs evolving independent of each other. These results support Nelson's (2005) contribution that these two functions are overlapping, but still differentiated enough to require them to maintain autonomy. Overall, indirect linkages garnered the second highest strong results in reporting.

There are understandably limitations to this study. As an examination of entrepreneurship academics attitudes and beliefs towards USO's, it does not offer much in way of tangible evidence on outcomes. The findings are more exploratory and are confined to the salience and experience of respondents who may have limited knowledge with technology transfer. What this study does provide is an interesting perspective from the viewpoint of stakeholders that are in many respects, are critically involved in the overarching issues of commercialization and entrepreneurial pathway building within modern universities. Thus the evidence provided in this paper does pose interesting avenues for new research.

## Conclusion

Caught between the demand-pull of a global knowledge economy and the societal push for its enhanced role in regional development, the modern university is concomitantly an agent of change and also an evolutionary example of it (Clark, 1998; Drucker, 1985). This ongoing transformation involves the creation of entrepreneurial pathways throughout all aspects of what the university is and does. In essence, the university as an organization is introspectively central to many levels of entrepreneurial examination, ranging from the cognitive (and the behavior of the individual), to social networks, environments and capacity (knowledge), to the emergence of new economic activity through firms and organizations, to the overarching social impacts that result (Low, 2001; Gartner, 2001; Aldrich, et al., 2001; Ucbasaran et al., 2001).

Therefore it is imperative to consider the linkages between entrepreneurship programs and technology transfer from many different perspectives. Entrepreneurial theory has a great deal to offer universities in transition. As the USO becomes an increasingly important piece of the commercialization process, those with understanding and expertise in both the applied and research ends of entrepreneurship will gain increasing value. With enough evidence presented on the significance of entrepreneurship in these processes, the question then focuses less on the "why" and more on the "how" of creating collaborative models for commercializing IP through spin outs.

## References

- Aldrich, H. (2001) "Many are Called, but Few are Chosen: An Evolutionary Perspective for the Study of Entrepreneurship", *Entrepreneurship: Theory and Practice*, Vol. 25, Issue 4 pp. 41.
- Binks, M., Starkey, K., Mahon, C. (2006) "Entrepreneurship education and the business school" *Technology Analysis & Strategic Management*, Volume 18, Number 1.  
[http://www.aucc.ca/about\\_us/membership/ourmemb\\_e.html](http://www.aucc.ca/about_us/membership/ourmemb_e.html)
- Blumenthal, D. (1996) "Relationships between Academic Institutions and Industry in the Life Sciences — An Industry Survey", *New England Journal of Medicine*, Vol. 334, No.6. pp. 368-374.
- Bradburn, N. (2004) "Asking Questions", San Fransisco: Jossey-Blass Publishers.
- Clark, B.R. (1998) "Creating Entrepreneurial Universities; Organizational Pathways of Transformation", IAU Press, New York.
- Degroof, J., Roberts, E. (2004) "Overcoming weak entrepreneurial infrastructures for academic spin off ventures." *Journal of Technology Transfer* 29. p.327-352.
- Drucker, P. (2002) "Innovation and Entrepreneurship", Perfectbound Publishers: London.
- Etkowitz, H. (2004) "The evolution of the entrepreneurial university." *International Journal of Technology and Globalization*, Vol.1, No. 1. pp 64-77.
- Finkle, T., Kuratko, D., Goldsby, M. (2006) "An Examination of Entrepreneurship Centers in the United States: A national survey," *Journal of Small Business Management*, Vol. 44(2) pp. 184.
- Franklin, S., Wright, A., Lockett, M. (2001) "Academic and surrogate entrepreneurs in university spin-out companies". *Journal of Technology Transfer* 26 (1-2), p. 127-141.

- Gartner, W., Vesper, K. (1994) "Experiments in Entrepreneurship Education: Successes and Failures," *Journal of Business Venturing*, 9(3), p.179-189.
- Gartner, W. (2001) "Is There an Elephant in Entrepreneurship? Blind Assumptions in Theory Development", *Entrepreneurship: Theory and Practice*, Vol. 25, Issue 4. pp. 27.
- Heckathorn, D. (1997) "Respondent-driven sampling: A new approach to the study of hidden populations", *Social Problems*, Vol. 44, pp. 174-199.
- Hindle, K. (2001) "Entrepreneurship Education at University: The Plus Zone Challenge," *Small Enterprise Research*, Vol. 2, p.3-16.
- Hindle, K. (2002) "How Entrepreneurial Capacity Transforms 'Small-I' into 'Big-I' Innovation: Some Implications for National Policy," *Telecommunications Journal of Australia*, Vol. 52, No. 3.
- Judd, C., Smith, E., Kidder, L., (1991) "Research Methods in Social Relations", Fort Worth, TX: Harcourt, Brace Jovanovich.
- Ibrahim A.B.; Soufani K. (2002) "Entrepreneurship education and training in Canada: a critical assessment," *Education + Training*, Volume 44, Numbers 8-9, November 2002, pp. 421-430(10).
- Kolvereid, L., Moen, (1997) "Entrepreneurship among Business Graduates: does a major in entrepreneurship make a difference?" *Journal of European Industrial Training* 21 (4). 154-160.
- Laric, M., Rinker, A., Herron, L. (2000). "A Decade of Experiential Entrepreneurship Education: Opportunities in Commercializing Technology", Baltimore: Merrick School of Business.
- Lockett, A., Siegel, D., Wright, M., Ensley, M. (2005) "The creation of spin-off firms at public research institutions: Managerial policy implications", *Research Policy*, 34, p.981-993.
- Lockett, A., Wright, M. (2005) "Resources, Capabilities, Risk Capital and the Creation of University Spin Out Companies", *Research Policy*, 34, p. 1043-1057.
- Low, M. (2001) "The Adolescence of Entrepreneurship Research: Specification of Purpose", *Entrepreneurship: Theory and Practice*, Vol. 25 Issue 4. pp. 7.
- Markman, G., Gianiodis, P., Balkin, P., Phan, P. (2005). "Entrepreneurship and University Based Technology Transfer," *Journal of Business Venturing*, 20, p. 241-264.
- Marshall, Budd, Givens, Fountain, (2005). "Entrepreneurial Assessment of Technology Commercialization and New Venture Formation Using a Decision Matrix to Direct Commercialization Strategies", Tampa Bay: The Center for Entrepreneurship at the University of South Florida, University of South Florida.
- Menzies, T., Paradis, J. (2002) "Encouraging Technology Based Ventures: Entrepreneurship Education and Engineering Graduates", *New England Journal of Entrepreneurship*, Vol. 5 No. 2. p. 57-63.
- Menzies, T. (2004) "Are Universities Playing a Role in Nurturing and Developing High Technology Entrepreneurs?" *The International Journal of Entrepreneurship and Innovation*, Vol. 5, No. 3, p.149-157.
- Moray, N. Clarysse, B. (2005) "Institutional Change and Resource Endowments to Science Based Entrepreneurial Firms", *Research Policy*, 34, p. 1010-1027.
- Nelson, A., Byers, T. (2005) "Organizational Modularity and Intra-University Relationships Between Entrepreneurship Education and Technology Transfer," Stanford University Colloquium on Entrepreneurship Education and Technology Transfer.
- O'Shea, R. Allen, T. Chevalier, A. Roche, F. (2005) "Entrepreneurial Orientation, Technology Transfer and Spinoff performance of U.S. Universities, *Research Policy*, 34, p. 994-1009.
- Roberts, Malone, (1996) "Policies and Structures for Spinning Off New Companies From Research and Development Organizations". *R & D Management*, 26 (1), p. 17-48.
- Ropke, J. (1998) "The Entrepreneurial University: Innovation, academic knowledge creation and regional development in a globalized economy", Phillips-Universität Marsburg Germany.
- Shane, S. Venkataraman, S. (2000) "The Promise of Entrepreneurship as a Field of Research", *Academy of Management Review*, Vol. 25, No. 1, pp. 217-226

- Shane, S. (2004) "Academic Entrepreneurship: University Spin-offs and Wealth Creation," Edward Elgar Publishing.
- Siegel, D., Phan, P. (2004). "Analyzing the Effectiveness of University Technology Transfer: Implications for Entrepreneurship Education," No.426, Colloquium on Entrepreneurship and Technology Transfer, Karl Eller Center, University of Arizona.
- Stevens, A., Toneguzzo, F. Eds. (2004) "AUTM Licensing Survey: FY 2003," Association of University Technology Managers: Northbrook, IL.
- Ucbasaran, D. (2001) "The Focus of Entrepreneurial Research: Contextual and Process Issues", *Entrepreneurship: Theory and Practice* , Vol. 25, Issue 4. pp.57.
- Witt, U., Zellner, C. (2004) "Knowledge Based Entrepreneurship: The Organizational Side of Technology Commercialization," Technical report, 2005. JEL classification: L23, M13, O31, O32.  
<http://infoscience.epfl.ch/getfile.py?recid=52229&mode=best>.
- Wright, M., Vohora, A., Lockett, A. 2004. "The formation of high-tech university spin-outs: the role of joint ventures and venture capital investors," *Journal of Technology Transfer* 29 (3-4), p. 287-310.
- Yencken, J., Gillin, M. (2003) "Entrepreneurial Capacity and the New Technology-Based Small Firm," A paper for the Small Enterprise Association of Australia and New Zealand 16<sup>th</sup> Annual Conference, Ballarat, 28 Sept - 1 Oct.
- Zucker, L., Darby, M., Armstrong, J. (1998). "Geographically localized knowledge: spillovers or markets?" *Economic Inquiry* 36 (1), 65-86.