ACADEMIC ENTREPRENEURSHIP AND THE ENTREPRENEURIAL ECOSYSTEM: THE UT TRANSFORM PROJECT

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ABSTRACT

The process of technology commercialization from universities has changed dramatically in the last few years. Many universities are rallying to improve society by creating social impact and wealth in their regions through the commercialization of technology derived from the research enterprise. Academic entrepreneurship is becoming part of the strategic mission of many universities, and the breadth of stakeholders involved in the activity has expanded. The creation and maintenance of a transformational and progressive entrepreneurial ecosystem within the university environment is essential to foster, support, develop, and commercialize new technologies. We outline the issues related to this shift in university culture, and provide the results of our experiment in creating such an ecosystem across the University of Texas System academic campuses and health science centers.

INTRODUCTION

Starting from the early ‘80s, there has been a substantial increase in the interest in entrepreneurial activity among universities in the US, and in many countries in Europe and Asia. The observation that entrepreneurs are a significant contributor to economic growth and job creation fueled the interest of public institutions and governments (Gans & Stern, 2003; Liao & Welsch, 2003; Lüthje & Franke, 2003; Oakey, 2003; Schramm, 2006; Hsu et al., 2007; Tracey & Phillips, 2007; Delgado et al., 2010; Glaeser et al., 2010; Delgado et al., 2012; Chatterji et al., 2013; Volchek et al., 2014). The acknowledgement that entrepreneurship is a discipline that can be learned has led to a myriad of different approaches to entrepreneurship education programs (Aronsson, 2004; Henry et al., 2005; Krueger, 2007). Furthermore, the enactment of the Bayh–Dole Act in the 1980’s reinforced the mandate for commercializing research via robust university technology transfer processes (Siegel & Phan, 2005), a phenomenon also known as academic entrepreneurship. Rivalry, competitiveness, and the increasing pressure to find new financing channels has pushed many universities to foster academic entrepreneurship by establishing technology transfer offices with the main goal of patenting and licensing intellectual property. In recent years, academic entrepreneurship has changed dramatically.

Universities now play a major role in promoting the creation of new firms on their campuses, or within close proximity in the surrounding area. The proliferation of

entrepreneurship courses and programs on campuses has led to more students involved in technology venture start-up activities and has evolved to include faculty and staff. Technology managers and researchers should rethink entrepreneurship in the academy to take into account these changes (Siegel & Phan). Achieving success with technology start-ups is important to schools because academic institutions need to adjust to new challenges, such as decreased amounts of federal research funding, increased emphasis on technology commercialization, pressure to limit tuition fee increases, and an overall criticism that the U.S. is losing its competitive edge in innovation and product development (Schramm, 2006). The creation and maintenance of a transformational and progressive entrepreneurial ecosystem within the university environment is essential to foster, support, develop, and commercialize new technologies (Kuratko, 2005). Such an ecosystem could help change academic mindsets and cultures and also result in higher competiveness in global markets, increased external funding via follow-up research dollars, enhanced educational environment for students and faculty gaining translational research experience, increased marketability of university graduates, and greater financial returns to the university via technology commercialization. In this paper, we present the results of our experiment in this arena, describing a multiphase approach to benchmarking, educating, soliciting, and funding technology commercialization projects across the University of Texas System academic institutions and health science centers.

ACADEMIC ENTREPRENEURSHIP

The enactment of the Bayh–Dole Act in the USA in 1980 pushed universities to establish technology transfer offices (TTO) with the aim to increase the commercialization of federally-funded scientific research. The technology commercialization process can occur through several modes, with traditional TTO's focusing on a mission of facilitate the patenting and licensing of new technologies. In 2012 alone, the annual licensing revenues generated by U.S. universities were $2.6 billion. More recently, scholars and policy makers have understood that the role of the individual scientist or engineer is crucial in order to successfully commercialize the university intellectual property. Consequently, ttos increasingly devote more attention to the creation of technology risk reduction activities and spin-off firms by scientists and faculty (Wright et al., 2004). The Association of University Technology Managers (AUTM) reports that during the fiscal year 2014 alone, 914 companies were started from university spin off and 965 new products were introduced to the market via a TTO (AUTM, 2014). The sharp increase in academic entrepreneurial activity in the university environment raises new questions and potential issues (Wright et al., 2004; Siegel & Wright, 2015). For example, new IP policies could be needed to change the traditional, non-commercial orientation of academic organizations within universities. IP ownership and equity issues arise from spin-off activities and require clear conflict of interest policies. Moreover, faculty and scientists face the tension between pursuing an entrepreneurial experience versus traditional academic activities that are commensurate with the promotion and tenure process; this choice may impact the success of the new firm. This tension is magnified by the emerging technology commercialization mission being adopted by universities.

The primary focus for universities has long been the creation and promotion of knowledge through research and education. Universities have evolved performance measurement systems that encompass grant funding and publications on the research side, and enrollment, teaching evaluations, and graduation rates on the academic side. From a community involvement perspective, they have been measured on their regional impact. There has been pressure

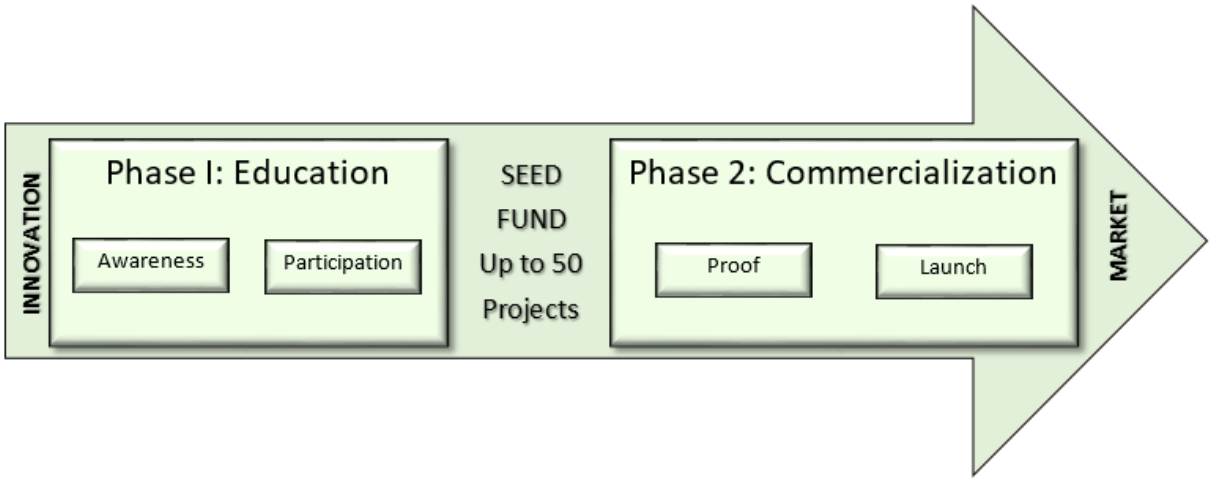
generated from the social, economic and political changes over the last two decades driving the creation of the "third" mission of the university, namely the direct contribution to enhanced regional economic development (Martin, 2012). New stakeholders are playing an important role in this dynamic scenario, including the growing number of players in the technology spin-off and start-up space. These are occurring both through formal education and technology transfer programs, as well as less formal campus ecosystems that enable and encourage new technology venture creation, albeit without a specific technology option or license (i.e. Student start-ups).

With an increasing number of entrepreneurship courses and programs launching in recent years, a rising number of entrepreneurially-equipped students are enrolled in academic entrepreneurship. Students increasingly collaborate with alumni and scientists to start new companies. However, antiquated policies and organizational barriers may not necessarily account for all dimensions of this new academic entrepreneurial ecosystem. A new emerging perspective on academic entrepreneurship is needed to close the gap between the new mission and the current policies and organization (Siegel & Wright, 2015).

UT TRANSFORM

The University of Texas (UT) System is composed of 14 academic campuses and health science centers. Each campus operates their technology commercialization activities independently, under the general guidance of the UT System Board of Regents Rules and Regulations for intellectual property management and commercialization. Each campus has unique research, academic, and regional differences that has led to a myriad of policies and procedures tailored by each campus. While many of the campuses do participate in joint research, discovery, and commercialization of technology, most of the technology transfer activities are for single campus technologies (i.e. No co-inventors from other UT campuses). However, a major theme identified at all campuses, was the need to bridge the "valley of death" between the end of grant-funded research activities, and the development of a proof-of-principle, technology demonstrator, or technology prototype that would de-risk the technology and improve the path to commercialization. The UT TRANSFORM project (Translational Research Advancement Network to Support, Fund, Organize, Roll Out, and Motivate UT Innovations) was established to help bridge this gap. Four Universities of Texas (UT) System institutions (UT San Antonio, UT MD Anderson Cancer Center, UT El Paso, and UT Austin) collaborated to enhance the academic entrepreneurship ecosystem across all UT campuses. The project, funded by the UT System, seeks to create and maintain a transformational and progressive entrepreneurial ecosystem within the university environment, an essential factor for fostering, supporting, developing, and commercializing new technologies. The project's goals in creating this ecosystem were not only to help change academic mindsets and cultures, but also to result in higher competiveness in global markets, increased external funding via follow-up research dollars, enhanced educational environment for students and faculty, increased marketability of UT graduates, and greater financial returns to the university via technology commercialization. Additionally, to the extent that the project could create greater visibility for entrepreneurship and commercialization across the UT System, it has the potential to attract new faculty and students who are interested in translating research innovations to market. The project comprised two major phases, namely: (1) education in innovation and entrepreneurship, and (2) identification, funding, and commercialization of promising and competitive technologies (Figure 1).

Figure 1
THE ENTREPRENEURIAL ECOSYSTEM PROJECT



Phase 1: Education

There is a growing trend for universities to promote and tout the level of technology transfer and commercialization they are engaged in. As a baseline to establishing academic entrepreneurship education, a multi campus study of faculty and student interests, perceptions, and needs of technology commercialization was conducted as a means to baseline the demand in University of Texas institutions. The baseline data provides initial insight into the magnitude of the issue from the faculty perspective and the types of faculty that are primarily involved and interested in technology commercialization.

The project's education objectives included:

- A comprehensive assessment of entrepreneurial orientation, perceptions and activity across UT System campuses.
- The creation of an Entrepreneurs Academy™, an online program designed to help faculty and student learn the fundamental concepts of commercializing their innovations. The modules provided in the Academy combine a selection of best-in-class videos, reading materials, examples, and assignments.

Phase 2: Commercialization

Based on the outcomes of the educational objectives, establishing clear activities to bridge the gap between research and technology commercialization was deemed necessary. The project's commercialization objectives included:

- Creating a competitive program for early-stage translational proof-of-principle seed funding, intended to accelerate the technology-commercialization pipeline. The project solicited proposals from across all UT System campuses.
- Establishing a web portal for proposal intake, dissemination to reviewers (including external angel and VC groups), and tracking outcomes. The portal also established a type of information clearing house for linking individuals with the available commercialization resources in their region, the latter being an evolving site.

ANTICIPATING PROBLEMS IN BUILDING THE ENTREPRENEURIAL ECOSYSTEM

The promise of common creation and maintenance of a transformational and progressive entrepreneurial ecosystem within the environment of UT institutions faces six key obstacles. These are not unique to UT institutions, but rather represent common obstacles all universities may face, namely:

1. Faculty buy-in and capacity
2. Institutional culture
3. Time commitment
4. Incorporation of offices of technology commercialization (OTCs)
5. Technology outlets
6. Critical mass

Faculty Buy-in and Capacity

Successful university commercialization requires certain essential preconditions, starting with an assessment of faculty buy-in and campus capacity for commercialization, the lack of which poses a major obstacle to a sustainable entrepreneurial ecosystem. Thus, the proposed project began with a UT System-wide assessment of barriers and motivators to increased commercialization, and entrepreneurial orientation, defined as the individual's propensity to engage in innovative, proactive and risk taking behavior to start new ventures or commercialize technology (Miller, 1983). These predictors have been shown to correlate with successful commercialization outcomes for universities, including filing patents and launching spin-offs (Todorovic et al., 2011).

Culture

Institutional culture, especially where hierarchical, can impede entrepreneurship (Fogel, 2006). Given the hierarchical nature of universities, our culture represents a significant obstacle to achieving the goals of this project. Moreover, the mismatch between the culture of the university and the culture of a start-up business can hinder the transition of a project from the academic realm to the commercial realm (Samsom & Gurdon, 1993). These cultural obstacles are so strong that the American system of technology commercialization is actually less conducive to entrepreneurship than that of Sweden (Damsgaard & Thursby, 2013). The UT TRANSFORM project involved activities specifically designed to address these issues of culture, primarily through workshops, UT System case studies, and other training for both researchers

and administrators oriented toward reshaping our academic culture (Van Burg et al., 2008). Indeed, this approach grows out of, and leverages, universities' principal role as educational institutions; if we can educate our students we ought to be able to educate ourselves.

Time Commitment

University faculty, and particularly the most productive research faculty, face well-known issues of scarce time resources (Jacobs & Winslow, 2004). As these productive academics are the very faculty whose research is most likely to lead to marketable technologies, the project faced an obstacle of competing demands for faculty time, particularly given the substantial time commitment required by commercialization activities. We addressed this obstacle by linking faculty with organizational resources that can take on much of the effort that would normally be borne by the faculty. This approach builds on the "two-in-a-box" approach to management by linking researcher experts with business experts (Voss, 1999; Pearce & Manz, 2005).

Interaction with OTCS

The offices of technology commercialization (OTCs) at UT System Institutions play a significant part in the entrepreneurial ecosystem, through their management of the IP disclosure, patenting, and licensing process. The UT Transform Program incorporated the OTCs into the broader university commercialization processes. This synergism augmented the reach of OTCs to a broader pool of technologies and entrepreneurial faculty, and enabled the potential for a greater number of start-ups and technology licenses, thus improving OTC performance metrics at all institutions. At UT MD Anderson Cancer Center, the OTC and OTD (Office of Technology Discovery) merged, resulting in more efficient and integrated collaboration. Similarly, at UTSA the OTC merged with the Office of Contracts and Industry Agreement under the Office of Commercialization and Innovation. This helped streamline the process from research discovery to start-up, licensing, and incubation, while informing the re-write of university policies that encourage the process. UTEP has also worked closely with their OTC and Mike Loya Center for Innovation and Commerce along similar lines.

Outlets

The costs of finding markets for technology innovations are significant for many universities (Swamidass, 2009). Geographic isolation compounds this problem. Compared with even small institutions in startup-intensive regions such as Silicon Valley and Route 128 around Boston, many UT institutions are at a significant geographic disadvantage. In startup-intensive regions, new innovations have access to many outlets for financing and development, in part because of the large number of venture capitalists present in the region (Cohen & Fields, 2000). In Texas's broad expanse, such opportunities are spread thin, and many of our institutions are located in regions where the venture-capital community is minimal at best. To address this obstacle, the project is worked to develop networks with venture capital firms and other incubator and accelerator outlets as part of the project selection and review process, thus engaging the potential investor and commercialization partners earlier in the process.

Critical Mass

The converse problem of the lack of outlets for innovation is a lack of critical mass in the number of innovative startups looking for funding. The relatively small size and geographical separation of many UT institutions means that, for their region, these institutions do not produce a large flow of startups sufficient to sustain a healthy population of venture capitalists and other sources of financing. For example, the Rio Grande Angels Investors Group, based in El Paso, closed in 2011, citing insufficient deal flow. To address this obstacle, this project exploited the aggregate strengths of the participating institutions, pooling the presentation of their innovations so that, from the perspective of a potential financier, the number of innovations is large enough to sustain continued interest and the building of the sorts of relationships that helped Silicon Valley to thrive (Cohen & Fields, 2000). Thus while each UT institution may operate a separate OTC, the ability to aggregate the portfolio of innovations, such as through and information portal, increases this critical mass.

METHODOLOGY

The UT-TRANSFORM project's two major phase—education and commercialization—necessitated different methodologies. The education phase comprised awareness and participation, each of which in turn had a specialized approach.

Awareness Survey

The awareness phase involved a massive survey of attitudes and experiences across faculty, staff, and students across all 14 UT System institutions. The study used a straightforward quantitative research design. We collected data through two online surveys administered through the project's team and the individual UT components. The Executive Vice Chancellor for the UT System approved the survey administration, and each participating campus chose whether to have the survey administered through the institution itself or by the project's research team. In either case, participants were recruited via an email message that invited participants to complete a brief survey asking them about their knowledge, understanding, and experience with innovation, entrepreneurial orientation, and commercialization. The survey was initially distributed to 75,000 individuals. There was a 25% response rate and 5% margin, resulting in a total of 25,000 participants enrolled in the study.

Survey 1 assessed department entrepreneurial orientation using the Entre-U Scale (Todorovic, Naughton, & Guild, 2011). The Entre-U scale consists of 16 questions, which measure four second-order dimensions of entrepreneurial orientation: research mobilization, unconventionality, industry collaboration, and university policy. The survey was specifically administered to academic administrators (deans and chairs) who responded to questions 1-7 addressing the extent to which statements about entrepreneurial orientation applied to their department or school. To avoid Survey 1 data being linked to specific department heads, the final study analysis and report do not contain any identifiable information and the results are reported in aggregate form.

Survey 2 assessed individual entrepreneurial orientation using a survey developed specially for this project, the Faculty, Student, and Staff Entrepreneurial Assessment (FSSEA). The scale comprises 14 questions about experiences with entrepreneurship, barriers, motivations for entrepreneurial activity, and individual buy-in, as well as needs for improving entrepreneurial

activity. The scale was designed for individual faculty, graduate students, and research staff to respond to questions on a five-point Likert scale about the extent to which statements about motives, perspectives, and barriers to entrepreneurship describe their attitude and experience. Participants were able to complete the FSSEA in 5-10 minutes. The data in Survey 2 were collected anonymously.

The project team analyzed the data from both surveys using SPSS V19 to perform descriptive statistics, as well as applicable non-parametric tests for investigating significant differences between demographic groups. Reliability and validity were assessed using the Cronbach's Alpha. Comments were sorted by question and topic, eliminating any identification of individual respondents.

Entrepreneurs Academy

The methodology for the Entrepreneurs Academy was a practical one: As the project's goal was to provide students, staff, and faculty of the UT System with on-line instruction in entrepreneurship, the project's approach involved creation and deployment of 17 on-line modules, offered through CourseSites. The modules can be accessed at http:// www.coursesites.com.

Commercialization

For the project's commercialization phase, the team also used a practical methodology involving a system-wide call for proposals for seed-funding for start-ups originating at UT System institutions. To this end, the project team held a seed-funding competition. The project developed a Web-based proposal management system that enabled submission of proposals, assignment of reviewers and summarization of ratings. This system was since expanded to enable grant recipients to report on project progress and to generate summary analyses for the seed-funding initiative as a whole (Novick et al., 2016). The reviewers for the proposals included the project's principal investigators plus outside venture capitalists, government agency research directors, personnel at technology development companies, and personnel from start-up incubators. Proposals were rated in terms of overall innovative idea, use of funds, commercial potential in terms of total market size, and clear customer need.

RESULTS

Individual Perceptions of Technology Commercialization and Entrepreneurship

The project surveyed graduate students, staff, and faculty across the 14 UT institutions to assess attitudes, perceptions and activity with innovation and commercialization (Table 1). Faculty in science, engineering, technology and math (STEM) fields were most likely to have received training, followed by respondents from business and the health/medicine fields. For example, among the 2,482 survey respondents, 354 (approximately 14%) were from engineering departments and schools. Among the engineering respondents, 49% of faculty and 10% of students indicated having received technology and commercialization training at the university.

Table 1 TECHNOLOGY TRANSFER TRAINING				
Received Training	**Faculty**	**Staff**	**Students**	**Total**
Yes	722	92	935	1,749
No	85	11	87	183
Missing survey	124	32	394	550

On a Likert scale of 1-5 (5 indicating highest agreement), engineering faculty and students both moderately agreed (mean of 3.49 for both faculty and students) that their departments encouraged them to focus on application of their research (Table 2). However, faculty and students did not strongly agree (means of 2.96 and 2.95, respectively) that their departments provided them sufficient support to be a successful entrepreneur or technology commercializer. Faculty and students tended to disagree (means less than 2.88) with the statement: "Technology transfer is valued as strongly as grants, publication or teaching."

Table 2 ORGANIZATION POLICY PERCEPTION		
Perceived…	**Faculty**	**Students**
Encouragement to create marketable technologies	3.49	3.49
Support and resources for commercialization	2.96	2.95
Technology transfer value compared to other academic activities	2.88	2.88

Nearly three-fourths of students and 86% of faculty agreed that engagement and/or collaboration with the private sector is needed to improve the transfer of research into commercially viable opportunities. When asked to indicate suggestions for private sector engagement and/or collaboration, engineering respondents most often suggested that universities should provide access to venues for regular interactions among faculty innovators, investors, and industry representatives. In addition, engineering respondents indicated a need for more technology incubators and increased awareness and university funding for technology scale-up, marketing, and investment. Notably, these three activities are traditionally the purview of private industry.

Many engineering respondents (51% of faculty and 66% of students) agreed or strongly agreed that partnering with other departments/disciplines is necessary to commercialize inventions. Among the engineering respondents, faculty and students who agreed that interdisciplinary collaboration was important most often suggested business as a collaborator. However, among non-engineering survey respondents, a wide range of disciplines indicated that

engineering specifically would be an important collaborator for commercializing innovations. Disciplines desiring collaboration with engineering included pharmacy, nursing, social work, architecture, arts and humanities, public affairs, and other health fields.

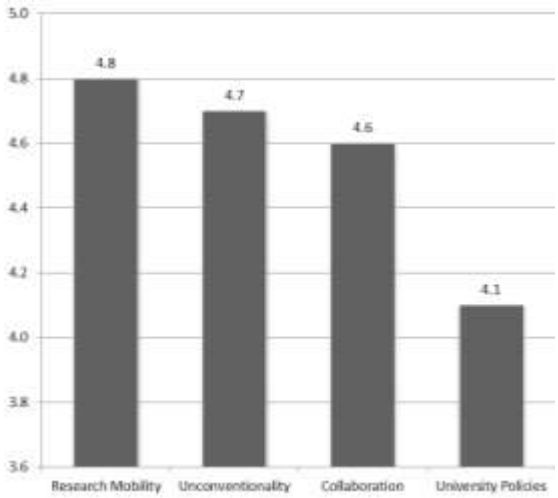
Entre-U Assessment

Using the work of Todorovic et al (2011), we surveyed departments at the UT system institutions using the ENTRE-U instrument. ENTRE-U consists of four dimensions that measure university department involvement in commercialization activities, defined as follows:

1. **Research mobilization:** Relates to research, involving external partners in research, and making sure that research outcomes are valued, useful, and shared with industry or other stakeholder groups.
2. **Unconventionality:** Relates to identifying opportunities, taking unconventional approaches (to funding, problems, and working with partners), and working outside the traditional university environment.
3. **Industry collaboration:** Relates to cooperation with industry; it suggests faculty and student involvement, as well as department-level cooperation with industry.
4. **Perception of university policies:** Relates to departmental perception of university policies and the extent to which they support departmental aspirations, and incent or impede innovation and unconventionality.

Figure 2 shows the mean Entre-U levels across the institutions involved in the project while research mobility rated the highest on the scale, unconventionality and collaboration were slightly weaker on average. University policies was the lowest rated dimension, suggesting the room for improvement to align with the desires and direction the departments wished to attain.

Figure 2
ENTRE-U RESULTS



Entrepreneurs Academy™

The project created and deployed an online certificate program in technology entrepreneurship, called the Entrepreneurs Academy™. The launch of a system-wide entrepreneurs' certificate was done as an asynchronous, self-paced program that trains potential entrepreneurs to translate technology ideas into new products and ventures. The Entrepreneurs Academy™ has 17 modules and results in s series of worksheets that form the basis for a rough business plan and proposal for seed funding to complete a proof of principle technology demonstrator (from Phase II of this program). Completion of the Entrepreneurs Academy™ was required in order to receive proof-of-principle funding. The expectation was this would drive more technologies towards risk reduction and readiness for investment by the University of Texas Horizon Fund, the strategic venture fund of the UT System, while also building a core experiential-based entrepreneurial competency (Krueger, 2007) amongst UT System faculty, staff, and students.

These business plans also served as the basis for any technology transfer office to assess the market potential of the innovation, thus improving the input to their patenting and licensing process. Feedback from participants suggests that the program provided useful training, and forced researchers to address market need questions that did not typically arise in their research. The program was required for investigators funded by the project's seed-funding program, and these investigators, who may have originally viewed the Entrepreneurs Academy™ as an administrative hurdle, commented that the program proved valuable for them.

Seed Funding

The project's seed-funding competition received 44 proposals and funded 33, in amounts up to $10,000 per project. The funded technologies included areas such as nanotechnology, power processing, online education, drugs development, and mobile health. Specific projects included, for example, "Roller printed semiconductor nanomembranes for flexible RF electronics" and "Proof-of-principle in vivo efficacy study of dengue antiviral drug candidate." The investigators were required to complete the Entrepreneurs Academy™ before receiving project funds. Subsequent to UT-TRANSFORM's $10,000 support, results include one acquisition of a supported project, a venture-capital term sheet for another project that values the company at $6.5 million, and an NIH RO1 of over $1 million for a new line of work.

Unlike other university-funded projects, these seed funded projects did not require that the IP be held by the university nor that they license a technology from the university. While many of the projects did meet these criteria, forcing such criteria had, in the past, excluded student and staff led technology start-ups. As a result, about a quarter of the applicants were student-led. The funding process also served to highlight deficiencies in the ecosystem, as was seen with one funded project withdrawing because the investigators were unable to negotiate an acceptable intellectual-property agreement with their home institution. This instance highlighted the fact the even in the presence of seed funding and a team desiring the right to pursue academic entrepreneurship, specific campus policies (i.e. failure to agree on licensing terms and have no deal is an option) can derail the commercialization process.

Ecosystem for Innovation and Entrepreneurship

a catalyst for discussion of these issues at the System level.

The project's development of a virtual ecosystem for innovation and entrepreneurship was sustained through subsequent support from the UT System. The pilot system developed in the project evolved into a comprehensive Web-based system named startuptrackertexas.org (Novick et al., 2016). The portal, which went live in The UT TRANSFORM project created a Web site that provides information for each UT-TRANSFORM campus with respect to resources available for university innovators who seek to commercialize their inventions. The resources include university offices for technology transfer and business incubation, plus complementary resources from the community (investors, incubators, technology partners, etc.). This part of the project sought to build a cross-UT System ecosystem for innovation and entrepreneurship, which proved to be more difficult than anticipated. The principal stumbling block is that processes and offices for technology transfer and business incubation differ markedly across campuses, even across the four campuses of the UT-TRANSFORM partners. While these differences likely reflect local priorities and history, they detract from providing UT System innovators a clear and consistent path for commercial development of their ideas. Thus while the project's Web site provides useful information for university researchers interested in commercial development, the result falls short of providing an innovation ecosystem that is system-wide. This result is linked to real differences in the ways that universities support innovation, and achieving the ecosystem goal depends on administrative forces beyond project's scope. Nevertheless, the project is starting to serve as June, 2015, enables visitors to

- Find the resources at UT System campuses that can help their start-up
- Create and manage seed-funding programs
- Browse and apply to seed-funding funding programs
- Form teams by meeting skilled people who want to work with them

UT System schools can use the portal's forms-based interface to build application forms for support, and faculty at these schools can then apply for this support. For example, Startuptrackertexas hosted the RFP for applications for Mike Loya Center Funding for Technology Start-Ups in Engineering at the University of Texas at El Paso. The portal supports also supports associated processes for reviewing applications and reporting on results from awarded projects. Maintenance of the portal has been supported through subsequent funding from the UT System.

The team-formation section provides a forum in which faculty can ask for or offer to provide help with a start-up; site administrators can manage forum traffic to delete spam and trolling. The resources section currently provides information on I&E resources at seven UT System schools. The page for each school contains customized information about, and links to, institutional and outside organizations that support formation of start-ups.

DISCUSSION AND CONCLUSIONS

The emerging new role of universities as entrepreneurial ecosystems requires institutions to develop a new culture and new strategic direction regarding academic entrepreneurship. Successful university commercialization requires certain essential preconditions, starting with an assessment of the motivation of faculty, staff, and students to engage in entrepreneurial behavior. Thus, our UT TRANSFORM project began with a UT system-wide assessment of barriers and motivators to start a venture. The results show how crucial the organizational culture is in

technology commercialization. Both students and faculty have perceived an insufficient amount of support from their departments for academic entrepreneurship. To address that issue, the UT TRANSFORM project implemented activities to change the organizational culture, primarily through training, workshops and case studies for both researchers and administrators.

The perceived need to engage the private sector to provide more funding and marketing opportunities for the new ventures is clear. The costs for commercialization are high for academic entrepreneurship and the relatively small size and geographical separation of many UT institutions means that these institutions alone do not produce a flow of start-ups large enough to sustain a healthy population of investors. The UT TRANSFORM project was designed to address the critical mass issue by identifying ways to exploit the aggregate strengths of the participating institutions, and pooling the presentation of their innovations. From the perspective of a potential financier, the number of innovations is large enough to sustain continued interest and the building of the sort of relationships that helped Silicon Valley to thrive.

Futures of the UT TRANSFORM Program

Once a program of this magnitude has been created, the tracking of the proposed success criteria will determine if it should be expanded and maintained. Based on lead indicators, success in the program should trigger funding for continued activities without incurring a gap in service. The costs for creating educational content will significantly decrease since most of the content was created under the first phase of the project. However, activities such as seed funding of selected technologies, organization of collaborative and educational events including local workshops, summer course for students, and online modules such as webinars will incur recurring expenses.

The strong suite of success metrics plus a clear and well-defined process for establishing a UT System evolutionary entrepreneurial ecosystem has the potential to feed the pipeline of new entrepreneurs and technologies achieving commercial success. These will undoubtedly accelerate success with the UT Horizon Fund by increasing the number of de-risked technologies and prepared entrepreneurs that can successfully deliver on new rounds of financing. The long-term outcome will be a marked increase in entrepreneurial activity, successful technology commercialization, and an ecosystem that is viewed as a benchmark university model that attracts and retains the best students and faculty, and is the first choice for industry when seeking commercialization partnerships.

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