Replication of Faculty Spin-off Programs at Smaller College and University Cohorts

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Abstract In 2009, Georgia Institute of Technology (Georgia Tech) was approached by several smaller colleges and universities in the United States for commercialization assistance. Since that time, Georgia Tech, a national leader in intellectual property creation and commercialization, has been attempting to replicate its successful faculty spin-off program, VentureLab, at these smaller cohorts. This effort is rooted in the belief that spin-off worthy innovation exists at smaller colleges and universities without a process to reach fruition, limiting the potential economic impact of federally sponsored innovation. Academic publications around university commercialization and faculty spin-offs suggest various variables which influence the outcome of university technology transfer efforts. This paper discusses these variables and others in the context of our efforts with interviews at eleven institutions. The findings suggest additional factors for consideration in the replication of large university commercialization programs at resource constrained, smaller colleges and universities.

Key words Faculty - spin-off – startup – hybrid – university - commercialization

1.0 Introduction

Since 2009, Georgia Tech has been approached by several smaller colleges and universities in the United States to exchange best practices for intellectual property licensing. With funding and guidance from the Economic Development Administration, we were able to meet with numerous colleges and universities to discuss their unique situations. From that work, Georgia Tech has been able to develop a process for working with many of these smaller cohorts[1]. This paper contains a brief history of university intellectual property management, an overview of common pathways for innovation at universities, a discussion of types of university startups, and a best practices review for smaller colleges and universities.

1.1 Brief History of U.S. University Intellectual Property Management

Today's concept of technology transfer originated in a 1945 report from Vannevar Bush, Director of the Office of Scientific Research and Development, to President Franklin Roosevelt. In "Science, The Endless Frontier", Bush encouraged a centralized approach to government sponsored research toward scientific progress and stressed the importance of basic research in improving health, security, and public welfare of the United States. The report recommended the creation of a Science Advisory Board and eventually led to the inception of the National Science Foundation (NSF) in 1950 to increase the flow of new scientific knowledge through sponsoring basic research and developing scientific talent. To support both applied industry and basic research, Bush also recommended that the government strengthen the patent system and clarify uncertainties in the tax code (Bush, 1945).

Although this report played a pivotal role in shaping science policy and promoting basic research, taxpayer dollars were spent on a myriad of technologies and inventions, but only a handful actually made it to market. While the National Institute of Health (NIH), Public Health Service (PHS), and Health, Education, and Welfare (HEW) were important sponsors of research, little was done to address the ownership of technologies and the intellectual property that was created.

[1] Smaller is relative to the sponsored research budget. The exact definition of smaller will be provided in section 3.1.

To transfer ownership from government to an academic institution, NSF and HEW developed Institutional Patent Agreements (IPA) detailing the conditions for university ownership (Mowery and Sampat, 2001a). These agreements allowed universities to own inventions they created under government-sponsored research projects and then grant exclusive licenses with private enterprises to develop university technology. However, the IPAs were cumbersome because each university had to negotiate separately with various government agencies (Mowery, 2001).

To address weaknesses in IPAs, Congress passed the Bayh-Dole Act that enabled the commercialization of these inventions between all universities and all government agencies. Another significant legislation promoting technology transfer is the Stevenson-Wydler Technology Innovation Act of 1980, which mandates Federal laboratories to actively seek opportunities to transfer technology to private industry, universities, and state and local governments, giving preference to U.S. based businesses where partners agree to manufacture in the U.S. (Industrial Partnerships Office, 2005).

While some universities had experimented with licensing Bayh-Dole innovations prior to 1980 (Roberts, 1991), the practice was bolstered by the 1980 act. According to Mowery and Sampat (2001b), the passage of Bayh-Dole spurred a dramatic expansion in technology transfer offices from 25 to over 200 from 1980 to 1995. The AUTM (Association of University Technology Managers) 2008 Licensing Survey reported that a staggering 3,381 startup companies, founded on university licenses, were in operation at the end of 2008 (Kordal, Sanga, and Tieckelmann, 2009).

The Bayh-Dole act of 1980 that launched university commercialization has been touted as "the most inspired piece of legislation to be enacted in America over the past half-century" (The Economist, 2002). Universities across America became centers of innovation and their researchers were able to commercialize inventions by creating new companies or licensing technology. Proponents of Bayh-Dole argued that millions of taxpayer dollars were spent developing technology that would not benefit the public good. They claimed companies were not willing to invest their own money to develop a nascent technology without rights to make a profit on their investment. An abundant number of technologies have been developed and brought to market as a result of Bayh-Dole that have led to firm and job creation, increased revenues, and access to otherwise potentially shelved technology.[2]

While some have hailed the Bayh-Dole Act for revolutionizing university commercialization and technology transfer, others have criticized the legislation for distorting universities' missions and research priorities to overspending of taxpayer dollars. A major issue was giving companies exclusive rights to publicly funded research that would later sell that technology to the consumer. Another criticism of the Bayh-Dole Act is that corporate sponsored research is changing the tenets of universities and higher education such as disinterested inquiry and information exchange through confidentiality agreements and publishing delays. (Press and Washburn, 2000; Thursby and Thursby, 2003; The Economist, 2005). Press and Washburn (2000) have argued that "universities themselves are behaving more and more like for-profit companies". Most all university commercialization and technology transfer literature posits that 30-years post Bayh-Dole, there have been shifts in university-industry relations, although the literature varies on raising practical or abstract questions about the changing dynamics.

1.2 Various Intellectual Property Models for U.S. Universities

Figure 1 illustrates common pathways for the management of intellectual property generated at U.S. universities. This effort was undertaken to depict a conceptual university ownership model (outlined rectangles) through output nodes which result in university startups (shaded rectangles), juxtaposed against alternate university ownership models and an inventor ownership model (outlined shapes with missing corners) discussed in recent literature (Kenney and Patton, 2009). At its core, this illustration serves to define the term spin-offs for this study and portray the myriad of paths that inventions can travel in between creative spark and perceived outcome.

[2] Press and Washburn (2000) reported that university commercialization adds 2,200 new firms, over 260,000 new jobs, tax revenue, and contributes $40 billion annually to the economy.

The starting point for this flowchart is the investment in sponsored research by industry clients and the federal government. A large majority of the industry funded research at universities is for the most part directed by industry and frequently in collaboration with industry. Therefore, intellectual property rights developed with industry are often encumbered and not available for licensing to third parties. However, as a result of the 1980 Bayh-Dole Act in the United States, the intellectual property from federal government sponsored research is the sole property of the university or universities which conducted the research. Therefore, the nodes depicted relate primarily to the processing of federally sponsored research.

1.2.1 University Ownership Model

First, the most common and pervasive university ownership model (outlined rectangles) will be reviewed. Through a process of in-reach to the faculty, deans, and chairs within the university, the Technology Transfer Office (TTO) solicits disclosures for inventive effort. In some cases, the TTO engages directly in ideation around the potential applications for research results.

In addition to the traditional TTO structure, there are two other methods by which inventions are disclosed and resolved. Also, several examples of public/ private partnership alternatives are provided for post-disclosure technology transfer agents, post-patent licensing agents, and post-license gap or seed funding agents.

- ***Public/Private Partnership Case (Post-Disclosure):*** In 2003, Noetic Technologies, a for-profit company, signed a service contract with the University of Southern Mississippi (USM) to serve as its TTO. Noetic Technologies screens disclosures, helps researchers determine the most appropriate path, and then provides step-by-step assistance throughout the commercialization process. Under this contract, Noetic also serves clients outside the university sector, including research organizations and private companies, and acts as the point of entry for companies interested in sponsoring research at the University. Noetic has a fixed-fee service agreement with the University of Southern Mississippi and can earn additional revenue from entities outside the university sector through licensing royalties, equity shares, or management fees which vary based upon the engagement and task.

  Noetic Technologies provides a variety of services to help commercialize a product early in the process, starting with screening university disclosures. Once a technology has been assessed, Noetic works with the inventor to determine the appropriate commercialization path (for example, license, patent, or publish) and assists them with the process. Noetic licenses technologies to third parties or, if appropriate, aggregates related licenses as a package. It also operates an incubator in a technology park near the USM campus.

  In collaboration with the Mississippi Technology Alliance, Noetic Technologies helps inventors apply for state sponsored seed funding. Alternately, as a for-profit organization, Noetic can choose to invest its own funds in a startup venture. Noetic provides coaching and management to the researcher, such as market research or intellectual property assessments, or it may develop a management team around the invention. With access to industry, angel investors, and service providers, Noetic serves an important network function for researchers. In addition, Noetic bolsters industry-university relations by representing the university at trade shows and other industry sponsored events.[3]

- According to the literature, there exists a faculty “gray market” for the transfer of intellectual property to industry, circumventing the established technology transfer mechanisms. The faculty can publish their research (Kenney and Patton, 2009), leave the university to form a company without disclosing (Nicolaou and Birley, 2003), form a startup company while maintaining their faculty position (Audretsch, Aldridge, and Ottel, 2006), and/or consult directly with a firm transferring intellectual property for fees or equity (Thursby, Fuller, and Thursby, 2009).

Returning to the path of ideation/invention disclosures to TTO in Figure 1, the disclosures are initially reviewed for encumbrances such as classified research categorization and multiple inventors across

[3] See http://www.noetictechnologies.org/

institutions. Those deemed to be unencumbered will be screened for patent applicability, open source applications, or dissolution based upon technical and market assessments.

For those disclosures which are patented, the university will typically pursue licensing to an established firm, a new firm, or a spin-off formed within the university. Those that are not licensed remain on the shelf, perhaps to be reviewed again for license as technology and markets evolve. According to the 2008 AUTM licensing survey, 16.8 percent of licenses are assigned to new firms/startups (Kordal et al., 2009).

Public/Private Partnership Case (Post-Patent): Aetos Technologies is an example of a private company that seeks out inventions and launches startup companies as a private partner to a university. In 2003, Auburn University's TTO invited Aetos to its campus to facilitate university commercialization pursuits. Although Aetos is an equity partner with Auburn, the company also co-develops projects with individuals, private companies, research organizations, and other universities. Aetos receives management fees, operating income, or equity shares of any assets for its services, depending on the type of invention. Aetos is located in the Auburn Technology Park, in close proximity to the university's TTO and faculty researchers.

Aetos enters the commercialization pathway after a technology has been disclosed and patented by Auburn. At this stage, Aetos provides technology evaluations, product/process development support, and management and financing resources. For promising inventions, Aetos guides the technology through the one of several commercialization paths: (1) obtaining license rights from Auburn and then sub-licensing the invention to a third-party, (2) taking an invention directly to market though a spin-out, or (3) securing co-development partnerships to generate cash flow and establish a planned exit strategy. Currently, Aetos does not bundle licenses for third parties, however the potential is ripe based on the types of technology developed at Auburn (for example, Molecular Recognition).[4]

University commercialization literature provides three designations for licensing innovations to startups: technology (a firm is created independent of the university with no formal affiliation with faculty inventor), hybrid (faculty stays with university and participates in ownership of the startup), and orthodox (faculty leaves university to create startup) (Smilor, Gibson, and Dietrich, 1990; Nicolaou and Birley, 2003). For purposes of this paper, portions of the methodology will focus on the subset of hybrid spin-offs.

Public/Private Partnership Case (Post-License): The Business Acceleration and Technology Out-licensing Network (BATON) is one of many programs housed within the North Carolina Biotechnology Center, a private, non-profit organization funded through taxpayer dollars. The Biotechnology Center's mission is to provide long–term economic and societal benefits to the state through supporting biotechnology research and business, education, and policy development.

BATON serves North Carolina University TTOs, research organizations, and individual inventors throughout the state in development of startups. University TTOs manage the disclosure, screening, and vetting process internally. Afterwards, if a university intends to form a biotech startup, the university can request assistance from BATON to secure service providers, network opportunities, and financing.

As part of providing access to financing, BATON offers gap or seed funding from the Biotechnology Center. Also, BATON offers coaching to assist inventors in developing business plans, setting financial goals, creating strategic development plans, establishing milestones, and researching market regulatory paths. BATON also helps a startup build a management team and provides access to network professionals, venture capitalists, angel investors, and potential customers. It has created a list of service providers that provide discounted services (pro bono, discounted, at cost, deferred, equity exchange) for a wide variety of startup needs. With the overarching goal of economic development, BATON attempts to foster startups that will create jobs and contribute to the state's economy.[5]

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[4] See http://www.aetostech.com/

[5] See http://www.ncbiotech.org/baton

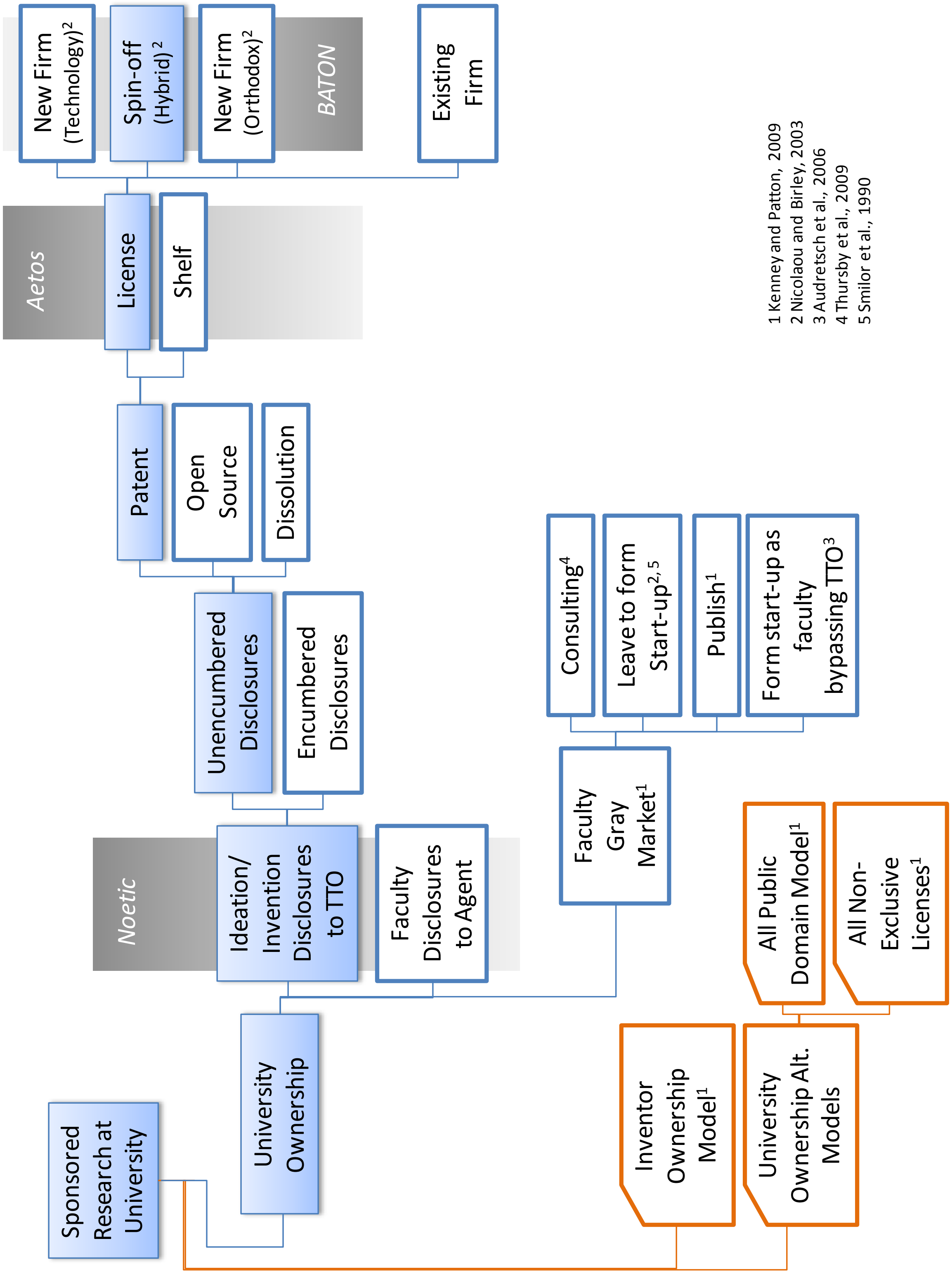

Figure 1: Common commercialization pathways for intellectual property generated at U.S. Universities

1.2.2 Inventor Ownership Model

Kenney and Patton (2009) describe the strengths and weaknesses of both the inventor ownership model and the current university ownership model. As proposed, with changes in federal policy and TTO procedures, the faculty would be able to choose the commercialization path and agent for bringing their innovations to market. In this environment, the university is merely a possible agent for the faculty. The authors postulate that TTO offices with effective practices will remain a viable commercialization choice for faculty.

1.2.3 Alternate University Ownership Model

Conversely, Kenney and Patton (2009) detail two strategies by which universities could retain their ownership of intellectual property while increasing the impact on these inventions on the economy. First, the authors suggest the classification of all Bayh-Dole intellectual property as public domain. This would foster the greatest dispersion of intellectual property across the economy. Second, the universities could adopt a 100 percent non-exclusive license strategy. In this manner, the universities would foster greater impact by enabling all competitive companies, not just a single entity. In addition, the universities would receive some compensation for TTO operations.

1.2.4 Public versus Private Institution

Jensen (2009) reported that public universities were more prolific at generating startups. This observation is perhaps in response to the economic development mission of public universities, creating local jobs. Research by Pressman (2001) and Tornatzky et al. (1995) (as cited in Shane, 2004) support the conclusions that spin-offs remain in the state where the university research emanated, creating jobs. Conversely, licenses to existing firms typically reside outside the university's state boundary, resulting in less of an economic impact for local industry and employment.

1.3 University Ownership Model: Faculty Startups and Hybrid Spin-offs

Most interestingly, 59 universities or 31 percent of AUTM Licensing Survey respondents had one or no startups in 2008 (Kordal et al., 2009). This statistic begs the question, "What are the enabling and constraining factors for these research universities?"

Based upon a review of current literature for university startups or faculty spin-offs, a model of independent factors which might influence startup activity at these research institutions has been created.[6] The literature can be agglomerated into seven categories around startup/ spin-off efforts. Figure 2 depicts a faculty spin-off (picture in center) founded based upon innovation from the university, operating in a university culture under guidance of a TTO, receiving coaching from inside and outside the university, obtaining capital from sources inside and outside of the university, accessing talent for the startup, and linking with extended networks for access to markets. The vertical blocks denote the source of factors as either intra-university or extra-university. The horizontal bars delineate the difference between human and financial capital.

[6] Unfortunately, the definition of a university startup is not consistent between reviewed literature sources. Therefore, the observations drawn from these publications must be observed under this lens.

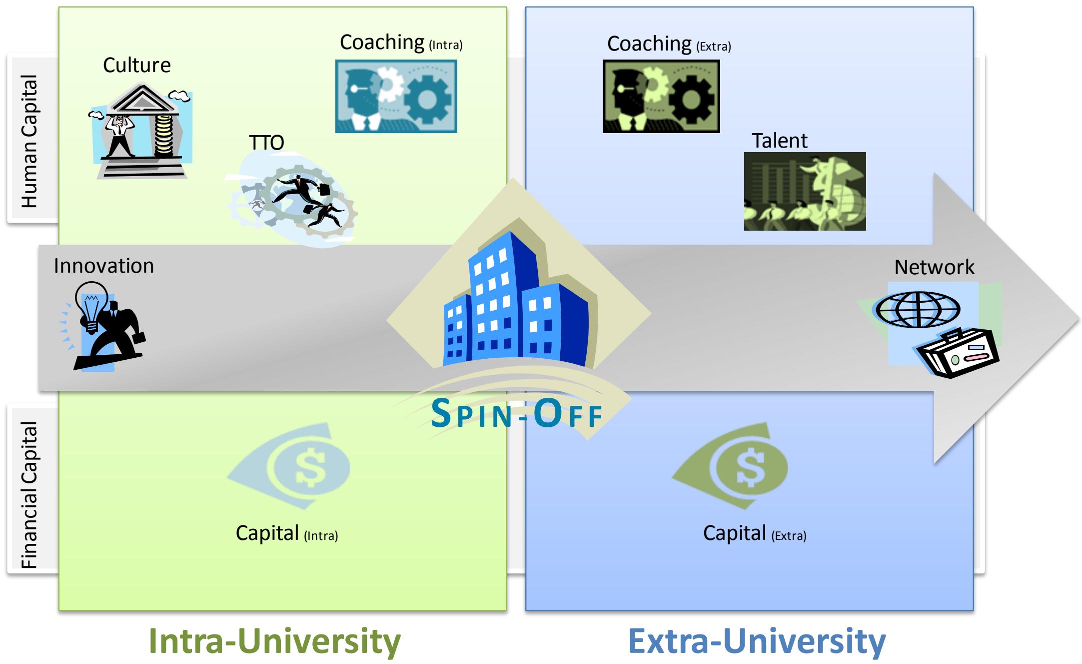

Figure 2: Model of Independent Factors Influencing Faculty Spin-offs

The following sections provide a concise review of the seven factors.

1.3.1 Innovation

Two attributes of innovation make the disclosures more appealing for university startup companies over licenses to existing firms. First, Thursby and Thursby (2000) reported that earlier stage technologies are best for licenses to university startups. In most cases, these technologies are not mature enough and require seed investments to migrate the technology along the readiness scale.[7] Second, innovations which appear to be divergent or dramatic improvements over existing innovations are more uniquely suited for university startups (Wood, 2009) as they create a large potential markets.

According to AUTM's Licensing Activity Survey for 2008, the following statistics were collected from 191 respondents. These statistics appear to cascade consecutively as a subset of the previous measure; however, there is a varied time lag effect between several of the statistics. The longest lags are between 1) patents filed and patents issued and 2) patents issued and license/options both of which could span across surveys. AUTM provides a 3 year cumulative measure of disclosures and research dollars but only single years numbers for patents filed, patents issued, and licenses.

The survey reports 595 university startup companies were defined as newly formed firms which licensed the patent. There is no distinction for hybrid, technology, or orthodox licenses as described by Nicolaou and Birley (2003).

While AUTM collects survey data, there is no reporting of ratios or relationships. There are several calculations that could contribute to the understanding of faculty startups.

[7] NASA and the Department of Defense use Technology Readiness Level continuums to measure the degree to which a technology is ready for infusion or market application.

- *Sponsored dollars per startup* (efficiency) – limited analysis because of the lag between funding and startup, and the funding is not delineated by source (federal and non-federal) or type of science.
- *Startups per license* (efficiency) – valuable data but not tied to faculty involvement with the licensor or economic development mission of the university.
- *Segmentation by funding amount and efficiency* – could suggest opportunities for programs to improve conversion of invention into innovation.

1.3.2 University Culture

Many universities question the benefits of faculty commercialization and are not willing to provide financial and staff resources to support university startup activities (Nicolaou and Birley, 2003). Therefore, any university pursuit of faculty spin-offs would need top down support for this culture (Bauer, 2001; Clark, 1998).

If the culture and resources are in place, a few respected, pioneering faculty can set the example for others in their departments and across campus (Feldman et al., 2000). Shane (2004) describes a contagion effect which can spread across the institution as more faculty spin-offs are formed (Bercovitz and Feldman, 2006; Louis, Blumenthal, Gluck, and Stoto, 1989; Kenney and Goe, 2004).

Evidence of university support for faculty commercialization can be manifested by lenient use of university resources (Tornatzky et al., 1995; as cited in Shane, 2004) and flexible guidelines around faculty participation in spin-offs (Mowery and Ziedonis, 2001). Addressing the individual researcher, Roberts' (1991) found that faculty with more extroverted personalities were the best candidates for pioneering a new spin-off initiative.

In general, the benefits of faculty spin-offs are improvements in the quality of faculty research (Louis, Jones, Anderson, Blumenthal, and Campbell, 2001), increased retention and attraction rates for faculty (Powell and Owen-Smith, 1998), and better rounded education for students (Georgia Tech TI:GER Program). Zucker, Darby, and Brewer (1998) concludes that more prestigious universities create more startups, which suggests that increasing startups within a university will improve its reputation.

Finally, it has been shown that there is a positive link between the quality of the engineering faculty, based upon National Research Council ratings, and TTO startup licenses (Jensen, 2009). This finding supports the notion of creating a university culture which attracts quality researchers with an interest in commercialization.

1.3.3 Technology Transfer Office (TTO)

Beyond top down university support for faculty spin-offs, the TTO can implement policies which can motivate faculty to create startups within the auspices of the university. The following are some of the policies found in published literature.

- *Exclusive licenses*: 90 percent of licenses offered to university startups were exclusive licenses versus only 37 percent of licenses to existing firms were exclusive (Pressman, 2001). An exclusive license provides the startup with an opportunity to mature the technology in a non-competitive environment.
- *Equity Ownership*: Feldman (2001) reported that university equity ownership had been increasing over the previous 20 years. Also, from 1993 to 1998 one study documented that 74 percent of universities elected equity share in startups (DiGregorio and Shane, 2003). Providing equity ownership in lieu of license fees eases the cash flow burden for a startup.
- *Faculty Royalty Share*: DiGregorio and Shane (2003) observed that increasing the faculty royalty share by 10 percent reduced the faculty spin-off rate by 20 percent. Therefore, to incent faculty spin-off activity, the TTO should reduce the royalty share, thus encouraging faculty startups as a means to obtain a greater financial result (ownership of firm over royalty from license).
- *Express License*: Georgia Tech has developed a certificate program for its faculty GT:IPS (Georgia Tech Integrated Program for Startups). For faculty who complete the commercialization course, the university will provide streamlined licenses, a first among U.S. universities.

In addition to policies, the staff and resources of the TTO can impact the success of faculty spin-off programs. Wright, Vohora, and Brinks (2003) wrote that many universities lack staff and resources to support faculty spin-offs, lessening their number. The AUTM 2008 survey found that 57 of 191 TTOs have five or less full-time equivalents including licensing officers, management, and all other staff (Kordal et al., 2009). Jensen (2009) compared TTO staff size and age of the TTO office to startups activity and found them to be positively related.

Also, Lockett, Wright, and Franklin (2003) found that the presence of TTO staff with startup credentials improved the office's startup activities. To face this staffing issue, some universities are choosing to contract out portions of their intellectual property management activities in order to adequately serve the institution. As mentioned earlier, Noetic is one such example. Other universities use scouts, aggregators, and other agents to license, bundle, or form startups.

1.3.4 Capital

The ability for faculty spin-offs to access capital is vital to their development. By definition, these startups are more divergent and early stage, requiring capital to mature market ready innovations. Florida and Kenney (1988) found that venture capital access is important for startup support. A study in the United Kingdom by Wright et al. (2003) observed that there was more startup activity in universities with pre-seed funding. Conversely, DiGregorio and Shane (2003) reported that availability of capital investment by universities or venture capital firms is slightly, negatively correlated to startup rates at universities.

In the AUTM 2008 Licensing Activity Study, only 12.5 percent of all the university startups formed between 2006 and 2008 received no outside funding (Kordal et al., 2009). The most prevalent sources were friends and family, venture capital, state funds, angels, and university funds. At Georgia Tech, our VentureLab program has utilized a combination of state funds, SBIR (Small Business Innovation Research), angels and venture capital, leveraging just over $14 million in state funding with over $500 million in outside investment in faculty spin-offs.

1.3.5 Coaching

In complement to traditional TTO programs, several universities are standing up what Gulbranson and Audretsch (2008) describe as proof-of-concept centers. The MIT Desphande Center and USD Von Liebig Centers are the two examples highlighted in the paper; however, Georgia Tech has its own entity in VentureLab. These centers seek to support faculty spin-offs by addressing the seven independent factors from Figure 2: innovation, culture & TTO, coaching, capital, talent, and networks. Also, these university affiliated organizations reside in close proximity to the universities, making it easier for the faculty to actively participate (Shane and Stuart, 2002).

Beyond TTOs and proof-of-concept centers, many universities have affiliated incubators. These incubators provide additional coaching outside the early formative stages of the spin-off. Incubation services generally provide support as described by the five C's developed at Georgia Tech: center, community, connections, consulting, and credibility. The Georgia Tech incubator ATDC (Advanced Technology Development Center) is one of the world's oldest and most successful incubators. It has graduated more than 120 companies which have raised over $1 billion in outside funding. Despite this success, DiGregorio and Shane (2003) found that incubation by universities is not correlated to startup rate.

1.3.6 Talent

As the life-cycle evolution of the spin-off moves further away from university influence, the publications around talent and networks becomes sparse. For Georgia Tech's VentureLab program, a significant amount of time is spent coaching faculty about the importance of securing key management talent for the spin-off. At VentureLab, serial entrepreneurs are often asked to provide guidance for these faculty spin-offs which can often lead to the serial being hired as the CEO. In addition, many incubation programs also focus on access to talent as one of their key offerings (Smilor and Gill, 1986).

1.3.7 Networks

The importance of extended support networks of service providers, customers, manufacturing partners, channel partners and others becomes paramount for these new firms' longevity and success. Nicolaou and Birley (2003) state that these "exo-institutional networks" for university startups help assure that faculty will stay at the university while maintaining ownership of a portion of the startup.

2.0 Methodology

The methodology for this paper is multimodal. First, we examined the AUTM 2008 Licensing Activity Survey to understand the connections between research, disclosures, licenses, and startups. In addition, we are testing a hypothesis that there is an underserved group of smaller colleges and universities that can support faculty spin-offs. For this group, we will try to identify best-in-class universities to survey in future work.

Second, the NSF's (National Science Foundation) WebCASPAR database contains self-reported survey information on research funding by type of source and type of science. We will review this data for a proposed segment of smaller colleges and universities.

Third, we will assess our past work and relationships with eleven smaller colleges to present data on overall trends for cohort strengths and weaknesses. Web sites for the eleven will also be reviewed.

Fourth, our effort will include a summary of the literature nomenclature for startups and spin-offs around university licensing.

3.0 Research Results

3.1 University Research and Licenses to Startups

Based upon data contained in the AUTM 2008 Licensing Survey, there is a positive relationship between research expenditures and number of university licenses let to university startups (Kordal et al., 2009). [8,9,10] There is clearly a lag in the conversion of research dollars into disclosures, and licenses into startups (sometimes years); however, the long term research budgets for these universities are fairly stable, making this analysis plausible.

Given this relationship, as research dollars decline in the AUTM respondent population so do the number of licenses to startups. In fact, of the 41 universities reporting no licenses to startups in 2008, 34 (or 83 percent) had research funding below $200 million. Because a large proportion of the universities without startups are found in this less than $200 million segment, those universities will be the target for our study. As a point of perspective, for 2008, these 34 universities collectively represented over $2.3 billion in research which was not connected to a startup.

3.2 Targeting Smaller Colleges and Universities (<$200 million in research)

3.2.1 AUTM 2008 Licensing Survey Data

Utilizing AUTM 2008 data for universities with at least one startup, measures of university startup performance were calculated for four subsets of the survey respondents. Based upon the obvious differences in startup activity $200+ million and under $200 million in research, these two groups were selected for analysis. In the course of the effort, smaller subgroups from the under $200 million and $200+ million

[8] All AUTM data utilized for this paper excludes U.S. Hospitals and Research Institutions, Canadian Institutions, and Third-Party Technology Investment Firms.

[9] The AUTM research expenditure amounts are inclusive of federal, industrial and other funding. The survey does not collect hard science research funding which typically leads to spin-offs.

[10] In 2008, AUTM defined a startup as a new entity formed to receive a license from the university. The definition could be more specific to include breakouts for hybrid, orthodox, and technology startups. Additional information on lineage of the technology licensed for each type of startup would assist future analysis.

segments were created based upon their performance generating 3 or more startups.[11] From the segmentation, a group of 19 universities has emerged with BiC (best-in-class) metrics for startup activity at institutions with under $200 million in research. Table 1 enumerates their outstanding measures of 4.3 startups on average, a very low $23.3 million of research per startup, and a high level of licensing to startups (1 in every 2.9 licenses). This far exceeds the efficiency of even the larger $200M+ universities with 3+ startups.

Also of note, while the <$200 million grouping has fewer startups per university, they appear to be more efficient in the ones they create, needing $30 million less in research per startup and performing marginally better on licenses per startup ratio. This efficiency dichotomy deserves additional study.

Table 1: Startup Metrics by University Research Funding Amount

University Research $ (Millions)	Avg. # of Startups per University	Research $ per Startup (Millions)	Licenses per Startup	N
$200+	6.4	$87.4	8.2	63
<$200	2.6	$41.4	4.6	49
$200+ (3+ Startups)	9.4	$72.1	6.5	43
<$200 (3+ Startups)	4.3	$23.3	2.9	19

Based upon the Table 1 metrics, the "BiC" universities have a clear advantage in startup leverage and efficiency. Further research with these universities needs to be conducted to understand if this finding is indicative of the application of the intra- and extra-university factors identified in Figure 1. From the AUTM 2008 survey, directionally, the BiC group (1) is less likely to have an associated hospital (53 percent versus 37 percent all others), (2) has one fewer TTO licensing FTEs at 3.0, (3) is equally as likely to license to a startup outside the state (23 percent of all BiC licenses to startups versus 27 percent all other), (4) and has only one private university in the group,[12] indicating a potential leaning of the BiC toward economic development.

3.2.2 NSF, Web CASPAR 2008

In addition to our review of the AUTM data, we assessed the 2008 NSF WebCASPAR (Integrated Science and Engineering Resources Data System) database which contains research funding for 676 colleges and universities. WebCASPAR indentified the 594 U.S. research institutions with <$200 million in research funding. This group represents 88 percent of all U.S. research universities.

Of particular note, using the AUTM university respondent with the lowest research funding amount as a floor ($3.2 million), WebCASPAR contains another 209 universities with research between $3.2 million and $200 million that did not participate in the AUTM study. This opens the question as to, "How much research funding has no startup outcome?" Arguably, the amount is much larger than the $2.3 billion estimate from the previous section of this paper.

[11] The variable "3 or more startups" was chosen because "4 or more startups" yielded a very small, single digit sample of universities. The "2 or more startups" variable was not used because the 3 or more startups" performance was more outstanding. The "1 or more startups" variable was not chosen because of the incidence of licenses to startups outside the state, year to year repeatability, and lower performance on the metrics.

[12] Designations from Yahoo Directory and university web sites.

Unfortunately, discrepancies between self-reported research funding amounts recorded by AUTM and WebCASPAR limit comparisons between datasets. For 2008, it was observed that more than half of the 82 (<$200M) AUTM institutions reported research dollars which varied +/- 10 percent when compared to the amounts self-reported in the WebCASPAR survey. This variability is possibly explained by differences in survey respondents and university fiscal years.

Nevertheless, WebCASPER provides a unique level of detail around the sources and types of research funding. Matching the 82 AUTM companies (<$200M in research) with their WebCASPAR responses revealed several interesting findings. Specifically, research expenditures were enumerated for federal and non-federal sources. And, within federal sources, the data is categorized by type of science funded. From this data, we have developed a federally funded "hard science"(FHS) measure which combines engineering, physical science, geosciences, life science, and math/computer research funding into one number, excluding psychology and social sciences.

Based upon the hard science agglomeration, the AUTM 82, on average, received 52.9 percent of their total research funding or $4.34 billion from FHS research. The BiC 19 garnered a smaller 41.5 percent of total funding from FHS research or roughly $14 million per university. Based upon internal faculty spin-off performance and two years of technical assistance, Georgia Tech has been working on the assumption that smaller colleges and universities must have at least $30 million in FHS research to support faculty spin-off activity. The AUTM BiC funding of $23.3 million in total research per startup and the WebCASPAR BiC $14 million in total FHS research is well below our expectation.

3.3 Observations from Smaller College and University Cohorts

Over the past two years, Georgia Tech has interviewed or provided technical assistance to eleven smaller colleges and universities with research funding between $5 million and $160 million. These universities range between no spin-off activity and a couple spin-offs over the past few years.

Our startup company coaches, "Venture Catalysts", have worked with over 150 faculty based spin-off companies, and other faculty in developing a snapshot of this cohort group. As a team, the Venture Catalysts rated the eleven universities based upon each of the intra- and extra-university factors using a scale of gap (no-experience), nascent (newly developed experience), transitional (improving experience), or robust (very experienced). Overall, the teams' ratings ranged between gap and transitional measures. No robust ratings were provided.

For four of the cohorts, there are simply no innovation building blocks. They have the task of trying to increase disclosures, if possible, and determine if faculty startups will be part of the long-term university culture. Perhaps, as has been discussed in Georgia for many years, several of these smaller colleges and universities could band together to share resources, with or without advisement from a larger mentor university. For the remaining seven universities, several weaknesses and strengths were evidenced.

The <u>weakest</u> ratings were around access to external capital (SBIR, venture, angel, etc.) and internal capital (internal seed funds). From our experience, connections to external capital resources are a major barrier for faculty spin-offs. In smaller communities, the ability to attract venture capital is complicated by the minimal amount of potential deal flow. Also, if the state does not have an SBIR assistance center, obtaining grants to fund research and commercialization are challenging. Georgia Tech, through its ATDC (Advanced Technology Development Center) incubator makes connections for faculty spin-offs to meet with and present to venture capitalists. In addition, ATDC operates a SBIR assistance program to support companies with grant preparation.

For internal capital, there are two options. One, the university can tap state funds designed to provide gap/seed stage investments in faculty innovations, moving the technology closer to commercialization. If the state does not offer one, a case should be made to the leadership to create one. In Georgia, we have the successful Georgia Research Alliance VentuerLab fund which has placed millions of dollars into Georgia Tech faculty spin-offs. Our university has been able to leverage this investment 35 to 1 with outside funding. The attraction of matching investment alone validates this initiative. Two, the faculty member can make a case to tap existing university IRAD (internal research and development) funds to enhance the innovation.

The strongest ratings were for external coaching (incubation, acceleration) and access to networks. Typically, the university is affiliated with an incubator or accelerator in the local community. In some cases, the university actually operates the incubator. In either case, if incubation exists, the TTO should be actively encouraging faculty to connect with incubator staff and to transition potential startups into incubation. The Georgia Tech ATDC has over 400 technology company members, many of which are faculty spin-offs originating from our VentureLab program.

For access to networks, universities typically have extended networks of alumni, community leaders, extension programs, economic developers, and corporate research clients. These connections can be leveraged to support the faculty spin-offs as they formalize. From our experience, the largest gap in networks is access to potential customers. These connections are essential for placing prototypes in potential customer hands to garner feedback.

The remaining ratings for talent and internal coaching were neither strong nor weak, but do represent challenges for even larger universities. For access to entrepreneur talent, Georgia Tech developed a cascading entrepreneur survey which helps to identify entrepreneurs in a community, creating an inventory which can be useful for networking and filling CEO positions for startups. Beyond CEOs, our university struggles with filling management positions for our startup community. For internal coaching, some smaller cohorts have access to faculty, staff, or entrepreneurs to provide coaching. At Georgia Tech, our VentureLab program provides the Venture Catalysts with startup experience to coach hybrid spin-offs.

Table 2 provides an overall view of the key hurdles and potential workarounds by factor for this smaller college and university cohort when compared to traditional licensing practices.

Table 2: Factor Hurdles and Workarounds for Smaller College and University Cohorts

Factors	Hurdles	Workaround
Innovation	Not enough disclosures to feed process	Target select highly funded, entrepreneurial faculty to drive disclosures
Culture & TTO	Focused on licensing not start-ups , (very different process); headcount	Solicit President's support; adopt pro-spin-off policies; cross university collaboration
Internal Coaching	Limited skills and experience	Connect with entrepreneurs in community to donate time
Internal Capital	Non-existent	Tap university IRAD budgets; pursue state funding
External Coaching	Limited connection	Link with incubation system in area
Talent	Limited connection	Conduct cascading entrepreneur inventory, hold open houses
External Capital	Never required for licensing	SBIR program, Angel networks, Serials
Network	Limited connection	Engage business community, chamber, economic developers

3.4 Phased Approach

Finally, based upon our work with this cohort, Georgia Tech has developed a phased approach to tackle the founding and growth of a faculty spin-off program. For simplicity and effectiveness, Georgia Tech coaches these cohorts through three stages. In Figure 3, the initial Phase (A) is to work with the university to establish internal processes to solicit disclosures and gain faculty interest in hybrid spin-offs. Within Phase A, the university must increase invention disclosure rate (more disclosures lead to more startups,[13] create a

[13] AUTM 2008 data reveals a strong link between university disclosure and startup numbers.

positive culture to promote faculty participation, and structure the TTO office and policies to become pro spin-off.

Subsequently, the university must focus on Phase B to establish an internal coaching network, perhaps with serial entrepreneur volunteers, and some access to gap or seed funding. The massive effort to create spin-offs in Phase A will go to waste without the coaching and seed programs to assist the faculty member.

In Phase C the formalization of relationships with extra-university connections will be essential for shepherding the new entity into the marketplace. These networks can be safe harbors for the small companies as they leave the insulated surrounding of the university.

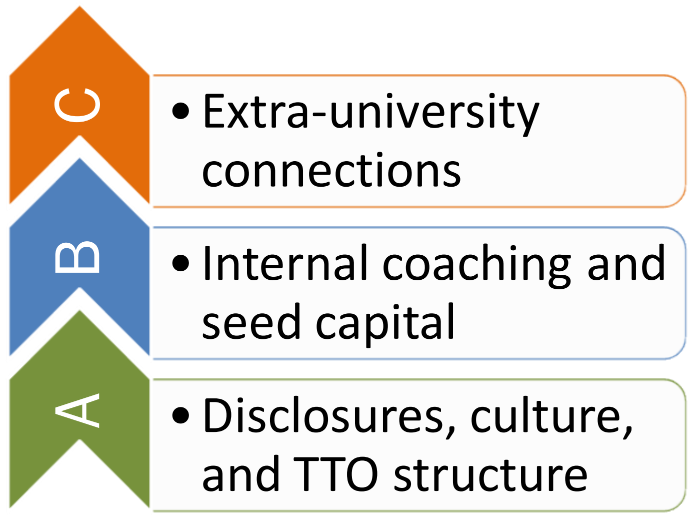

Figure 3: Three Phases for Implementation of Faculty Hybrid Spin-off Effort

Finally, while the phased approach appears to be sequential, there is no one path to enable a university for faculty spin-off success. However, the phases present a real world model in which necessary conditions must exist for spin-off activity. For example, without significant disclosure rates and research, there will be no building blocks on which to form a company.

4.0 Conclusions

The pathways by which university inventor ideas become commercialized are varied. This paper reviews the specific pathway for hybrid faculty spin-offs. With a foundation in the literature, a model of factors impacting the success of hybrid spin-offs was developed. The model was utilized as a guide for documenting Georgia Tech's interaction with a cohort of 11 smaller college and universities.

This paper also outlines how smaller colleges and universities (<$200 million per year in research) are addressing intellectual property creation and commercialization. The two primary challenges impede success are access to both internal capital and external capital. Some of the more proactive smaller colleges and universities are addressing these primary and other secondary challenges through a series of creative and innovative workarounds. In fact, this group of smaller colleges and universities considered "best-in-class" appears to be even more efficient in some measures than their much larger rivals. Surprisingly, there is an opportunity to take advantage of an untapped pool of research at smaller colleges and universities that have yet to create or report startup companies – estimated to be far in excess of $2.3 billion per year.

Much of this paper was based on the qualitative interaction with only 11 colleges and universities. In addition, the literature review has inconsistencies in the definitions for startups and spin-offs. As noted, the data from AUTM and WebCASPAR could have been more homogenous. A more quantitative and thorough follow-on study is recommended to overcome these shortcomings.

This paper has also identified three new opportunities for future studies. First, conducting case studies for the 19 BiC universities to determine how they have achieved efficiencies in startup formation. In addition, measures of their effectiveness at raising funds (internal and external) and growing jobs should be collected. Second, investigate if and how the 19 BiC contribute to Venture Hubs (regional ecosystems of commercialization). The goal would be to use existing data sources to formulate and test a hypothetical measure of the strength of universities linked to local commercialization ecosystems. Potential datasets could include: 1) funding for commercialization, clusters, and proof-of-concept centers; 2) Entrepreneurship Index and other measures of a favorable environment; 3) external capital for communities; and 4) web review of talent and social networks. Thirdly, track the lineage of inventions which were the foundation for sustainable, hybrid faculty startups.

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