A Quantitative Investigation of the Relationship between Technology Transfer Outreach Programs and Innovation Output at U.S. Research Universities

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Dedication

To my parents, Mr. Wen Tune Lee and Mrs. Y.Y. Ko Lee

To my husband and daughter, Hubert and Tiffany Chou

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I sincerely extend my thanks and appreciation to my dissertation committee for their hard work and advice. In particular, I appreciate the tireless support from Dr. Joy Phillips through the research journey. In addition, special thanks to Dr. Joyce Pittman for the rigorous mentoring when I was exploring the research methods. I do not think I would have successfully completed this research project without their dedications and help.

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Thanks to my friend Joy Tsai for her friendship and support in managing the startup company, I established while I was attending the Ed.D. program.

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Abstract

A Quantitative Investigation of the Relationship between Technology Transfer Outreach Programs and Innovation Output at U.S. Research Universities

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University administrators regard technology transfer as their "Third Mission," because they benefit from more than a billion dollars in annual revenue stream through technology transfer operations. Technology transfer (TT) is the process by which research intensive universities transfer scientific innovations from an academic institution to companies and receive financial compensations. Although innovator engagement is a critical step towards encouraging innovation output, universities have not paid much attention to outreach programs. While a large body of literature has focused on downstream value-creation of commercialization, it has neglected to investigate the upstream innovation-creation process resulting in limited insights. The purpose of this research study was to build upon work engagement theory and multi-perspective models to investigate the relationship between TT outreach programs and innovation output at U.S. research universities. The research design included a quantitative internet survey method involving 163 U.S. research universities and 223 innovators. Data from the survey were analyzed using inferential statistics and IBM SPSS quantitative software to investigate the relationship and explore innovator engagement phenomenon. By identifying preferred training programs and communication channels, recognition and reward systems, and innovation output, this study aims to inform and guide university officials on effective outreach programs preferred from the perspectives of innovators

and TT professionals. The findings indicated innovation output is associated with TT outreach programs. Experienced innovators preferred one-on-one interactions with TT offices to address their specific concerns and utilized up-to-date websites with searchable database at their conveniences. Innovators also expressed time constraint to innovate. Although TTOs recognized face-to-face interaction is an effective channel, budget constraint to have enough work force to manage such interactions is a challenge. Both innovators and TTOs indicated university administrators needed to include TT activities in the promotion and tenure consideration. In conclusion, outreach programs have the potential to increase innovation output for novice innovators that include students. University administrators should consider faculty's technology transfer accomplishments as academic achievements and allow time for faculty to innovate.

Chapter 1: Introduction to the Research

Introduction to the Problem

In 1980, the Bayh-Dole Act (Public Law 96-517) allowed universities, nonprofit research institutes, and teaching hospitals to own and commercialize the intellectual property (IP) that results from federally funded research (Stevens et al., 2011). Universities established technology transfer offices (TTOs) to manage IP disclosures, conduct marketing, and transfer the IP to companies to receive financial compensation for the universities. Technology transfer in an academic setting refers to the utilization of faculty's research discoveries to benefit the public through collaboration with companies. Some TTOs implement outreach programs to increase IP awareness and encourage researchers to participate in technology transfer activities. Universities also benefit from the financial compensation that results from the transfer of research discoveries to companies.

Technology transfer (TT) processes at United States (U.S.) research universities include two phases: the innovation creation phase and value creation phase (Ho, Liu, Lu, & Huang, 2014). Complying with employment contracts and university patent policy, faculty researchers are required to disclose the IP generated from their research to TTOs prior to publishing. The disclosure of IP discoveries permits researchers and universities to secure rights to obtain patent protection. By leveraging technologies with sound patent protection, TTOs' professional staff are able to secure license deals and negotiate fair compensation for the IP towards the value creation phase of the TT process. Cities, states, and industries view academic research partners as knowledge powerhouses and important players in economic development (Shaffer, 2015).

Research and development expenditures, TTO size, faculty size, and faculty quality are all factors influencing TTO operating models (Brescia, Colombo, & Landoni, 2014; Xu, Parry, & Song, 2011). In the past 10 years, it has become a common practice for TTOs to partner with regional entrepreneurial experts to facilitate faculty startup formations leveraging faculty innovation output (Atkinson & Pelfrey, 2010; Huggett, 2014; Osiri, McCarty, & Jessup, 2013). Swamidass (2013) suggested university policies include turning some of the unlicensed IP to fuel university startups since an estimated 75% of university IP inventions are not licensed. A comprehensive current trend study of the TT sector conducted by Huggett (2014) provided insights about TTOs' move to aggressively seek commercial partners and startup formations that require good working relations between innovators and TT professionals.

The technology transfer outreach programs are critical mechanisms for universities to support and communicate with innovators. Although most organizations have "innovation" embedded in their mission statements, Amabile and Pratt (2016) offered "genuine openness to new ideas, a system for developing creative ideas, and an offensive strategy of leading the organization's industry into the future" as true indications of an organization's motivation to innovate (p. 161). Nijhof, Krabbendam, and Looise (2002) proposed a method to exempt innovators from ordinary tasks and allow them to concentrate their efforts on developing promising ideas. Amabile and Pratt (2016) stated, "sufficient time to explore creative solutions and implement those solutions effectively is an often-neglected organizational resource" (p.162). Further, organizational work environment affects individual creativity. A work environment that supports creativity is an important component that can be systematically influenced (Amabile,

1988; Amabile & Mueller, 2008; Amabile & Pratt, 2016; Kamler & Thomson, 2004). Effective implementation of outreach programs by TTOs can support the working environment of the innovators. Unfortunately, outreach programs are not part of the common TT evaluation components, despite the potential positive impact that IP awareness and IP protection strategies have on strengthening innovator engagement and innovation output. Common evaluation indicators are limited to the number of IP disclosures, patents issued, licenses executed, license revenues, corporate partnerships, funding support, and the formation of startup companies (Balas & Elkin, 2013; Huggett, 2014; Osiri, McCarty et al., 2013).

Upon examining synergistic extrinsic motivation related to university patent policy that recognizes and rewards innovator's contribution to innovation, the importantce of reward system and patent policy is indicated as the authonoted noted that:

> …with recognition that acknowledges the value of the work done (such as a plaque on a company's wall of honor), or with rewards that allow the individual to engage more deeply in activities that are intrinsically interesting (such as funding for a successful team to work on a new pet project that the team has proposed). By contrast, controlling motivators inhibit self-determination and, thus, likely undermine the intrinsic motivation necessary for creativity. (Amabile & Pratt, 2016, p. 176)

University patent policy, which covers faculty reward systems and TTO's operational guidelines, are factors that influence the attitude of researchers toward technology transfer. Faculty reward systems represent the recognition of an innovator's contribution to the university and to the research community. Renault (2006) reported entrepreneurial behaviors that affect the productivity of TT efforts include decisions related to industry collaboration, patenting, and spinning off companies.

The recent recession of 2008-2009 and declining federal research funding have resulted in a financial crisis, which has greatly reduced university endowments (Nelles &

Vorley, 2010). Due to these growing concerns, research intensive institutions have begun to reevaluate revenue generation strategies by leveraging TT operations and utilizing research achievements and discoveries to increase revenue and supplement expenditures in research (Gordon, 2015; Kim, 2013). In fact, many U.S. research university administrators consider TT as the "Third Mission" revenue-generating channel. According to the Association of University Technology Managers (AUTM), an international association of technology transfer-related professionals, TT is a growing operation within research universities that has enabled participating universities to collect more than two billion in annual license revenue since 2013 (Huggett, 2014). AUTM's most recent 2015 survey showed the number of invention disclosures (which is a direct measure of institutional impact) reached 25,313 with 15,953 new U.S. patent applications filed and 6,680 issued U.S. patents. Over 1,012 new startups have also directly impacted local economies, and more than 72% of the new businesses have remained in the institution's home state, retaining locally trained talent. Further, consumers and businesses have benefited from 879 new products, and license revenue has generated more than $28.7 billion in net product ("FY2015 Licensing Survey," 2017). These data indicate faculty's innovation plays a significant role in revenue generation for U.S. research universities as well as for the economic growth of the home state.

Research shows that a creative environment supports innovator engagement and positively affects innovation (Amabile, 1988; Amabile & Pratt, 2016; Ekvall, 1996; Robinson & Stern, 1998; Tanner & Reisman, 2014). In a university setting, innovator engagement is a critical first step towards innovation output in the form of new IP. IP is the fuel of the technology transfer engine. Although previous research has been

conducted on the assessment of organizational creativity environments and their impact on innovation output in various business settings, an investigation into the relationship between TT outreach programs and innovation output within the context of an academic setting has been neglected (Amabile, 1988; Amabile & Pratt, 2016; Ekvall, 1996; Isaksen & Ekvall, 2015).

Over the past 15 years, a large body of literature related to TT in an academic setting has mainly focused on the downstream value-creation phase of technology commercialization at research universities. Downstream value-creation is the phase where TTOs market and license patent protected IP to companies. Past research efforts have assumed TTOs at universities have abundant technologies to commercialize. Presently, there is limited insight into the relationship between innovator engagement and increased innovation output that is primarily engineered by TT outreach programs - a necessary step to increase innovation output and revenue.

Statement of the Problem to be Researched

Presently, U.S. universities allocate limited resources to outreach programs to support innovator engagement, even though it has been reported that since 2013, technology transfer operations generated two billion dollars in annual revenue. These data indicate that TT efforts have the potential to produce a larger revenue stream, which can also support city and state economic development. Presently, U.S. universities do not clearly define outreach programs as part of a TTO's operational function (Ho et al., 2014; Huggett, 2014; Silvernagel, 2014; Stevens et al., 2011). Based on resources available, TTOs at U.S. research universities conduct ad hoc outreach programs to connect and communicate with potential innovators. Most universities assume researchers and

students automatically become innovators and produce abundant IP inventory for technology transfer (Silvernagel, 2014). The reality is most researchers pay little attention and are not committed to the pursuit and transformation of their creativity into IP inventory due to other competing demands on their time and effort (Nijhof, Krabbendam, & Looise, 2002). Although several research studies have investigated the commercialization of university IP (Ho et al., 2014; Huggett, 2014; Osiri, McCarty et al., 2013; Silvernagel, 2014; Stevens et al., 2011; Xu et al., 2011), very little has been done to question whether active and engaging outreach interactions and communications between TTOs and researchers positively impact the ability and desire of researchers to transform their creativity into innovation. West et al. (1998) conducted a longitudinal study involving 14 research universities in the United Kingdom and reported a departmental climate supportive of innovation did not predict subsequent research excellence (West, Smith, Feng, & Lawthom, 1998). This finding seems to be contrary to well-received positive correlations between supportive organization climate and innovation performance (Amabile, 1988; Amabile & Pratt, 2016; Ekvall, 1996; Robinson & Stern, 1998; Tanner & Reisman, 2014). Research excellence was commonly perceived to be a precursor of IP generation. Therefore, the current research study is clearly warranted.

At the present time, there is no formal framework for informing and guiding universities to develop and conduct effective outreach programs that would directly facilitate and impact innovation output. Investigating the relationship between effective TT outreach programs and innovation output will provide valuable information regarding the perceptions related to effective TT educational training programs and communication channels that benefit innovators, as well as TT professionals and administrators at U.S.

research universities. The current TT practices clearly appear to lack an effective systematic approach to communicate, inspire, and interact with innovators to increase awareness in IP generation and TT process. Potential innovators seldom understand their creative capacity and are discouraged to explore their aptitude due to high pressure from university administrators to apply for research grants and publish research findings (Nijhof et al., 2002). Thus, this study seeked to identify effective outreach programs, as defined by both innovators and TT professionals, to establish a framework that will inform and guide U.S. research universities towards increasing innovation output.

Purpose and Significance of the Problem

The purpose of this quantitative research study was to investigate the relationship between TT outreach programs and innovation output in the context of U.S. research universities. The study was conducted by (a) identifying current U.S. research universities' resources allocation towards TT outreach programs; (b) determining the impact of these outreach programs from the innovators' perspectives; and (c) relating these combined efforts into innovation output. The TT outreach programs in the study covered both outreach training programs and communication channels between TT professionals and innovators at U.S. research universities. The stakeholders in this research study were innovators, TT professionals, and administrators. Innovators were university researchers who had internal and external research funding, TT professionals were staff members who worked at TTOs or university units that had TT functions, and administrators were Vice Presidents of Innovation or Academic Deans or Directors or other leaders who overseed research at U.S. universities.

The significance of the study was that it generated new knowledge and provided practical applications on how to improve TT outreach programs and subsequent innovation output. Given the scant information on the role of outreach programs and innovation output, this research study identified effective mechanisms to support innovation engagement through a quantitative method approach using survey data and an AUTM annual survey report. The goal of this study was to identify desirable outreach programs and communication channels perceived by innovators and TT professionals to create a general guiding framework that can significantly impacts not only innovators, TT professionals, and administrators at U.S. research universities but also the economic development of cities and states. TT offices could utilize the knowledge gained to systematically execute outreach programs that align with innovators' interests.

Reportedly, engaged innovators are more inspired to explore their creativity and more committed to transform creativity into innovation and IP inventory (Bhatnagar, 2012; Upham, 2006). Similarly, administrators from U.S. research universities in cooperation with city and state economic development agencies can leverage the guiding framework to promote academic and industry collaborations, thus furthering the economic growth at the city and state level.

Research Questions

This research study utilized a quantitative approach that employed survey methods to target TT professionals and innovators at U.S. research universities and investigated the relationship between TT outreach programs and innovation output. The study leveraged knowledge of TT professionals to identify current outreach programs and their respective characteristics. In addition, the study explored effective TT training

programs and preferred communication channels from the innovator's perspective. TT professionals at U.S. universities were members of the Association of University Technology Managers (AUTM) who participated in AUTM's 2015 TTO annual survey, and innovators were fellows recognized by National Academy of Inventors (NAI) in 2015 - 2016. The perspectives of the administrators were also important as they related to TT operations and resources allocation supportive of TT operation. The researcher obtained these perspective data from the 2015 AUM annual survey report.

The central question that guided the study was "What is the relationship between TT outreach programs and innovation output at U.S. research universities?" To address this overarching question, the researcher developed a survey method to answer the following questions at 163 U.S. research universities:

1. Based on the perspective of a TT professional, what are the types and characteristics of a TT outreach operation at selected universities?
2. Based on the perspective of an innovator, what are the desired features of TT outreach programs at selected universities?
3. To what extent does the relationship between TT outreach programs and innovator engagement impacts innovation output?

Using Kahn's work on engagement theory (1990), the following null hypotheses were tested:

Null hypothesis 1. There is no association between TT outreach programs and IP inventory at U.S. research universities.

Null hypothesis 2. There is no association between TT office's outreach programs and license revenue.

Null hypothesis 3. There is no association between TT outreach programs and number of full time TT employees, which include support staff.

Null hypothesis 4. There is no association between university research funding level and TT outreach programs.

Null hypothesis 5. There is no association between innovators' participation in TT outreach programs and innovators' research funding level.

Null hypothesis 6. There is no association between innovators' participation in TT outreach programs and report of invention.

Conceptual Framework

Researcher's Stance and Experimental Base

Grix (2002) stated an individual's ontological and epistemological positions shape how questions are posited and how the individual studies and answers the questions. Scotland (2012) examined the philosophical underpinnings of scientific, interpretive, and critical research paradigms and explored the relationship of how ontology and epistemology drive methodology and methods. In agreement with Grix (2002) and Scotland (2012), the researcher's initial ontological stance of post-positivism was influenced by her scientific training background and her belief that a real world exists, independent of perceptions and theories (Maxwell, 2005), and that innovation is the product of the reality (Bloomberg & Volpe, 2016). However, a formal business education has facilitated the evolution of the researcher's paradigm switch to a constructivist position, which is driving her research to study and interpret multi-social realities consisting of nature and human actors (Guba, 1990; Maxwell, 2005; Poni, 2014; Scotland, 2012).

The researcher's epistemological belief is that social reality is constructed by a study of participants' perspectives, organizational climate, and interactions among participants. This stance is similar in part to Maxwell's belief of epistemological constructivism in that "what people perceive and believe is shaped by their assumptions and prior experiences as well as by the reality that they interact with" (Maxwell, 2005, p. 43). The researcher has 14-plus years of experience in leading a technology transfer office at a private U.S. research university. Her experience has affirmed the importance of participants' perspectives and their impact on innovator engagement and innovation output. The researcher's quantitative methodology used survey methods with quantitative and qualitative analyses to investigate the relationship between outreach programs and innovation output. Her study was designed to involve TT professionals and innovators to explore the possibility of reaching a consensus about an effective TT outreach framework that guides U.S. research universities to address innovator engagement challenges in the future. Thus, the researcher capitalized on her experiences, insights, and subjectivity to design a relevant research project (Glesne & Peshkin, 1992; Maxwell, 2005).

The researcher leveraged a constructivist paradigm that employed surveys to identify the trend of existing TT outreach programs and compile a list of outreach programs that were perceived as effective by innovators. Utilizing the 2015 AUTM annual report and data collected from the TT professionals and innovators, the research study used inferential statistics to determine the relationship between TT outreach programs and output, namely IP inventory and license revenue. Further, the study examined the relationship between innovators' participation in TT outreach programs,

their research funding, and the generation of new IP. As reported by Creswell (2015), the survey method design with closed and open-ended questionnaires enabled the researcher to develop a quantitative account of the general features of effective outreach programs and explore the central phenomenon of innovator engagement.

Conceptual Framework

The research study built upon proven concepts and theories to establish a general framework that increased innovator engagement and innovation output (Kahn, 1990; Udwadia, 1990). Building upon Kahn's (1990) engagement theory, Udwadia (1990) examined the organizational and managerial issues relating to creativity and provided a multiple perspective model. The multiple perspective model included three interacted perspectives: the individual, the technical, and the organizational. The individual perspective focused on the person's specific creative characteristics and behavior. Creative individuals have higher intelligent levels, more extensive background, and specific knowledge. Creative individuals are often more risk-taking orientated and intrinsically motivated. Creative individuals derive their satisfaction from being involved in the process of developing new perspectives. The technical perspective focused on needed material and human resources and their impact to creativity. Collaboration and communication were keys to secure needed human and material resources for creativity (Udwadia, 1990).

Communication also is essential for managers to provide feedback when the innovation does not have the commercial merit to be developed. The organizational perspective focuses on the organizational and managerial actions that positively or negatively affect and support creativity. Free, open, and flexible organizational

environment with minimum external constraints allow innovators to pursue novel possibilities, exchange, and discuss ideas that release innovative behaviors. Encouraging new ideas and risk-taking with appropriate recognition are also important (Udwadia, 1990).

Belkin, Zhao, Tolboom, and Farris (2008) offered, "In order to foster creativity in organizations, companies must identify creative individuals based on both their creative potential and the actual output measurements as well as ensure organizational working climate to be conducive of creativity" (p. 2). Maxwell (2005) proposed, "A study must take account the theories and perspectives of those studied, rather than relying entirely on established theoretical views or the researcher's perspective" (p. 53). Bhatnagar's multi-level empirical research found psychological empowerment affected work engagement, which secured high innovation and low turnover. Psychological empowerment predicted work engagement and innovation (Bhatnagar, 2012).

Nijhof, Krabbendam, and Looise (2002) proposed a method of exempting idea generators to allow for freedom and flexibility to develop innovation, an idea that echoed Amabile's componential theory about the work environment. The organizational components were basic resources or materials, a set of processes, and motivation to innovate. Amabile and Pratt (2016) stated the work environment influences creativity in a number of ways. For example, within an organization, creativity was affected by the highest levels of leadership, through the strategies they set, the policies they established, and the values they communicated. Creativity was affected by all levels of management, through every day practices in dealing with individuals, teams, and projects as well as everyday attitudes and behaviors, through dyadic interactions and team dynamics (p.180).

Furthermore, networking and collaborations were key to transforming creativity into innovation (Yusuf, 2009). These research findings had great implications for the research study.

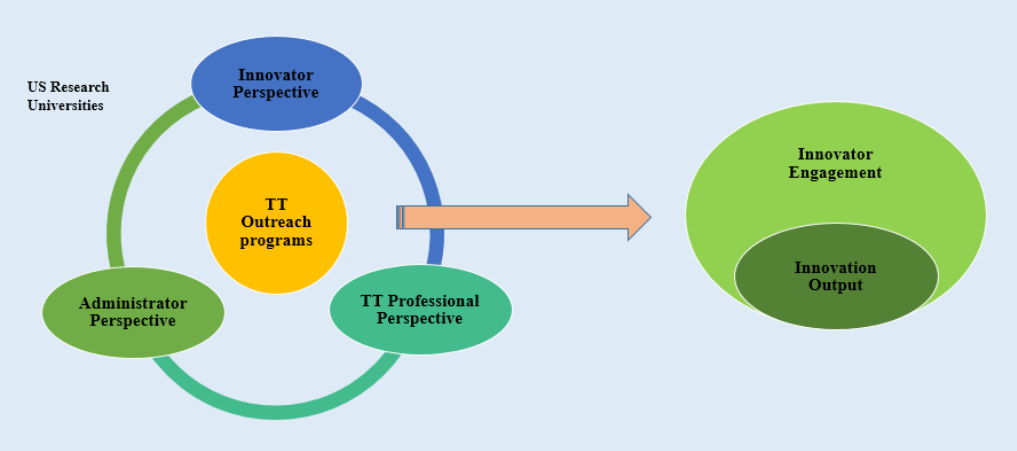

Figure 1. Multiple perspectives conceptual framework of technology transfer outreach programs and innovation output

Two comprehensive conceptual maps of the research study, as shown in Figure 1 and Figure 2, were based on the syntheses of various conceptual frameworks including engagement, psychological empowerment, work environment, and work engagement (Adler, 2012; Amabile & Mueller, 2008; Bakker, Schaufeli, Leiter, & Taris, 2008; Bhatnagar, 2012; Glesne, 2006; Kahn, 1990; Maxwell, 2005; Udwadia, 1990; Yusuf, 2009).

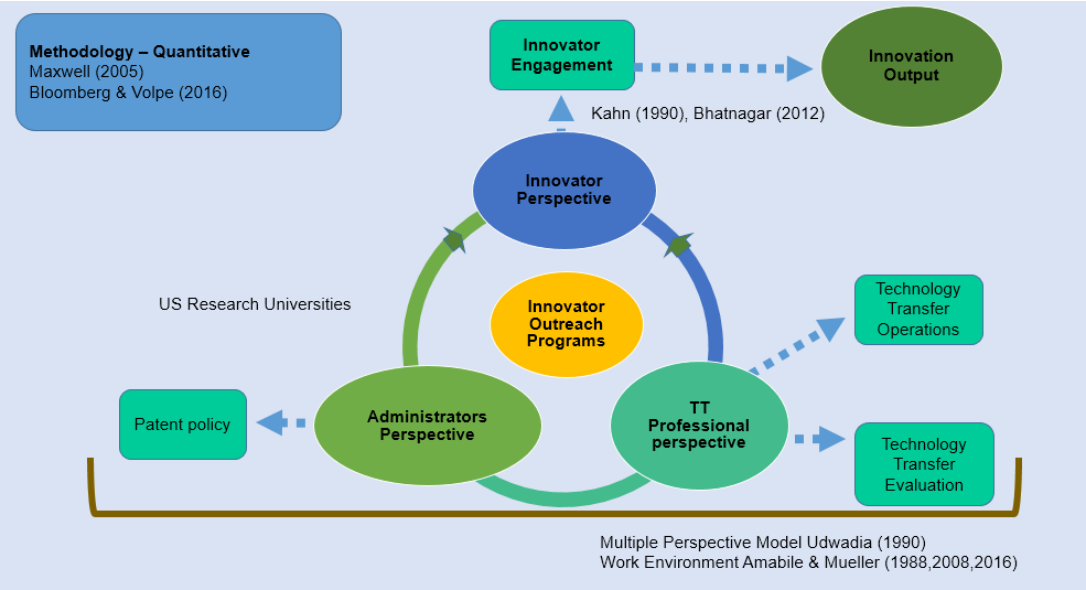

Figure 2. Detailed conceptual framework with theories

These characteristics implied that effective innovator engagement mechanisms could be achieved through encouraging collaboration, empowerment, and recognition when executing TT outreach programs. The researcher constructed three streams of research that served as the foundation for the conceptual framework: technology transfer operations, innovator engagement, and work environment.

Definition of Terms

Creativity: The production of novel or original ideas of useful value (Policastro & Gardner, 1999; Udwadia, 1990).

Innovation: The successful creation, development, and introduction of new products, processes, or services (Tanner & Reisman, 2014; Udwadia, 1990). Further, innovation also means the successful implementation of creative ideas within an organization (Amabile, 1988).

Innovators: The innovators in the research study mean researchers who receive federal funding and conduct research at the U.S. universities (Sternberg, 1999).

Outreach Programs: The programs include communication channels and educational training programs (Lin & Liu, 2012). Communication channels include website, newsletters, face-to-face meeting, social media, email, and text. Educational training programs include seminars, networking events, and training workshops (Robinson & Stern, 1998).

Innovator Engagement: Faculty and students feel engaged and inspired to do their best work that are novel and useful intellectual property (Bhatnagar, 2012).

Intellectual Property: A work or invention that is the result of creativity, such as a manuscript or a design, to which one has rights, and for which one may apply for a patent, copyright, and trademark. In the study, innovation output mean inventory of intellectual properties, which include but are not limited to biological materials, copy righted materials, and inventions (Silvernagel, 2014).

Research University: In this research study, U.S. 4-year universities conducting research with funding from federal government, foundations, industry, gifts from private donors; and active participation in technology transfer (Stevens et al., 2011).

Technology Transfer: Process of converting scientific and technological advances and discoveries into marketable goods or services (Huggett, 2014; O'Kane, Mangematin, Geoghegan, & Fitzgerald, 2015; Stevens et al., 2011).

Psychological Empowerment: Empowerment relates to organizational commitment in this study (Bhatnagar, 2012).

Work Engagement: A positive, fulfilling, affective-motivational state of work-related well-being that is characterized by vigor, dedication, and absorption. Workers are more engaged in situations that offer them more psychological meaningfulness and psychological safety, especially when they are more psychologically available (Bakker et al., 2008; Kahn, 1990).

Assumptions, Delimitations, and Limitations

The researcher has 14 plus years of experience in managing a TT office at a Pennsylvania-based private U.S. research university and has developed assumptions about the potential innovators, TT professionals, administrators, and university culture:

- Innovators welcome the opportunity to provide their perspective regarding outreach programs. Innovators truthfully answer the survey questions.
- Innovator engagement would increase TT related work engagement and produce IP inventory.
- TT professionals are interested in providing their perspectives about outreach program. TT professionals truthfully answer the survey.
- Administrators at U.S. research universities are interested in strengthening innovator engagement and committing resources to TT offices for effective outreach programs.

The population for this research was TT professionals and innovators from U.S. research universities. Due to resource constraints, the project was delimited by focusing on 163 U.S. research universities that were members of AUTM and had participated in the 2015 TTO annual survey as well as 223 NAI fellows who were experienced innovators at the same 163 research universities. The researcher initially conducted a

convenient sampling pilot study to validate the survey instruments followed by a randomized survey to gather perspectives from TT professionals and innovators. The survey instruments for both target populations included open-ended and closed-ended style questionnaires. The study included both surveys by an email invitation and data collected through Survey Monkey. The researcher tested the hypotheses and addressed research questions by utilizing inferential statistics and explored emerging patterns or themes in order to understand the engagement phenomena from both perspectives. Thus, the researcher coded and analyzed the quantitative data using one-way and two-way ANOVA and bivariable regression analyses to investigate relationships among the variables, such as outreach programs, number of reports of invention, funding status, and innovator preferences.

The limitations of this study included (a) the inability to examine trust issues between innovators and the TT professionals nor the empowerment of TT professionals by the administrators; (b) the lack of understanding of the political situation that can affects TT operations; and (c) the possibility of sampling error in the survey method due to the culture, policy, innovator characteristics, and TT operation models of different research institutions. Ninety five percent (40/42) of the responded innovators had more than 20 years of academic research experience. However, by involving innovators and TT professionals who belong to professional associations as target populations, this study decreased some of the biases and limitations as it explored the relationship between the outreach programs and innovation output.

Thus, the suggested framework sought to provide features of an effective outreach program that will inform and guide U.S. research universities to positively impact

innovation output in the future. The goal of this study was to support universities to utilize the knowledge gained from this research and incorporate it into their specific local components to further strengthen the outreach programs as they see fit.

Summary

In recent years, administrators at U.S. research universities have regarded technology transfer operations as the "Third Mission" due to its significant revenue generating potential. Cities and states in the U.S. have also become dependent on research universities as knowledge powerhouses and the important role they play in economic development. Today, university TT has successfully generated a billion dollar annual market by itself.

Researchers for the past three decades have studied the functions and effectiveness of TTOs, technology commercialization mechanism, patent policies, and theories. Research thus far has covered downstream processes of TT with a focus on patent protection and technology commercialization. There is currently limited mention of TT outreach programs that improve innovator engagement and build IP awareness and IP protection strategies to promote further innovative creation and development. Therefore, there is a need for research to provide a framework that will guide universities in innovator engagement through effective outreach programs that result in productive innovation output.

This research study was a quantitative method design, which included a convenience sampling pilot study at City University of New York and a random sampling survey at 163 U.S. research universities. The survey instruments included open-ended and closed-ended style questionnaires. The researcher conducted both study surveys by

an email invitation, and data were collected using Survey Monkey. The study had have two target populations: (a) the TT target population is the 163 U.S. research universities that participated in the AUTM 2015 survey and (b) the innovator target population is 223 NAI fellows from the same 163 U.S. research universities. The researcher tested the hypotheses and addressed research questions utilizing inferential statistics, as well as coded and explored patterns or themes to understand the engagement phenomena from both perspectives. The research provided insights on approaches to establish a framework of effective outreach programs preferred by innovators and served to inform and guided U.S. research universities on approaches that promote innovation output.

In the following literature review chapter, the researcher constructed three streams of literature to serve as the foundation of the conceptual framework: technology transfer operations, innovator engagement, and work environment.

Chapter 2: The Literature Review

Introduction to Chapter 2

At the present time, U.S. universities allocate limited resources to outreach programs to support innovator engagement, even though it has been reported that since 2013, technology transfer operations have generated two billion dollars in annual revenue (Huggett, 2014). Chapter 2 provides a review of the literature in support of this quantitative method design study to investigate the relationship between TT outreach programs and innovation output. Presently, outreach programs as part of a TTO's operational function is not clearly defined by universities (Ho et al., 2014; Huggett, 2014; Silvernagel, 2014; Stevens et al., 2011). Although abundant research covers TT operations in commercialization of university innovation output in IP, there is no research that specifically investigates whether TT operations related to TT outreach training programs and effective communications positively impact faculty's desire to transform their creativity into innovation output (Ho et al., 2014; Huggett, 2014; Osiri, McCarty etal., 2013; Silvernagel, 2014; Stevens et al., 2011; Xu et al., 2011).

This research study used a quantitative survey method design, which included a convenience sampling pilot study at City University of New York (CUNY) to validate the survey instruments and a random sampling study survey at 163 U.S. research universities. The study conducted surveys by email invitation and collected data through Survey Monkey. The study included two target populations: (a) the TT professionals and (b) the innovators at 163 U.S. research universities. The study analyzed the quantitative data with one-way and two-way ANOVA and bivariable regression analyses to investigate relationship among variables such as outreach programs, number of report of

invention, funding, and innovator preferences. The researcher tested the hypotheses and addressed research questions utilizing inferential statistics. Additionally, the researcher coded and explored patterns to understand the engagement phenomena from both perspectives.

Innovator engagement is essential for innovation output. Building upon Kahn's (1990) engagement theory, Udwadia (1990) examined the organizational and managerial issues relating to creativity and provided a multiple perspective model. Free, open, and flexible organizational environment with minimum external constraints allowed innovators to pursue novel possibilities as well as exchange and discuss ideas related to innovative behaviors. Similarly, componential theory indicated that a supportive work environment can systematically influenced creativity (Amabile, 1988; Amabile & Mueller, 2008; Amabile & Pratt, 2016).

Bhatnagar's multi-level empirical research found that psychological empowerment affected work engagement, which in turn secured high innovation and low turnover. However, a longitudinal study involving 14 research universities in United Kingdom conducted by West et al. (1998) found that a departmental climate supportive of innovation did not predict subsequent research excellence, even though research excellence is commonly perceived to be a precursor of IP (West et al., 1998). This finding was contrary to well-received positive correlations between supportive organization climate and innovation performance by scholars (Amabile, 1988; Amabile & Pratt, 2016; Ekvall, 1996; Robinson & Stern, 1998; Tanner & Reisman, 2014). These studies suggested a need to conduct the current research study.

Amabile (2008) suggested the organizational work environment affects individual creativity. Management must take actions to foster innovation and resources allocated for innovation development and implementation (Amabile, 1988). Despite the potential for a positive impact of outreach programs on innovator engagement and innovation output, outreach was not included as one of the measures of effective implementation of TTO operations and function. Common evaluation indicators included the number of IP disclosures, patents issued, licenses executed, license revenue, corporate partnership, funding support, and the creation of new startup companies (Balas & Elkin, 2013; Huggett, 2014; Osiri, McCarty et al., 2013; Siegel & Potterie, 2003).

Fostering new ideas and risk-taking coupled with appropriate recognition and rewards are important (Udwadia, 1990). Synergistic extrinsic motivation related to university patent policy which recognized and reward innovators' contribution to the innovation output have been examined (Amabile & Pratt, 2016). Most university patent policies included a faculty reward system to recognize an innovator's contributions to the university and the research community. Research by Renault (2006) indicated that faculty entrepreneurial behaviors included decisions about collaboration with industry, patenting and spin off companies, which affected the productivity of academic TT efforts.

Thus, this research study addressed an important knowledge gap related to the effectiveness of TT outreach programs in supporting innovation engagement and encouraging innovation output. Presently, there does not appear to be a formal guiding framework for TT offices to conduct effective outreach programs. Rather, most TT offices at U.S. research universities conducted ad hoc training programs that by themselves do not appear to be a definitive function of TT offices. Therefore, this study

is important and timely as it addressed innovator engagement as a function of productive outreach programs.

Several practical and philosophical assumptions drived this research paradigm based on componential theories (Moss et al., 2009; Poni, 2014; Scotland, 2012). The nature and human actor components in this research study were innovators, TT professionals, administrators, and work environment at U.S. universities. The researcher's current stance is constructivism with a prior stance of post-positivism where she believes that a real world exists independent of our perceptions and theories (Maxwell, 2005). Her epistemology belief is that social reality is constructed by the study of the participant's perspective, organizational climate, and interactions among participants (various components). The research study used the multiple perspective model proposed by Udwadia to study the perspectives of innovators, the TT professionals, and the administrators with the goal of establishing a guiding framework to increase innovator engagement (Udwadia, 1990). The research method employed a quantitative survey to systematically gather and analyze data to obtain a quantitative account of the features of effective outreach programs based on the perspectives of innovators and TT professionals respectively.

The study (a) identified current U.S. research universities resources allocation towards TT outreach programs; (b) determined the impact of these outreach programs from the innovators' perspectives; and (c) related these combined efforts into innovation output. This literature review is organized to explore three areas of research: TT operations, followed by innovator engagement, and work environment.

Literature Review

Since 2003, literature has been published covering the downstream value-creation process of TT at research universities with limited attention paid to the innovation creation phase, assuming research universities generate abundant IP and technologies for TTOs to commercialize. The perceived lack of importance and oversight given to the innovation creation phase is evidenced by the scarcity of research and publications devoted to TT innovator engagement (Balas & Elkin, 2013; Gordon, 2015; Gumbi, 2010; Ho et al., 2014; Siegel & Potterie, 2003). Instead, literature focused on TT value-creation related operation evaluation measurements due to the resulting annual billion-dollar revenue stream from academic TT operations and its impacts on economic development (Atkinson & Pelfrey, 2010; Gumbi, 2010; Ho et al., 2014; Shaffer, 2015; Ustundag, Ugurlu, & Kilinc, 2011). As a result, U.S. research universities have begun to view TT as a "Third Mission" revenue generation channel.

Moving to the innovation creation phase of the TT operations, research studies have found that work engagement influences innovation creation outcomes at a broad scope of business settings. However, creation of innovation as the fuel of TT operations at U.S. universities was not well-examined (Bakker et al., 2008; Bhatnagar, 2012; Blakeney, Carleton, McCarthy, & Coakley, 2009; Nijhof et al., 2002; Shafer, 2010; Udwadia, 1990; Van Gorp, 2012; Yusuf, 2009). Considering that innovator engagement is a critical first step in generating innovation output, literature rarely mentions TT innovator engagement. There is limited guidance and insight into best practices for innovator engagement through TT outreach programs. Therefore, a guiding framework is needed to ensure effective TT

innovator engagement outreach programs (Gumbi, 2010; Ho et al., 2014; Silvernagel, 2014).

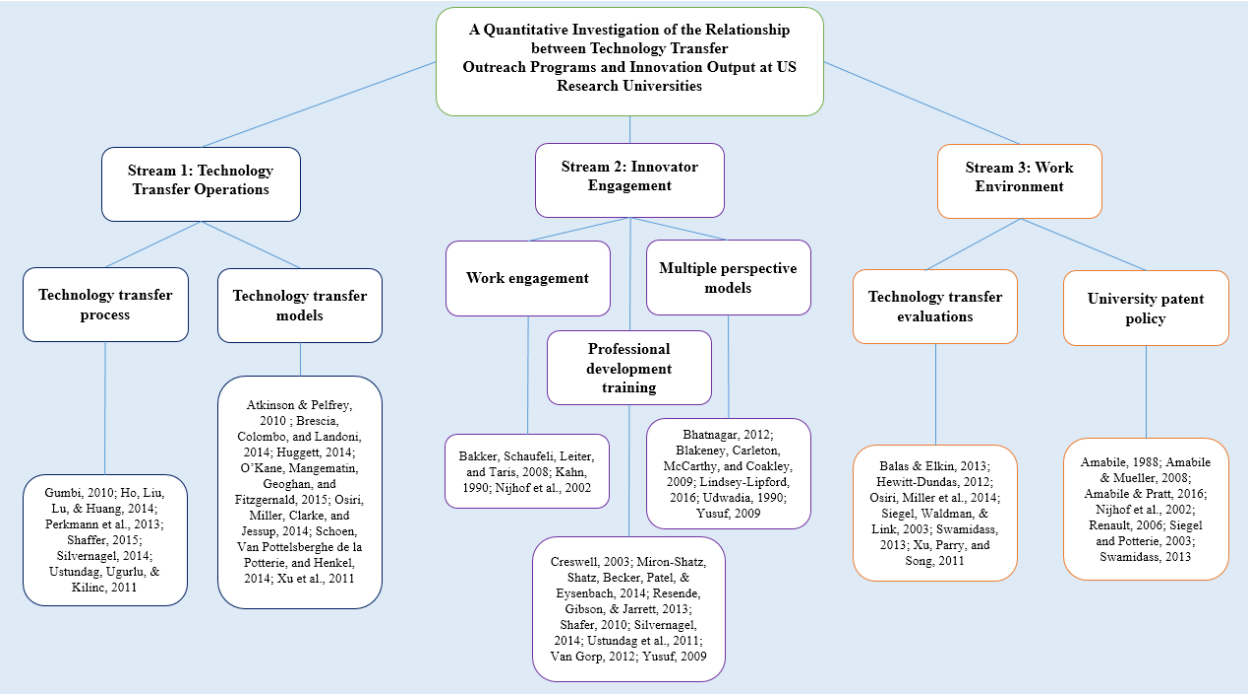

Figure 3. A literature map of the research study

This literature review was organized to explore three areas of research: TT operations, innovator engagement, and work environment. A literature map is depicted in Figure 3.

Stream 1: Technology Transfer Operations

In 1980, the Bayh-Dole Act (Public Law 96-517) was enacted and allowed universities, nonprofit research institutes, and teaching hospitals to own the IP resulting from federally funded research and to commercialize the IP as they wish (Stevens et al., 2011). TTOs manage IP disclosure, conduct marketing, and transfer the IP to companies

and receive financial compensation. TT operations at U.S. research universities have two components: TT process and TT office operating models. TT process at U.S. research universities includes innovation creation phase and value creation phase (Ho et al., 2014). Gumbi (2010) established a six-level IP value system for the TT process. Although Gumbi mentioned the importance of creating awareness of IP and the need for proper IP management as part of TTO functions, the author did not provide an implementing mechanism for TT outreach programs. Research and development expenditures, TTO age, faculty size, faculty quality and TTO funding independences are all factors influencing TTO operating models (Brescia et al., 2014; Xu et al., 2011). In the past 10 years, it has become a common practice for TTOs to collaborate with regional entrepreneurs to facilitate faculty startup formations and aggressively seek commercial partners (Atkinson & Pelfrey, 2010; Huggett, 2014; Osiri, McCarty et al., 2013; Xu et al., 2011).

Technology transfer process. Ho, Liu, Lu, and Huang (2014) offered a two-stage TT process in the innovation creation phase. In this phase, university capacities required were (a) attract funding from federal and industry; (b) accumulate technology; and (c) ability to obtain issued patent. The authors included accumulating technologies as part of the TT process (Ho et al., 2014). However, the literature did not mention TT outreach programs to inform innovators about IP awareness or IP protection strategy to promote innovator engagement. Scholars as well as university administrators often assumed IP generation was an outcome of conducting research. Therefore, researchers should have such knowledge about IP generation. In addition, research innovators often paid little attention to IP protection and secured patent rights for their research

discoveries since universities did not recognize IP generations as factors for promotional consideration. Without IP awareness, research innovators might not be aware of their capacity in generating IP and disclosing such IP to TTOs.

Gumbi (2010) established a six-level IP value system and assigned IP creation and maintenance with "0" at the lowest value level, assuming that IP creation and maintenance are part of research innovators' regular research output. Although Gumbi mentioned increasing awareness of IP and the need for proper IP management as part of TTO functions, he failed to offer any actionable TT outreach programs. In the IP management indicator, Gumbi's research showed the number of IP disclosures positively correlates to IP awareness and participation of technology transfer-related activities. Again, the author suggested interactions and communications with innovators were important but provided no suggestion for how to execute such suggestions (Gumbi, 2010). Similarly, Ustundag, Ugurlu, and Kilinc (2011) suggested training and education in the TT field when these authors studied factors influencing TTOs' performance but offered no guiding framework of the suggested TT training and education program. Results from this research study aimed to be used as a mechanism to bridge the gaps in this lack of specific direction for TT innovator engagement outreach programs.

Silvernagel (2014) offered empirical studies about student experiences regarding IP and university IP policy and the reaction of campus IP experts to the student perspective. The study conducted student surveys and interviews with campus IP experts to gather data. The research concluded TTOs' training programs of university TT process and IP policy were found to be key to developing a productive student IP culture. The article recommended an expanded IP-related training for faculty without providing any

outreach programs that encouraged innovator engagement and innovation output (Silvernagel, 2014).

In the value-creation phase, a successful TT operation required university to have: (a) the ability to secure licenses; (b) the ability to negotiate fair deals; and (c) the ability to start companies (Ho et al., 2014). Leveraging accumulated technologies with sound patent protection, TTOs' professional staff through their network and marketing efforts were able to secure license deals and negotiate fair compensation for the offered IP. Licensing mechanisms include, but were not limited to, collaboration, option, license, and sponsored research arrangements. Through the licensing mechanism, researchers gained access to industry resources to support scientists' research interest and assist product development of the licensed IP (Perkmann et al., 2013). Research universities and the companies became partners through the frequent interactions between researchers at the universities and companies. Further, cities and states in the U.S. often benefited from such academic-private partnership and came to depend on research universities as knowledge powerhouses and played an important role in economic development (Shaffer, 2015).

Technology transfer models. Operating models depended on TTOs' support functions in IP, research, and spin-off. TTOs might include functional teams such as technology transfer, corporate alliances, and startup venture. Some TTOs had all three functional groups while others had TT only and one other functional group. Research and development expenditures, maturity of TTO, faculty size, faculty quality, and a TTO's independent funding were all factors influencing TTO operating models (Brescia et al., 2014; Xu et al., 2011).

Four main organizational TTO structures were identified by Schoen, Van Pottelsberghe de la Potterie, and Henkel (2014) as:

1. Classical TTO which is part of the university administrative structure and serves only one university
2. Autonomous TTO which has a higher degree of autonomy than the classical TTO
3. Discipline-integrated technology transfer alliance (TTA) which services several universities and is not part of the university administration structure
4. Discipline-specialized TTA, which focus on one academic discipline at the departmental level. (p. 445)

In addition, a study conducted by Brescia, Colombo, and Landoni (2014) presented analyses of the organizational structure of 200 TTOs at the world's top-ranked universities. The Times Higher Education's 2012-2013 world university ranking was used to select the universities. The findings revealed that TTOs, as part of an internal university structure, consisted of 65% of the whole TTOs with 41% single office and 24% multiple-offices (Brescia et al., 2014).

Since 1980, upon the enactment of Bayh-Dole Act, most of the U.S. research universities have established TTOs to manage and support IP commercialization. O'Kane, Mangematin, Geoghan, and Fitzgernald (2015) studied TTOs' single agent-multiple principle relationship with academics and management within the university and showed TTOs identify-conformance and identity-manipulation to shape a wholly distinctive identity to establish legitimacy. A single agent-multiple principle relationship often caused conflicting expectations. For example, when the researcher led a TTO at a

Philadelphia-based research university, she had dual reporting obligations to the Vice President for Research and the Office of General Counsels that presented conflicting priorities. Without legitimacy, TTOs had challenges in accessing resources and consternation when promoting technology commercialization (O'Kane et al., 2015).

In addition to TT-only operation model, two additional sub-models often linked to TTOs: TT startup venture and TT corporate alliances. These two sub-models could be part of a TTO or operated in cooperation with TTOs. For TT startup venture, Osiri, Miller, Clarke, and Jessup (2014) conducted a comprehensive study of academic entrepreneurship (AE). AE was defined as the exploitation of academic institution's IP to create social or economic value. AE was presented as a subset of academic-based entrepreneurship and entrepreneurship. The five determinants were:

1. Institution's capacity to generate IP
2. Institution's entrepreneurial culture
3. Access to financial capital
4. The presence and the characteristics of university TTO
5. The involvement of entrepreneurial experts. (Osiri, 2014 p. 42)

It has become a common practice for TTOs to partner with regional entrepreneurs to facilitate faculty startup formations (Atkinson & Pelfrey, 2010; Huggett, 2014; Osiri, Miller et al., 2014). For TT corporate alliances, a comprehensive study of the current trend of the TT sector conducted by Huggett (2014) offered rankings in gross license revenue, National Institutes of Health (NIH) funding, startup formation, issued patents as well as license and option executed. Although the study focused in the life science field, it provided insight about TTOs' move to aggressively seek commercial partners and

startup formations. However, Huggett mentioned no innovator engagement other than for TTOs to facilitate academic-industry relationship with the assumption that generation of disclosable IPs happened by themselves (Huggett, 2014).

Summary. The literature review in the TT operations stream provided knowledge in the downstream process of value-creation phase of TTOs. Although scholars acknowledged the importance of educational training in TT as well as business trainings for researcher innovators, the literature provided no insights regarding how to establish and implement the training and education programs. In addition, literature indicated interactions and communications with innovators were essential, but no clear mechanism was offered (Gumbi, 2010). Clearly, there is a need to conduct a study to establish a guiding framework for conducting TT innovator engagement outreach programs at U.S. research universities. The next stream of literature review focused on innovator engagement at the innovation creation phase.

Stream 2: Innovator Engagement

Studies have found work engagement influences innovation creation outcome in a broad scope of business settings. However, creation of innovation as the fuel of TT operations in U.S. universities context was not well-examined (Bakker et al., 2008; Bhatnagar, 2012; Blakeney et al., 2009; Kahn, 1990; Nijhof et al., 2002; Shafer, 2010; Udwadia, 1990; Van Gorp, 2012; Yusuf, 2009). In this literature research stream, studies related to innovation about work engagement, multiple perspective model, and professional development training were reviewed and summarized.

Work engagement. Kahn (1990) found that people devoted different degrees of their personal energies into physical, cognitive, and emotional labors when performing in

work roles. Kahn conducted two qualitative, theory-generating studies of summer camp counselors and members of an architecture firm through observations, interviews, and author's participatory observations. Upon completion of the study, Kahn then conceptualized and proposed the work engagement theory. Kahn (1990) notes, "The exploratory research suggests that people tacitly deal with multiple levels of influences - individual, interpersonal, group, intergroup, and organizational- by examining them, at varying degrees of awareness, for what they imply about the meaningfulness, safety, and availability that characterize role performances" (p. 718). Psychological meaningfulness was linked to work environment that created incentives or disincentives to personally engage. Psychological safety was linked to factors of social systems that created nonthreatening, predictable, and stable social situations for an individual to be engaged. Last, psychological availability was linked to individual distraction that consumes people's attention and reduces their resources to engage in role performance. Further validating Kahn's work engagement theory, the study by Bakker, Schaufeli, Leiter, and Taris (2008) in occupational health psycology also found engaged employees had high levels of energy and identified strongly with their work through vigour, dedication, and absorption.

Relating to Kahn's proposed psychological availability, Nijhof et al. (2002) proposed a method of exempting idea generator. Innovators were exempt from ordinary tasks and allowed to concentrate their efforts on developing a promising idea (Nijhof et al., 2002). Nijhof et al. used a qualitative case study method with data triangulation approach. The authors enagaged two researchers to gather data and a third researcher to conduct data analysis, a representative check, and presenting a chain of evidence in a

medium-sized company. Data triangulation was achieved through the gathering of empirical data, interviews, informal meetings with both leader and employees, and obervation. Idea development depended on innovator and management both convinced of its potential. This interaction was very similar to the interaction between research innovators and the TT professionals at the U.S. research universities and demonstrated the needs of knowledge about effective communication channels in addressing innovator engagement.

Multiple perspective models. Udwadia (1990) proposed a multiple perspective model to examine the organizational and managerial issues relating to creativity. The multiple perspective model included three perspectives: the individual perspective, technical perspective, and organizational perspective. The individual perspective focused on the individual creative characteristics and behavior. Creative individuals had a higher intelligence level, a background that is more extensive, and specific knowledge. Creative individuals were often more risk-taking orientated and intrinsically motivated. Creative individuals derived their satisfaction from being involved in the process of developing new perspectives. The technical perspective focused on needed material and human resources and their impact on creativity. Collaboration and communication were keys to secure needed human and material resources for creativity.

Communication also was essential for managers to provide feedback when the innovation did not have the commercial merit to be developed. The organizational perspective focused on the organizational and managerial actions that positively or negatively affected creativity. Free, open, and flexible organizational environment with minimum external constraints allowed innovators to pursue novel possibilities as well as

exchanged and discussed ideas that released innovative behaviors. Encouraging new ideas and risk-taking with appropriate recognition were also important (Udwadia, 1990). Udwadia's study was very relevant to the current research because the innovators at U.S. research universities shared similar characteristics as the creative individuals in the study even though Udwadia's study was focused in business settings.

Blakeney, Carleton, McCarthy, and Coakley (2009) supported a similar multiple perspective concept as proposed by Udwadia (1990) and examined the science of innovation in the context of healthcare. With limited research in the healthcare context, the authors looked to fields such as social sciences, engineering, and diverse business industries to explore an emerging norm to establish a guiding framework in healthcare. The authors considered innovation as having three interdependent components: individual or team creativity, the innovation itself, and a supportive environment (Blakeney et al., 2009). The research study utilized a similar multiple perspective strategy to identify effective TT innovator outreach programs and establish a guiding framework. The research study used an online survey to obtain innovator's perspective of effective TT innovator outreach programs.

According to the Survey Monkey website (2014), online surveys where the researcher was not affiliated with the sites could gather, at best, a 30% response rate (Lindsey-Lipford, 2016). Table 1 lists a literature study of the past six years of doctoral dissertations related to faculty at higher education and quantitative online survey research.

Table 1

Doctoral Dissertations Related to Quantitative Online Survey Research Method About Faculty at Higher Education

Response Rate	Participants invited	# of institution or Association	Theses Title	References
28%	278/981	1	An analysis of online survey response behavior of university faculty members	Smith, G. (2004)
32.51%	488/1501	1	Cooperative Education at Wilmington University: Perceived Value and Barriers to the Successful Implementation	Caffo, D. C. (2017)
25%	448/1114	Writers of education Journals	Education Scholars' Perceptions and Practices toward Open Access Publishing	Ellingford, L. M. (2012)
8.24%	412/5000	National Communication Association	Exploring the relationship between faculty perceptions of chairperson-faculty member communication exchanges and department climate	Hallsten, J. (2015)
21.80%	218/1000	6	Faculty perceptions of self-plagiarism and other forms of academic dishonesty among university students	Vincent-Robinson, C. (2016)
32%	32/100	1	Faculty Perceptions, Attitudes, and Behaviors Towards Educating African American Male Students	Powell, S. E. (2016)
15.40%	354/2298	3	Organizational socialization of community college adjunct faculty: A correlational analysis of content, context, and the dimensions influencing socialization outcomes	Lindsey-Lipford, W. (2016)
41.50%	42/101	1	Predictors that influence job satisfaction of foreign-born faculty at a Midwest higher educational institution	Reeder, M. (2016)
39% and 33%	237/699 and 159/484	2	Professional development for teaching in higher education: Faculty perceptions and attitudes	Pesce, J. R. (2015)
8.03%	205/2550	1	A Quantitative Study of Online Faculty Members' Self-Perceived Teaching Efficacy	Vilkas, B. J. (2017)

The response rates were: 8.03%, 8.24% (national communication association), 15.4% (three colleges), 21.8%, 25%, 28%, 32%, 32.5%, 36%, and 41.5%. Some of the researchers discussed whether to generalize the research result based on the response rate. Based on this researcher's experience working with faculty innovator at higher education for the past 20 plus years, she expected a response rate of 10-15%.

Bhatnagar's multi-level empirical research found psychological empowerment affected work engagement which secured high innovation and low turnover intention. Psychological empowerment predicted work engagement and innovation (Bhatnagar, 2012). Further, Yusuf (2009) suggested networking and collaboration were keys to transforming creativity to innovation (Yusuf, 2009). The multiple-level study and the multiple perspective model had great implications for the research study. These characteristics implied innovators' perspectives impacted effective TT outreach programs which promoted collaboration and innovation output.

Professional development training. Yusuf (2009) noted, "The quality of human capital and its enhanced creativity create preconditions; but catalyzing that innovation requires triggers and mechanisms that reinforce certain types of productive behavior" (p. 4). Shafer (2010) investigated whether professional training activities contributed to high levels of employee engagement. Shafer used Kahn's work engagement model as the theoretical framework for the study. The study was a qualitative multi-case study with both leaders and their employees as participants. Both leaders and their employees shared their reactions and knowledge related to the training program. The data collection methods included observations, interviews, company documents, artifacts, and other archival records. Shafer utilized Creswell's (2003) data analysis and interpretation

process to organize and prepare the data for analysis. The study found that leaders, who were employee-centered, were supportive of employee collaboration on organizational initiatives and mentored their employees' growth and development of highly engaged employees. Although Shafer (2010) studied and found that work engagement could be achieved through professional development training programs, creativity and innovation cannot be directly correlated to professional development training and work engagement. This reflected the need for the study to investigate the relationship between TT outreach programs and innovation output.

Trust is another factor that needs to be considered. Interestingly, Van Gorp (2012) conducted an exploratory investigation of perceptions of organizational support for innovation among employees of a nonprofit credit union in a Midwestern state. The study involved a 534-employee web-based survey, made up of previously tested scales. The study found organizational trust and work engagement positively correlated to organizational support for innovation. It suggested roles for leaders are in prioritizing innovation activities, addressing differences in disposition among employees, and supplying adequate resources. One of the recommendations of the study was for leaders to engage employees in innovation activities and assure that trust was integrated in innovation systems (Van Gorp, 2012). This aligned with the research to identify a TT innovator engagement outreach programs and to provide a guiding framework for implementation. Ustundag et al. (2011) also suggested TT training and education but offered no guiding framework of the suggested TT training and education program.

Similarly, Silvernagel (2014) concluded TTO training programs as part of the university TT process as well as IP policy to be keys to developing a productive student

IP culture with no suggestions about execution (Silvernagel, 2014). Various studies suggested TT training programs for research innovators are needed (Miron-Shatz, Shatz, Becker, Patel, & Eysenbach, 2014; Resende, Gibson, & Jarrett, 2013). Correspondingly, Resende and colleagues (2012) presented a qualitative analysis tool as a best practice guide for TTOs to improve their effectiveness and efficiency. Actual practices that promoted interactions in various TT processes were collected including the U.S. Department of Defense laboratories, 29 U.S. universities, one Singapore university, one Australian university, and 51 TTOs in U.S. and Portugal (Resende et al., 2013). In addition, Miron-Shatz, Shatz, Becker, Patel, and Eysenbach (2014) examined the lack of business training for practice physicians and healthcare professionals, and its adverse effects in the ability of integrating sciences and business to generate disclosable IP and commercialization. The authors found no business training offering except TT offices and MD/MBA programs (Miron-Shatz et al., 2014). Clearly, TTOs' outreach educational program and innovator engagement have high impacts in innovation creation.

Summary. Creative individuals at research university settings shareed similar characteristics as Udwadia (1990) described in his research. TT innovator engagement outreach programs are well suited to harness creative individuals' energy and release innovation. Through the TT outreach programs, innovators interact with TT professionals to build trust and to share their ideas. Although innovator engagement is a critical first step to generate IP, literature rarely mentioned how to implement TT innovator engagement in the U.S. research university context. Since Shafer (2010) found that work engagement could be achieved through professional development training programs, and creativity as well as innovation could not be directly correlated to

professional development training and work engagement, as such, this research study examined the relationship between TT professional development programs through TT outreach programs and innovation output in a U.S. research university context. Again, there is no guidance for TT innovator engagement outreach programs. Therefore, a guiding framework is needed to ensure effective TT innovator engagement through outreach programs.

Stream 3: Work Environment

Management must take actions to foster innovation and resources allocated for innovation development and implementation (Amabile, 1988). Amabile (2008) proposed the componential theory and suggested work environment high in supports for creativity positively affects creative individuals. Creativity could be systematically influenced, and a work environment supportive of creativity was one of the affecting components (Amabile, 1988; Amabile & Mueller, 2008; Amabile & Pratt, 2016). Amabile and Pratt (2016) suggested effective management practices that influence creativity and innovation in the orgnizational setting included but were not limted to individual autonomy, constructive feedback on creative efforts, equitable and generous rewards and recognition for good creative efforts (regardless of outcome), less bureaucracy in the organization, and supportive collaboration across teams, departments, and units. The authors also suggested synergistic extrinic motivation promotes creativity and innovation output. Suggested examples included the following:

> …with recognition that acknowledges the value of the work done (such as a plaque on a company's wall of honor), or with rewards that allow the individual to engage more deeply in activities that are intrinsically interesting (such as funding for a successful team to work on a new pet project that the team has proposed). (Amabile & Pratt, 2016, p. 176)

In addition, Maxwell (2005) proposed that "A study must take account of the theories and perspectives of those studied, rather than relying entirely on established theoretical views or the researcher's perspective" (p. 53). Therefore, research about TT evaluations and patent policy provided insights related to innovators' working environment supported by the TT operations. U.S. research universities can implement these organizational management practices through TT outreach programs to encourage innovator output. Therefore, there is a need to investigate the relationship between outreach programs and innovator output.

Much research had been conducted about measurements of TT performances at U.S. research universities since 1980 when Bayh-Dole Act (Public Law 96-517) was enacted and allowed universities to have ownership to commercialize innovation output generated from federal funding (Stevens et al., 2011). The commonly studied TT performance evaluation indicators included but were not limited to number of IP disclosure, patents issued, licenses executed, corporate partnership, and startup formation (Balas & Elkin, 2013; Huggett, 2014; Osiri, McCarty et al., 2013; Siegel & Potterie, 2003). These evaluation indicators were all measures focusing on the TT value-creation phase while the TT innovator engagement outreach programs that promoted the critical innovation creation phase of TT were not included. There was rarely mention of TTOs' performances in conducting outreach programs to inform innovators about IP awareness and IP protection strategy to encourage innovation as one of the evaluation indicators nor faculty recognition in the patent policy other than royalty sharing to innovators.

Nijhof et al. (2002) proposed a method of exempting idea generators. Innovators are exempt from ordinary tasks and allowed to concentrate their efforts on developing a

promising idea (Nijhof et al., 2002). Amabile and Pratt (2016) stated, “sufficient time to explore creative solutions and implement those solutions effectively is an often-neglected organizational resource” (p.162). Although most organizations have “innovation” embedded in their mission statements, Amabile and Pratt (2016) offered, “genuine openness to new ideas, a system for developing creative ideas, and an offensive strategy of leading the organization’s industry into the future” as true indication of an organization’s motivation to innovate (p. 161).

Amabile and Pratt (2016) proposed a new dynamic componential model of creativity that emphasized organizational work environment influences on individual-level psychological process. The research was based on a multi-study field research program with primary data consisting of daily electronic diaries that participants submitted at the end of their workday from 238 professionals, on 26 teams working on creativity-related projects at seven organizations. The authors suggested innovation progress at the organizational level stimulated a progress effect in both individual and organizational levels that led to futher innovation. The findings also included that affect-induced postive mood led to higher level of creativity and dimension of performance and was related to the progress of an individual’s creativity outcomes. Work environment could either facilitate or impede progress, and on average, local leaders had a stronger impact on the perceived work environment than high-level leaders or the overall work environment. The TT professionals represented local leaders who could induce positive moods through conducting effective outreach programs perceived by innovators. The research study investigated the realtionship between outreach programs and innovation output related to a sense of progress in creative idea development through effective TT

communication channels. The channels were used to communicate progress of idea generation and development since progress wass one of the components to faciliate intrinsic motivation to creativity.

Technology transfer evaluations. Xu, Parry, and Song (2011) examined the correlations between invention disclosures and the characteristics of TTO, federally funded research and development (R&D) expenditures, TTO size and maturity, faculty size, faculty quality, and TTO independence funding. Invention disclosure was a report submitted by a faculty innovator to his or her TTO that describes research discoveries and the invention in a detailed format. The authors found little research was conducted related to factors that affect invention disclosures. The authors argued larger TTOs had more knowledgeable TT agents who could build stronger faculty-TTO relationships and encourage more invention discourse submission with no mention about how to build such relationship. A quantitative method utilizing standard deviation and mean was used. Data were gathered from 123 TTOs' websites, the 2004 Association of University Technology Manages (AUTM) annual survey report, and the National Science Foundation (NSF). The study found that federal R&D expenditures and TTO size positively correlated with the disclosure number. For large TTOs (FTEs >4.0), invention disclosures positively correlated to faculty quality while for small TTOs, faculty size, royalty share to inventors, and TTO age positively correlated to invention disclosure. TTO funding independence has no impact on IP disclosures. The strength of this article was it provided needed knowledge about the TTO characteristics that affect IP disclosure. The weakness was it did not provide suggestions about how to leverage this information to improve the number of IP disclosures. Faculty reward systems had been linked to

effectiveness of TTOs through the number of IP disclosure and startup formations (Siegel, Waldman, & Link, 2003; Swamidass, 2013). Although Xu et al. (2011) touched on faculty reward systems such as royal sharing to inventors positively impacting IP generation, there was no mention of a mechanism in helping researchers better understand patent policy, which provided guidelines for such faculty recognition, and reward system through outreach programs.

Osiri, Miller et al. (2014) conducted a comprehensive study of academic entrepreneurship (AE). The authors presented a definition and framework of AE. AE was defined as the exploitation of an academic institution's IP to create social or economic value. AE was presented as a subset of academic-based entrepreneurship and entrepreneurship. Five AE determinants were proposed and supported by literature. The authors reviewed and analyzed data gained from extensively reviewing five leading entrepreneurship journals from their inception until 2010. Their mixed methods research focus was establishing a practical framework for AE and future research. The five determinants were: (a) institution's capacity to generate IP; (b) institution's entrepreneurial culture; (c) access to financial capital; (d) the presence and the characteristics of university TTO; and (5) the involvement of entrepreneurial experts. The authors indicated the article's findings support further research in each of the five determinants (Osiri, Miller et al., 2014).

Hewitt-Dundas (2012) examined the differences in strategic priority of knowledge transfer, organizational supports, and the scale and scope of the knowledge transfer activities between high research intensity and low research intensityin UK. Interestingly, Hewitt-Dundas' findings showed that institutional and organizational resources such as

ethos and research quality shaped a university's knowledge transfer instead of the TTO's knowledge transfer capacity. Although Hewitt-Dundas' study was conducted in the United Kingdom, his findings provided important insight about being mindful of other factors beyond TTO's control and may influence TT performance when considering TT performance evaluation indicators. The study finding can be used to guide universities on whether to include TTO's performance in outreach programs as one of the TT performance evaluations.

University patent policy. University patent policy covers faculty reward systems in participating TT activities and TTOs' operational guideline, which influences researchers' attitudes toward TT. Research by Renault (2006) indicated research professors' entrepreneurial behaviors included decisions about collaboration with industry, patenting, and spinning off companies. These entrepreneurial behaviors affected the productivity of universities' TT efforts. Research professors' concerns about the proper role of universities in the management of knowledge and in university patent policy could affect these behaviors (Renault, 2006). Similarly, research by Swamidass (2013) suggested university policies included turning some of the unlicensed IP to fuel university startups. An estimated 75% of university IP inventions were not licensed. Swamidass' research put forth factors to promote startup formation such as the need for very early evaluation of all inventions for their startup potential, the need for pre-license seed funds through proof-of-concept programs to advance early-stage inventions to the next stage, and the need for TTO personnel skilled in enabling startups (Swamidass, 2013).

Siegel and Potterie (2003) studied and concluded, based on 55 interviews of 98 entrepreneurs, scientists, and administrators at five research universities, that faculty reward systems as part of the patent policy is one of the most critical organizational factors that affect the TT effectiveness. TTO staffing/compensation practices and cultural barriers between universities and firms were two other factors (Siegel & Potterie, 2003). There is a need for universities to help faculty innovators better understand the patent policy. However, despite the importance for research innovators to understand university patent policy, no literature mentioned TTO's involvement in facilitating research innovators' understanding of the policy and provided a mechanism of addressing their concerns to encourage innovator engagement. The research finding provided insights about whether effective TT outreach programs impact innovator engagement.

Summary. The literature review in the work environment related TT evaluation and patent policy stream evidenced the importance and effects of patent policy, faculty reward system, and TT operation guideline in research innovators' attitude toward working relations with TTOs. Universities' capacity to generate IP is one of the determinants that enabled research universities to leverage their IP to create social or economic value as concluded by Osiri, Miller et al. in 2014. Much research had been conducted about TT evaluations at U.S. research universities since 1980 when Bayh-Dole Act (Public Law 96-517) was enacted (Stevens et al., 2011). The TT valuation indicators included but were not limited to number of IP disclosures, patents issued, licenses executed, corporate partnerships, and startup formations without TT outreach programs (Balas & Elkin, 2013; Huggett, 2014; Osiri, McCarty et al., 2013; Siegel & Potterie, 2003). Finally, no literature could be found that mentioned TTO's involvement in

facilitating research innovators' understanding of the policy and suggested a mechanism of addressing their concerns to encourage innovator engagement.

Summary

The literature review provided support of this quantitative method design study to investigate the relationship between TT outreach programs and innovation output. This literature review was organized to explore three areas of research: TT operations, followed by innovator engagement, and work environment related TT evaluations and university patent policy.

Although abundant research covered TT operations in commercialization of university innovation output in IP, no research could be found that specifically investigated whether TT operations related to TT outreach training programs and effective communications positively impacted faculty innovators' desires to transform their creativity into innovation output (Ho et al., 2014; Huggett, 2014; Osiri, McCarty et al., 2013; Silvernagel, 2014; Stevens et al., 2011; Xu et al., 2011). Most universities assumed that researchers and students automatically became innovators and produced abundant IP inventory for technology transfer (Silvernagel, 2014). The reality was researchers paid little attention and were not committed to the pursuit and transformation of their creativity into IP inventory due to other competing demands on their time and effort (Nijhof et al., 2002). Innovator engagement is essential for innovation output.

Kahn's (1990) engagement theory and Udwadia's (1990) multiple perspective model examined the organizational and managerial issues relating to creativity and concluded that a free, open, and flexible organizational environment with minimum external constraints allowed innovators to pursue novel possibilities as well as exchanged

and discussed ideas that released innovative behaviors. Similarly, componential theory proposed by Amabile (2008) indicated creativity could be systematically influenced, and a work environment supportive of creativity was one of the affecting components, suggesting that organizational work environment impacted individual creativity (Amabile, 1988; Amabile & Mueller, 2008; Amabile & Pratt, 2016).

Despite the potential positive impact of outreach programs to provide innovators a supportive environment to learn about IP awareness and IP protection strategy that strengthen innovator engagement and affect innovation output, TTOs' performances in outreach programs were not included as one of TT evaluations to monitor the effective implementation of the outreach programs by TTOs. Common evaluation indicators were limited to number of IP disclosures, patents issued, licenses executed, license revenue, corporate partnership and funding support, and startup formation (Balas & Elkin, 2013; Huggett, 2014; Osiri, McCarty et al., 2013; Siegel & Potterie, 2003). Synergistic extrinic motivation related to university patent policy which recognized and rewarded innovators' contribution to the innovation output were also examined (Amabile & Pratt, 2016).

The literature review in the TT operations stream provided knowledge in the downstream process of the value-creation phase of TT operations. Although scholars acknowledged the importance of educational training in TT as well as business trainings for researcher innovators, the literature provided no insight regarding how to establish and implement the training and education programs. Despite interactions and communications between innovators and TT professionals considered essential by scholars, existing literature offered no clear methods for improvement (Gumbi, 2010). Creative individuals at research university settings shared similar characteristics as

Udwadia (1990) described in his research. TT innovator engagement outreach programs are well suited to harness creative individuals' energy and release innovation. Through the TT outreach programs, innovators interact with TT professionals to build trust and to share their ideas. Although innovator engagement is a critical first step to generate IP, the literature rarely mentioned TT innovator engagement in the U.S. research university context. Similarly, Shafer (2010) studied and found that work engagement could be achieved through professional development training programs. However, creativity and innovation could not be directly correlated to professional development training and work engagement. The research study examined the relationship between TT professional development programs through TT outreach programs and innovation output in the U.S. research university context. The literature review in the work environment-related TT evaluation and patent policy stream evidenced the importance and effects of patent policy, faculty reward systems, and TT operation guidelines in research innovators' attitude toward working relations with TTOs. Much research had been conducted about TT evaluations at U.S. research universities since 1980 when Bayh-Dole Act (Public Law 96-517) was enacted (Stevens et al., 2011). At the present time, the TT evaluation indicators included but were not limited to number of IP disclosures, patents issued, licenses executed, corporate partnerships, and startup formations (Balas & Elkin, 2013; Huggett, 2014; Osiri, McCarty et al., 2013; Siegel & Potterie, 2003). TTOs' performance in conducting outreach programs was not one of the evaluation indicators.

The literature review revealed a knowledge gap about effective TT outreach programs to support innovation engagement and encourage innovation output, thus, demonstrating need for present research study. Additionally, there is a need for a formal

guiding framework to inform and guide U.S. research universities to strengthen innovator engagement through TT outreach programs. Clearly, there is a need to study TT innovator engagement outreach programs and to provide a guiding framework for implementation.

In the following methodology chapter, the researcher proposed a quantitative research study with survey methods targeting 163 U.S. research universities to address the research questions and test the null hypotheses.

Chapter 3: Research Methodology
Introduction to Chapter 3

The purpose of this quantitative research study was to investigate the relationship between TT outreach programs and innovation output at U.S. research universities. The central question that guided the study is "What is the relationship between TT outreach programs and innovation output at US research universities?" In order to address this overarching question, the study developed a survey method to answer the following questions:

- Based on the perspective of a TT professional, what are the types and characteristics of a TT outreach operation at selected universities?
- Based on the perspective of an innovator, what are the desired features of TT outreach programs at selected universities?
- To what extent does the relationship between TT outreach programs and innovator engagement impacts innovation output?

Using Kahn's work on engagement theory (1990), the study tested the following null hypotheses:

Null hypothesis 1. There is no association between TT outreach programs and IP inventory at U.S. research universities.

Null hypothesis 2. There is no association between TT offices' outreach programs and license revenue.

Null hypothesis 3. There is no association between TT outreach programs and number of full time TT employees, which include support staff.

Null hypothesis 4. There is no association between university research funding level and TT outreach programs.

Null hypothesis 5. There is no association between innovators' participation in TT outreach programs and innovators' research funding level.

Null hypothesis 6. There is no association between innovators' participation in TT outreach programs and report of invention.

The TT outreach programs in the research study covered both outreach training programs and communication channels between TT professionals and innovators. The research study used a quantitative approach with cross-sectional survey methods. It utilized validated measurement instruments with semi-structured open-ended and closed-ended questionnaires through the web-based Survey Monkey across 163 U.S. research universities (Creswell, 2015; Russ-Eft & Preskill, 2009). Collected quantitative and qualitative data were analyzed using IBM SPSS Statistics quantitative software package as well as qualitative cataloging and coding analysis techniques. The study used one-way and two-way analysis of variance (ANOVA) with subsequent Post hoc tests to test the correlation between communication channels, educational training programs, research funding, TT office size, and innovation output. In addition, the study used bivariable linear regression analysis to explain and predict the relationship between outreach programs and innovation output variables (Creswell, 2015; Johnson & Christensen, 2014; Krathwohl & Smith, 2005; Ravid, 2015; Singh, 2007). The study categorized and coded the descriptive data from open-ended questions to develop themes. The study contributed to the engagement theory, multiple perspective model, and componential model of

creativity and innovation in organizations (Amabile, 1988; Amabile & Pratt, 2016; Kahn, 1990; Kamler & Thomson, 2004; Krathwohl & Smith, 2005; Udwadia, 1990).

This chapter included four main sections: research design and rationale, site and population, research method, and ethical considerations. The research method section included survey methods, data collection and analysis procedures as well as stages of data collection.

Research Design and Rationale

The research design was a quantitative research study that utilized a cross-sectional survey method where the researcher collected data at one point in time with a validated self-report survey instrument to investigate the relationship between TT outreach programs and innovation output at 163 U.S. research universities through perspectives of both innovators and TT professionals (Creswell, 2015; Ravid, 2015). Creswell (2015) indicated, "A cross-sectional study can examine current attitudes, beliefs, opinions, or practices. Attitudes, beliefs, and opinions are ways in which individuals think about issues, whereas practices are their actual behaviors" (p. 380).

The researcher conducted cross-sectional surveys simultaneously with two target population sets using simple random sampling at 163 U.S. research universities that participated in the 2015 AUTM survey (Krathwohl & Smith, 2005; Kumeh, 2012; Singh, 2007). One survey targeted TT professionals, and the other survey targeted innovators at the 163 U.S. research universities. Through TT professional and inventor associations such as AUTM and NAI, the researcher identified target populations and established invitation lists to conduct the survey across U.S. research universities. For the TT professional samples, the study invited TT offices at all 163 U.S. research universities

that contributed to the 2015 AUTM annual survey to participate in the TT professional survey and provide information about current innovator educational training programs and communication channels with innovators. Similarly, for innovator samples, all 250 NAI fellows who had been recognized by the NAI in 2015 and 2016 from these 163 U.S. universities were invited to participate in the innovator survey and provide information about their preferred outreach programs. The perspectives of the administrators were also important as they related to TT operations and resources allocation supportive of TT operation. The study obtained this information from the 2015 AUTM annual survey report.

Creswell (2015) suggested, "Assessing certain factors to predict an outcome is best suited to quantitative research" (p. 13). In addition, the researcher's belief in a constructivism paradigm guided the researcher to study the relationship between outreach programs, innovation engagement, and innovation output utilizing engagement theory and multiple perspectives model to establish general features of effective TT outreach programs perceived by innovators at U.S. research universities (Creswell, 2015; Scotland, 2012).

Further, componential theory proposed by Amabile (1988) indicated creativity can be systematically influenced where a work environment supportive of creativity was one of the affecting components confirmed researcher's approach to collect both quantitative and qualitative data about innovators', who are creative individuals, perspectives in work-related activities that impacted their innovation output. Singh (2007) stated, "To assess the impact of a social change, it is necessary to do a stakeholders' analysis to have the views of all partners associated in the process" and

"…try to identify their interest in various project objectives and output" (p.7). The research study selected a quantitative method approach with a survey method to focus on the investigation of correlations between outreach programs and innovation output across different research universities without involving specific individual universities' policies, politics, and cultures. Singh (2007) suggested it is "…not easy to identify their [stakeholders'] interests especially if they are hidden, multiple, or are in contradiction with the stated objectives of the organization or individual" (p.7). A qualitative method probeed the respondents' assessments of the relative effectiveness of the outreach programs and their reasons for believing some are more effective than others (Berkowitz, 1997). Similarly, beneficiary assessment is a qualitative method for researchers used to investigate and evaluate target populations' opinions, needs, and concerns regarding a process primarily through three primary data collection techniques: (a) in-depth interviews; (b) structured and unstructured focus group discussions; and (c) direct and participant observations. Although the research study did not utilize customary interview and focus group methods, the researcher collected data related to innovators' perspective through open-ended questionnaires and subsequent qualitative categorying and coding analysis to understand the innovators' opinions, needs, and concerns. It is necessary to avoid negative impacts to the relationship between innovators and their universities and yet accomplish the data collection. The research study had selected open-ended questionnaires in addition to close-ended questionnaires with the survey method (Singh, 2007). The anonymous survey method empowered innovators across the 163 universities to answer the survey questions candidly, which facilitated validity and avoided negative impact to innovators' working relationship with their respective universities. Such good

working relationships were important to facilitate implementation of the effective outreach programs and ensuring innovative output (Hanson, Creswell, Plano Clark, Petska, & Creswell, 2005).

Singh (2007) writes:

> Participation of stakeholders in the planning and designing process ensures that their concerns and issues form part of the project implementation processes…Thus, it allows the implementing agency to articulate the project's development outcome and impact and establish meaningful indicators to monitor and evaluate them. (p. 8)

Site and Population

Population Description

The research study had two groups of populations at U.S. research universities: innovators and TT professionals. Universities that received U.S. federal research funding were required to establish TT offices to manage innovation output generated from the funded research. Most U.S. research universities were active in some form of TT related activities (Stevens et al., 2011). TT professionals had business experience or technical expertise to assist faculty innovators through the TT process. TT professionals' functions included but were not limited to seeking patent protections for invention disclosures that had commercial merits and transferring the novel discoveries and inventions to commercial partners in exchange for fair financial reward for the universities. The innovators were researchers who received funding and conducted research at U.S. universities. Through conducting research, the faculty innovators conceived novel ideas and reduced such ideas to practices addressing unsolved problems. Through the

assistances of the TT office at their university and patent lawyers, faculty innovators received patents from the U.S. Patent and Trademark Office to protect their innovation output.

Table 2
Detailed Summary Information of Targeted 163 US Research Universities

Federal Research Expenditure	< $40M	$40M, and < $75M	$75M, and < 150M	$150M, and < $200M	> $200M
# of universities	47	19	27	15	55
Number of Report of Invention	< 25	25 - 50	51, and < 100	101 - 200	> 200
# of universities	72	30	19	21	21
License Income	< $250,000	$250,000, and < $1M	$1M, and < $5M	$5M, an < $10M	> $10M
# of universities	42	23	47	20	31
Technology Transfer Staff	Up to 5	6 - 10	11 - 15	16 - 25	> 25
# of universities	72	30	19	21	21

Data source: AUTM 2015 survey report

One targeted population set was the TT offices that participated in the 2015 Association of University Technology Managers (AUTM) survey (Huggett, 2014), as shown in Table 2. AUTM is an international professional organization for TT professionals, universities, and related supporting entities. The total number of the U.S. research universities with TT offices in the target population was 163 according to the most recent 2015 AUTM annual survey (FY2015 Licensing Survey, 2017).

The other targeted population set was fellows at the National Academy of Inventors (NAI). NAI was founded in 2010 to recognize and encourage inventors with patents issued from the U.S. Patent and Trademark Office. The NAI website stated its

mission and goal as “enhance the visibility of academic technology and innovation, encourage the disclosure of intellectual property, and translate the inventions of its members to benefit society” NAI, 2016). A fellow is an innovator who works at or affiliates with a U.S. university, who has received at least one U.S. issued patent, and who is nominated by his or her university for recognition at the NAI. The estimated innovator number of the target fellow population was 250.

Site Description

The researcher conducted the target population surveys through the internet. Therefore, the research study had no need to select physical sites to enter and conduct the research. In addition, the site selected to conduct a pilot program to validate the survey instruments was the City University of New York (CUNY) which is the largest urban university in the U.S. located in New York City, New York. CUNY has 24 colleges and 535 faculty inventors. CUNY established its Technology Commercialization Office (TCO) in 2004. TCO receives new technology disclosures and evaluates them for their commercial potential, facilitates the transfer of CUNY intellectual property by nurturing collaborations with industry, develops a protection and marketing strategy with inventors through patent and copyright protection, and supports the formation of start-up companies (“Innovation & Entrepreneurship at The City University of New York”, 2017). According to the Director of TCO at CUNY, its office was active in conducting outreach programs and had strong entrepreneurial culture, high-volume TT activities, and strong industry relationship. However, the pilot study indicated a different faculty perspective based on less than 25% survey response rate from 12 participated faculty of the 50 invited participants whom were considered active innovators by its TCO. Clearly,

a large-scale survey was needed to obtain innovators and TTOs' perspectives about the outreach programs.

Site Access

The researcher conducted a survey of targeted TTOs and NAI fellows through the internet by web-based Survey Monkey. The participants received an email invitation to the survey and participated in the survey through his or her computer. The researcher did not require individual physical site access to distribute the survey at the 163 U.S. research universities.

For the pilot study, the researcher leveraged her network to gain site access. The researcher contacted the Director of the TCO at CUNY and obtained written permission to conduct a pilot study to validate both TT and innovator survey instruments with 50 faculty selected by the TCO. Proactive communication with CUNY prior to and during the research study was important to gain and maintain access to the site.

Research Methods

The quantitative method involved a two-part cross-sectional survey design to collect data at one point in time. The two-part survey included conducting a pilot study at CUNY with a convenience sampling of a small group of selected participants to validate the survey instruments and conducting subsequent study surveys of the target TT professional and innovator population sets.

Description of Methods Used

A quantitative simple random sampling survey approach provided an efficient way to gather quantitative and qualitative data from a large sample. Johnson and Onwuegbuzie (2004) suggested the use of a questionnaire that included a summated

rating scale to collect quantitative data collection and one or more open-ended questions to collect qualitative data. This section described instrument description, participant selection, identification and invitation as well as data collection.

Instrument description. The researcher established two survey instruments referencing three validated instruments. Three validated measurement instruments were used as references: Keys® to Creativity (Keys), Innovation and Situational Outlook Questionnaire (SOQ), and Outreach and Engagement Measurement Instrument (OEMI) (Amabile, 1988; Amabile & Mueller, 2008; Amabile & Pratt, 2016; Ekvall, 1996; Hilpert & Husman, 2016; Hilpert, Husman, & Stump, 2016; Isaksen & Ekvall, 2015). The study used one survey instrument for each target population. The survey instrument for the innovators included four components: demographics, TT outreach programs, communication channels, and recognition and reward. The survey for the innovators had 18 questions and took participant approximately 10 minutes to complete. The survey instrument for the TT professionals included three components: demographics, TT outreach programs, and recognition and reward. The survey for the TT professionals had 16 questions and took participants approximately 15 minutes to complete.

The researcher addressed validity and reliability by conducting factor analysis and a pilot study. A factorial analysis of variance was utilized to evaluate two independent variables with a determination of interaction with three or more groups. Ravid (2015) stated the content validity "…refers to the adequacy with an instrument measures a representative sample of behaviors and content domain about which inferences are to be made" (p. 210). Through the pilot study, the researcher confirmed both the innovator questionnaire and the TT professional questionnaire were comprehensive enough to

collect all data needed to address the research questions and test the hypotheses (Radhakrishna, 2007). Ravid (2015) suggested Cronbach's coefficient alpha could be used to "…assess the reliability of instrument with different type of item formats using scores obtained from a single testing of the instrument" (p. 202). For reliability, the researcher used the responses of the pilot study that included 12 innovator participants and a TTO director who were able to understand and answer the questions with no additional feedbacks to estimate reliability.

The researcher conducted a pilot study at CUNY to validate the survey instrument upon IRB approval (Creswell, 2015; B. R. Johnson & Onwuegbuzie, 2004). An instrument was built by combining and modifying types and styles of existing questionnaires and validated instruments related to various outreach programs in other contexts (B. R. Johnson & Onwuegbuzie, 2004). Checklist and rating style were included. The Likert scale checklist (e.g. strongly dislike to strongly prefer) consisted of commonly known TT training programs and communication channels (Creswell, 2015). The survey instruments included both close-ended and open-ended questions to identify current TT outreach programs, their respective characteristics, communication channels, number of report of invention submitted, issued patents, funding, and perceived effectiveness of respective programs to explore target populations' preferences and deepen understanding of their perspectives (Jacob & Furgerson, 2012).

The researcher conducted a pilot study at CUNY using the developed sample survey instrument. Based on the results and feedback from the pilot study, the researcher modified the survey instruments before the targeted population is surveyed (Creswell, 2015). Cover letter sample and survey instruments are listed in Appendix A.

Participant selection. Utilizing the AUTM database and the NAI database, the research study deployed simple random sampling strategy for participant selection in the study surveys. The total number of the targeted population of TTOs at U.S. research universities was 163. The study invited the TT professional samples to participate in the research study survey. The TT professional samples consisted of one TT professional representative per each of the 163-targeted TTOs. Similarly, all 223 NAI Fellows who were recognized by NAI in 2015 and 2016 from the 163 U.S. universities were invited to participate in the survey as the innovator samples. The simple random sampling of TT professionals and innovators through AUTM and NAI (which were the two main international associations supporting technology transfer for TT professionals and innovators) provided insights about perspectives of TTOs and innovators at the U.S. research universities (Creswell, 2015).

According to the Survey Monkey website (2014), online surveys where the researcher was not affiliated with the sites could gather at best a 30% response rate (Lindsey-Lipford, 2016). Literature study, as listed in Table 1, of the past six years of doctoral thesis related to faculty at higher education and quantitative online survey research indicated a response rate range of 8.3% to 41.5%. Although a $10 gift card was offered to innovator participants as reward for completing the survey, based on the researcher's experiences working with faculty innovators at higher education for the past 20 plus years, she expected a response rate of 10-15%.

For the pilot study, the researcher worked with the TCO Director at CUNY and used convenience sampling to select 50 faculty who were willing and available to participate in the pilot study (Creswell, 2015). None of the selected faculty members was

NAI fellows, therefore the study had no need to exclude any pilot study innovator participants from the final target population (Creswell, 2015; R. B. Johnson & Christensen, 2014).

Identification and invitation. Utilizing the AUTM website, the NAI website as well as websites of TTOs at the selected 163 U.S. research universities, the researcher populated email contact information of the selected 163 TT offices and 223 NAI fellows. The researcher distributed invitations to both target population sets through emails invitation containing a hyperlink, which connected the participants to Survey Monkey. Survey Monkey is a web-based survey engine to collect survey results. The email contained the purpose of the study and the instructions of how to participate in the survey. Each survey instrument started and ended with a thank you note. It informed the participants about approximate timeframe to complete the survey and asked the participants to answer each question and complete the survey. The email invitation also included a $10 gift card for participants who participated and completed the survey upon conclusion of each survey study.

The researcher deployed a similar process for the pilot study at CUNY. Invitations to both target population sets were distributed through emails invitation containing a hyperlink, which connected the participants to Survey Monkey. The email contained the purpose of the study and the instructions of how to participate in the survey. Each survey instrument started and ended with a thank you note. It informed the participants about approximate timeframe to complete the survey and asked the participants to answer each question and complete the survey. The email invitation also included a $10 gift card for participants who participated and completed the survey upon

conclusion of the pilot study. Further, the study informed the participants that the information they provided would be treated as confidential and by completing the survey, they were consenting to the survey (Creswell, 2015; Russ-Eft & Preskill, 2009). In addition, the researcher followed the Drexel IRB guideline regarding the informed consent requirement.

Data collection. The data collection of both TTO and innovator surveys were through Survey Monkey with an email invitation and follow-up emails to facilitate higher response rate. The study used Survey Monkey to collect results and provide simple statistic data in table and charts. Based on the experiences gained from conducting the pilot study, the researcher sent reminder emails weekly, which is different from the bi-weekly reminder emails as in the pilot study, upon the initial invitation emails to both TTO and innovator invitation lists to encourage the target populations to complete the surveys.

Data Analysis Procedures

The researcher reviewed and compared the latest AUTM 2015 annual survey report with the data collected to avoid sampling errors and ensure validity (Creswell, 2015). The study used IBM SPSS Statistics package to conduct data analyses. SPSS is a quantitative software product, which enabled the researcher to perform inferential statistics such as one-way and two-way ANOVA and bivariable regression analysis to test the hypnosis and explain the relationship between outreach programs, and innovation output variables (Ravid, 2015; Singh, 2007). Descriptive data collected from open-ended questionnaires provides opinions, attitude, and relationship. The researcher categorized and coded the collected data to develop patterns to test and confirm the hypotheses and

contribute to the multiple perspective model (Krathwohl & Smith, 2005). The researcher checked response rate and bias in responses in addition to simple descriptive analysis. In addition, the study reported aggregate responses to each item on the questionnaires as variances and standard deviation to recognize general patterns of responses and variations. The study researcher conducted statistical procedures and factor analysis as Creswell (2015) suggested, "As with all instruments, scores need to be reliable and valid, and statistical procedures such as internal consistency checks (e.g. the alpha reliability statistic) and validity (e. g. factor analysis), represent means for making these assessments" (p. 401).

The study used frequency and percent distribution for the analysis of survey data to outline the preference of the training programs and communication channels. Since the quantitative portion of the survey collects nominal and ordinal data mainly Likert scale, the study used frequency and bar charts to display the central tendency of the individual and overall outreach programs. Nominal and ordinal data were data not measured on an interval or ratio scale (Ravid, 2015). Further, the study assessed degree of dispersion by range. Combining the data collected by the survey and the 2015 AUTM annual report, the researcher used correlation methods such as Pearson's r to express the relationship. The overall outreach programs were assessed by a cross-case analysis (Russ-Eft & Preskill, 2009). Further, the quantitative data were coded and analyzed to determine any relationships among variables such as current TT outreach programs, their respective characteristics, preferred communication channels, number of reports of invention submitted, issued patents, funding, staff numbers, and perceived effectiveness of respective programs. Creswell (2015) suggested using "Descriptive statistics that

indicate general tendencies in the data (mean, mode, and median), the spread of scores (variance, standard deviation, and range), or a comparison of how one score relates to all others (z scores or percentile rank)" to express the findings (p. 180).

The researcher used variability to express the spread of the scores of various training programs and preferred communication channels in a distribution graph to indicate the types, effectiveness, and preference of each program perceived by the innovators and TT professionals. The researcher applied inferential statistics to draw conclusions about innovators' preferences and verify null hypotheses of any relationship between outreach programs and innovation output (Creswell, 2015). Specifically, one-way and two-way ANOVA (with associated F-ratio) were utilized to investigate association and test null hypotheses between TT outreach programs and IP inventory, license revenue, number of full time TT employees, and university research funding level. In addition, they were used to investigate association between innovators' participation in TT outreach programs and innovators' research funding level and innovation output.

The key independent variables included but were not limited to TT outreach training programs, communication channels, research funding, number of TT professionals and staff as well as university patent policy. The dependent variables were the number of reports of invention, issued patents, and license revenue (Ravid, 2015). The study carried out a one-way and two-way ANOVA through a two-step process: (1) to determine whether there were statistically significant differences between the means, and (2) if statistically significant differences existed, then post-hoc pairwise comparison was required to determine which means were different from each other. Finally, since

regression may be used to predict the values of outcome (e.g. innovation output) variable based on the values of the predictor (e.g. frequency of conducting outreach programs) variable, a bivariable regression analysis was conducted to explain and predict the relationship between outreach programs and innovation output (Ravid, 2015).

The qualitative data collected from the open-ended questions on the survey was categorized and coded to seek patterns or themes and to better understand the engagement phenomena from the innovators' perspectives. The study carefully documented decisions about category determination. In addition, the researcher paid attention to outliers in order to identify additional preferences for improving the existing programs or establishing future programs. Qualitative modes of data analysis provides ways of exploring patterns or themes depending on the research questions being addressed. This research study examined the relationship between TT outreach programs and innovation output at U.S. research universities. Major phases of data analysis included data reduction, data display, and conclusion drawing and verification with data reduction focused on innovator engagement to address the research questions (Berkowitz, 1997).

Stages of Data Collection

The research study included three stages of data collection: (1) pre-data collection preparation, (2) pilot study, and (3) study data collection. In the first pre-data collection preparation stage, the researcher developed survey instruments and incorporated feedback from advising professors in preparation for conducting a pilot study at CUNY to validate the survey instrument. In addition, the researcher populated the TT professional and innovator email invitation list with contact information.

Table 3
Research Questions Data Collection and Analysis

Design	Variables	Data Collection	Type of data	Data Analysis	Reporting Format
What is the relationship between TT outreach programs and innovation output at US research universities?					
Quantitative method	Innovator engagement	Survey with Closed and open ended questions	Quantitative rating and scaling data, descriptive text data	One-way and two-way ANOVA and bivariable regression analyses; text analysis and theme building	Figures and tables
Q1. Based on the perspective of a TT professional, what are the types and characteristics of a TT outreach operation at selected universities?					
Quantitative method	Seminars, face to face meeting, networking events	Survey with Closed and open ended questions	Quantitative rating and scaling data, descriptive text data	Descriptive and inferential statistics ; text analysis and theme building	Figures and tables
Q2. Based on the perspective of an innovator, what are the desired features of TT outreach programs at selected universities?					
Quantitative method	Seminars, face to face meeting, networking events	Survey with Closed and open ended questions	Quantitative rating and scaling data, descriptive text data	Descriptive and inferential statistics ; text analysis and theme building	Figures and tables
Q3. To what extent does the relationship between TT outreach programs and innovator engagement impacts innovation output?					
Quantitative method	Engagement phenomenon	Survey with Closed and open ended questions	Quantitative rating and scaling data, descriptive text data	Descriptive and inferential statistics ; text analysis and theme building	Figures and tables

The preparation of the pre-data collection stage was concluded by June 2017. The second data collection stage was a two-month pilot study that started in July 2017 at CUNY upon receiving IRB approval from Drexel University in early July 2017. The study collected data to validate the survey instruments by September 15, 2017. The third data collection stage was a four-month target population surveys and started in September

2017. Follow-up weekly-email reminders were sent from late September through mid-December. The data collection was concluded by the end of 2017. Table 3 provided a summary of research question and data collection and analysis.

In addition, Table 4 details study data collection time line. Appendix C lists study time line.

Table 4
Research Study Data Collection Timeline

Pre-data collection	Pilot study	Study survey
Prior to July 5th	July 7- September 30, 2017	October 17- November 30, 2017
Survey instruments and invitation preparations; IRB application	Conducted pilot survey with biweekly follow-up emails and collected data to validate the survey instruments	Conducted target population surveys with follow-up email reminders

Note. Drexel University approved study IRB on July 5th, 2017.

Ethical Considerations

The rights of the participants were protected according to federal, professional associations, and institutional ethical guidelines. The researcher disclosed to the participants the study purpose, procedures, risk, benefits, and the limits of confidentiality. The study used a web-based survey engine with no identifier to maintain confidentiality. Participants were ensured they were free to withdraw at any given time during the survey. Since the research involved human subject, IRB approval was required according to Drexel University human subject research policy. Institutional Review Boards (IRBs) have the responsibility of reviewing all research conducted in an institution receiving funds from the U.S. Department of Health, Education, and Welfare, whether any of the funds go to a specific study. The researcher had obtained the Collaborative Institutional

Training Initiative (CITI) certificate. The researcher, as a sub-investigator of the research study, consulted with the Drexel Human Research Protection Department to confirm whether an IRB review was required for both the pilot study and sample survey. The researcher worked with the IRB coordinator to complete the documents required by Drexel University and completed the electronic submission process to seek IRB approval. The study did not employ similar practice to seek IRB approval at CUNY since CUNY accepted Drexel IRB. The researcher conducted study according to the submitted protocol.

Complying with Drexel University human research policy, the researcher maintains the human research records, including executed consent documents for at least three years after completion of the research study. Identification of the survey participants were known only by the researcher and kept confidential. The researcher encrypted the study data which will be kept at a safe place for at least three years.

Summary

The research study was a quantitative method design, which included a pilot study and a study survey with two target populations at 163 U.S. research universities. A convenience sampling pilot study was conducted with 50 faculty innovators at CUNY to validate the survey instrument prior to using the instrument for the study surveys. The survey instruments for both target populations included open-ended and closed-ended style questionnaires. The researcher conducted both surveys by email invitation and collected data through Survey Monkey. For the TT target population sample set, the research study invited 163 U.S. research universities that participated in the AUTM 2015 survey. Two hundred and twenty-three NAI fellows were invited to participate in the

survey as the target innovator population sample set. The study coded and analyzed the quantitative data with one-way and two-way ANOVA and bivariable regression analyses to investigate the relationship among variables such as innovator preferred outreach programs, number of reports of invention, and funding. The researcher tested the hypotheses and addressed research questions utilizing inferential statistics as well as explored patterns to understand the engagement phenomena from the TTOs' and innovators' perspectives. Through the findings, the research established a framework of effective outreach programs preferred by innovators to inform and guide U.S. universities and promote innovation output.

In the following chapter, the researcher presented findings, results, and interpretation of the data collected from the quantitative study surveys targeting 163 U.S. research universities and the AUTM 2015 annual survey report.

Chapter 4: Finding, Results, and Interpretations

The purpose of this quantitative research study was to investigate the relationship between TT outreach programs and innovation output at U.S. research universities. In the study, the TT outreach programs covered both training seminars and communication channels between TT professionals and innovators, whereas reports of invention and license revenue represent innovation output. The research study used a quantitative approach with cross-sectional survey methods and utilized validated measurement instruments with semi-structured open-ended and closed-ended questionnaires. The measurement instruments were validated by conducting a pilot study through Survey Monkey at CUNY. Following the conclusion of the pilot study, a web-based survey was conducted through Survey Monkey across 163 U.S. research universities.

The methods of data collection included one pilot study, one innovator survey for innovators who had at least one issued U.S. patent and were accepted as NAI fellows in 2015 and 2016, and one technology transfer office survey for TTOs that had participated in the 2015 AUTM annual survey. The researcher completed these three sets of surveys over a course of approximately five months. The researcher sent out friendly weekly email reminders through Survey Monkey to encourage survey participation and increase response rate.

For the pilot study, the researcher sent the surveys to 50 faculty at CUNY and its TTO. Twelve CUNY faculty completed the survey with a response rate of 24% (12/50). CUNY TTO also completed the technology transfer office survey. All 12 CUNY faculty and its TTO were able to read, answer, and complete the measurement instruments with no additional feedback.

For the larger scale innovator survey, 223 NAI fellows were invited. Forty-four innovators completed the innovator survey, providing a 20% (44/223) response rate. The study also invited 163 TTOs at U.S. research universities that participated in the AUTM 2015 annual survey. Seventy-four TTOs completed the survey, which represented a 45% response rate (74/162). One request to be removed from the study was received, citing lack of time to participate in the survey.

As mentioned in Chapter 3, according to the Survey Monkey website (2014), online surveys where the researcher is not affiliated with the sites could gather at best a 30% response rate (Lindsey-Lipford, 2016). A literature search of the past six years of doctoral theses related to faculty at higher education and quantitative online survey research indicates a response rate in the range of 8.03% to 41.5%. The present study received a higher than expected response rate from lessons learned through conducting the pilot study at CUNY and aiming at the right time to initiate the large-scale surveys with weekly friendly reminders to encourage participation. A summary response rate is shown in Table 5.

Table 5
Survey Response Rate

Institutions	Participated*	Invited	Response Rate
City University of New York (CUNY)- TTO	1	1	100%
City University of New York (CUNY)- Innovators	12	50	24%
Targeted Technology Transfer Offices (TTOs)	74	163	45%
Targeted Innovators	44	223	20%

* *Note.* One TTO asked to be removed from the list and was not counted as participated

The researcher verified the collected quantitative data from the 74 responded TTOs regarding number of reports of invention, license revenue, and federal research funding with the AUTM 2015 annual survey. The collected data of the innovator survey and the technology transfer office survey are attached in Appendix C and Appendix D.

The quantitative and qualitative data were analyzed using IBM SPSS Statistics quantitative software package and qualitative cataloging and coding analysis techniques respectively. The study used correlation analyses and one-way and two-way analyses of variance (ANOVA) with subsequent post hoc tests to test the correlation among number of reports of invention (ROI), license revenue, frequency of conducting educational training programs, federal research funding, TT office size, preferred communication channels, and patent policy impact. In addition, the study used bivariable linear regression analysis to explain and predict the relationship between frequency of conducting outreach programs and innovation output variables.

Findings

Findings of the TTO Survey

Federal research expenditure. As shown in Figure 4, based on the TTO survey data reported by the 74 TTOs, 41% (30/74) of the TTOs have more than $200M in federal research expenditure, which indicated active research programs at these research universities as well as strong support for research activities and the potential to facilitate the generation of invention output. Approximately 46% of the TTOs have research expenditures ranging from $40M to $200M, and the remaining 13% of the TTOs have less than $40M.

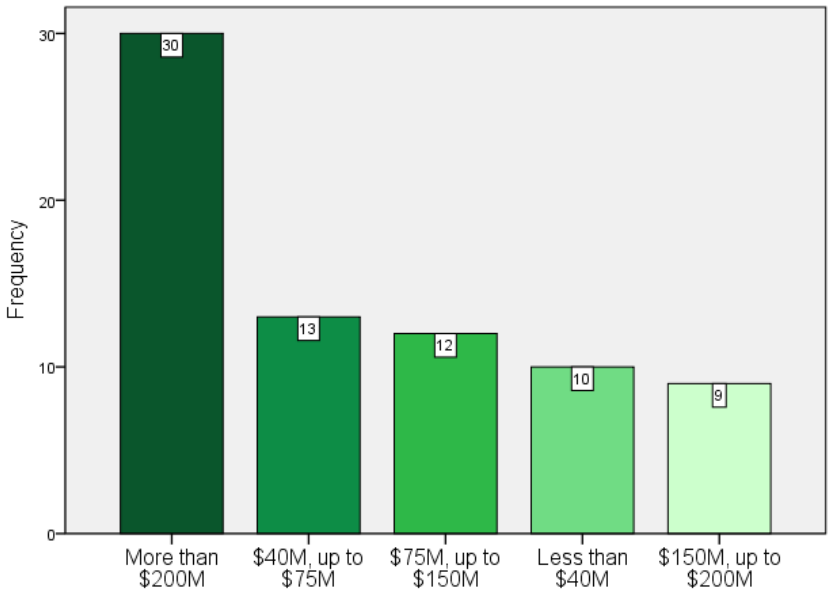

Figure 4. TTO Survey - University Federal research expenditure in FY 2015. Data source: TTO Survey, n=74. The findings are placed by the frequency of preference.

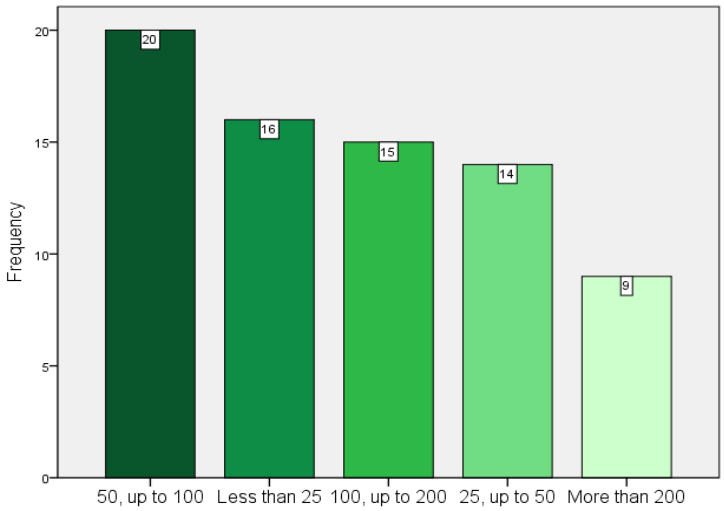

Figure 5. TTO Survey - University report of invention in FY 2015. Data source: TTO Survey, n=74. The findings are placed by the frequency of preference.

Reports of invention. Twenty-five to one hundred reports of invention were reported by approximately 46% (34/74) of the TTOs, while 22% (16/74) TTOs have less than 25 invention disclosures. As shown in Figure 5, 12% (9/74) reported more than 200 invention disclosures and 20% (15/74) reported 100-200 reports of invention. The findings indicated the surveyed TTOs received a wide number of reports of invention, ranging between 25-200.

License revenue. Thirty-one percent (23/74) of the TTOs reported receiving $1M-$3M in license revenue through technology commercialization, followed by $250k to $1M revenue reported by 23% (17/74) of the TTOs. Although 22% (16/74) of TTOs received less than $250K revenue, 14% (10/74) of TTOs reported more than $10M revenue. The findings as shown in Figure 6 indicated reports of invention have been commercialized and universities received financial compensation.

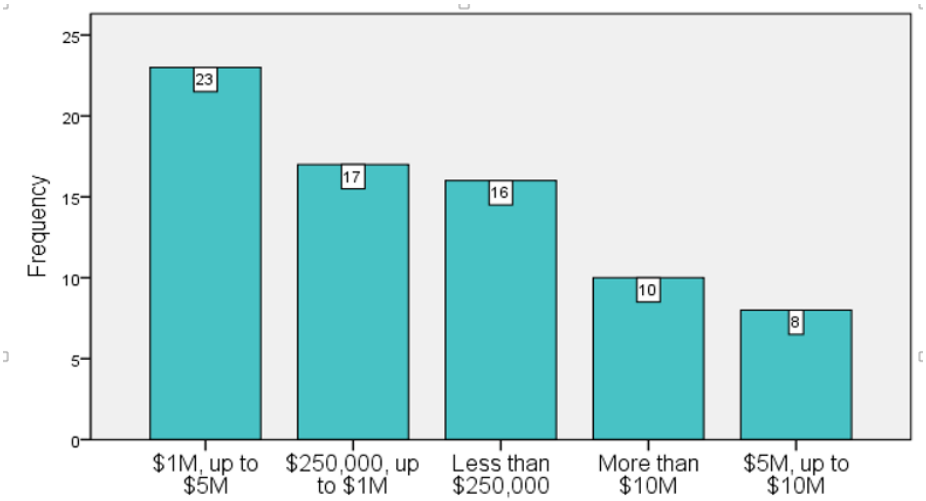

Figure 6. TTO Survey - University license revenue in FY 2015. Data source: TTO Survey, n=74. The findings are placed by the frequency of preference.

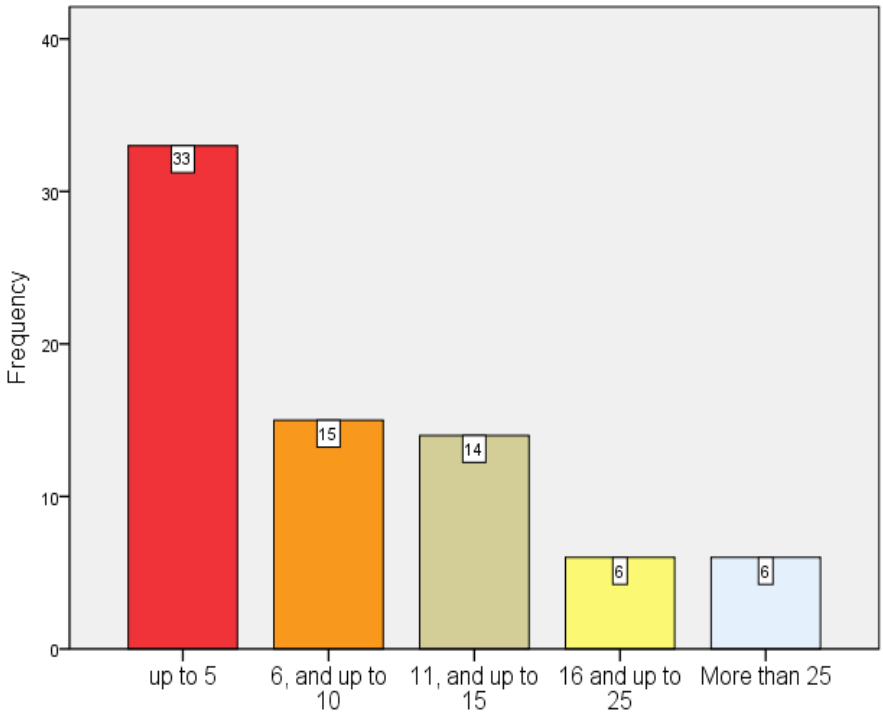

Figure 7. TTO Survey - University TTOs sizes include support staff in FY 2015. Data source: TTO Survey, n=74. The findings are placed by the frequency of preference.

TTO size. Forty-five percent (33/74) of the TTOs have a staff size of five or less and roughly 40% of the TTOs have a staff size between six and 15. The findings as shown in Figure 7 presented more than 80% of TTOs have staff size of 15 or less with limited large size TTOs. Table 6 provides a detailed summary of the responded 74 TTO survey participants.

Table 6
Detailed Summary Information of the 74 US Research Universities Participated in the Technology Transfer Office Survey

Federal Research Expenditure	< $40M	$40M, and < $75M	$75M, and < $150M	$150M, and < $200M	> $200M
# of Universities	10	13	12	9	30
Number of Report of Invention	< 25	25 - 50	51 - 100	101 - 200	> 200
# of Universities	16	14	20	15	9
License Revenue	< $250,000	$250,000, and < $1M	$1M, and < $5M	$5M, and < $10M	> $10M
# of Universities	16	17	23	8	10
Technology Transfer Staff	< = 5	6 - 10	11 - 15	16 - 25	> 25
# of Universities	33	15	14	6	6
Conduct Outreach Programs	Yes	No			
# of Universities	61	12			

Data source: AUTM 2015 survey report and the 2017 TTO Survey by the study

Frequency of conducting outreach programs. More than 80% of the 73 reported TTOs conducted outreach programs. Approximately 40% (30/72) of TTOs conducted outreach programs more than three times a year, and approximately 24% (17/72) and about 17% (12/72) conducted outreach every other month or monthly respectively as shown in Figure 8. The findings show outreach programs are a common activity and are part of the TTOs' operations.

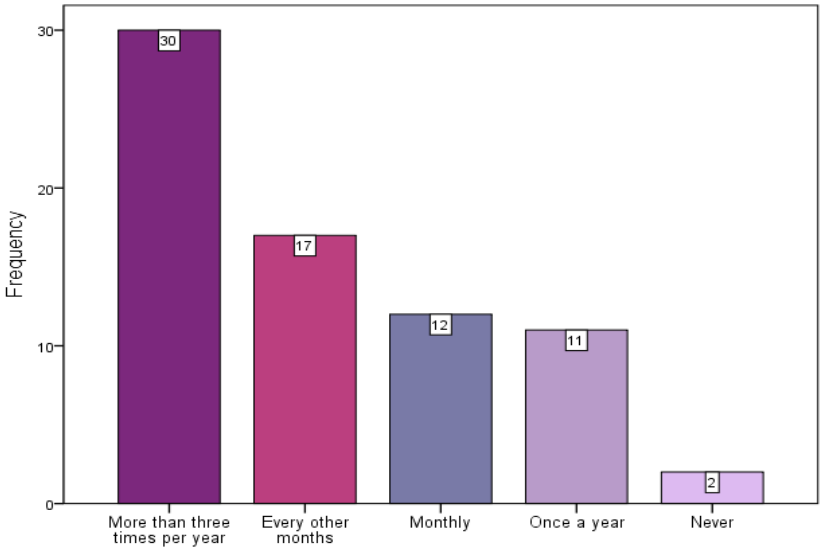

Figure 8. TTO Survey - Frequency of conducting outreach programs in FY 2015. Data source: TTO Survey, n=74. The findings are placed by the frequency of preference.

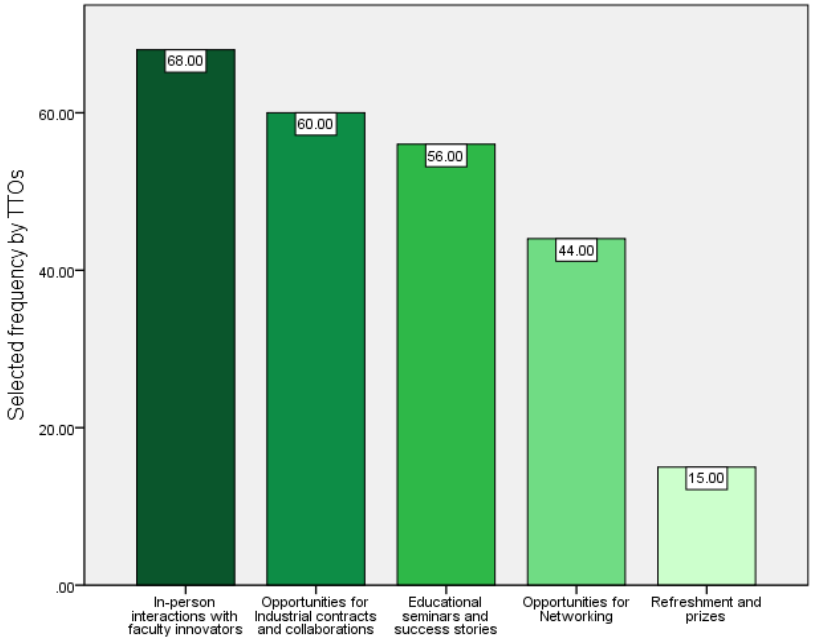

Figure 9. TTO Survey - Effective aspects of outreach programs in FY 2015. Data source: TTO Survey, n=74. The findings are placed by the frequency of preference.

Effective aspects of outreach programs. More than 96% (68/71) of the responding 71 TTOs (three skipped the question) considered "in-person interactions with faculty innovators" most effective followed by "opportunities for industrial contracts and collaborations" (84.5%; 60/71) and "educational seminars and success stories" (78.9%; 56/71). Approximately 20% (15/71) of the TTOs also included "refreshment and prizes" as an effective aspect. As shown in Figure 9, findings about "opportunities for industry contracts and collaborations" represent faculty desire for additional funding to conduct research and is a well-received outreach focus for TTOs' consideration. Two individual TTOs also suggested, "community business development' and "pitch competitions" as being effective strategies. In addition, one TTO elaborated, opportunities for funding [is the most effective technology transfer outreach], all of the above are marginal."

Impact of outreach programs to faculty. Approximately 60% (45/71) of the TTOs considered the TT training programs had a moderate impact on faculty innovators' desire to participate in TT, and about 20% (15/71) of TTOs considered such training programs influenced faculty largely. However, there are also roughly 15% (11/71) of the TTOs considered such training to have very little influence on faculty. Each institution's faculty composition may contribute to varying degrees of outreach outcome.

Effective communication channels. Seventy TTOs responded to multiple choices of effective communication channels to share information about TT with innovators. As shown in Figure 10, 70% of responding TTOs reported "through innovators' colleagues" and through "Departmental Chair, Dean, and Administrators" followed by about 60% reporting through "TT educational seminars" and "up-to-date website includes searchable database", and roughly 36% via "Campus-wide TT email

announcement." Four individual TTOs also suggested, "one-on-one targeted meetings [with innovators] are effective as suggested previously as one of the TTOs' preferred outreach program features. In addition, one TTO elaborated, "We hold a lunch once a year and invite all faculty to join us with a patent attorney sponsor at every table." Another TTO stated, "Up to date searchable website and campus-wide email communications would be great and effective tools; however, we do not have funds to upgrade our website and don't have support (approval) for sending out campus wide email messages." This response indicates TTOs' challenges and lack of resources to implement effective tools to reach faculty innovators.

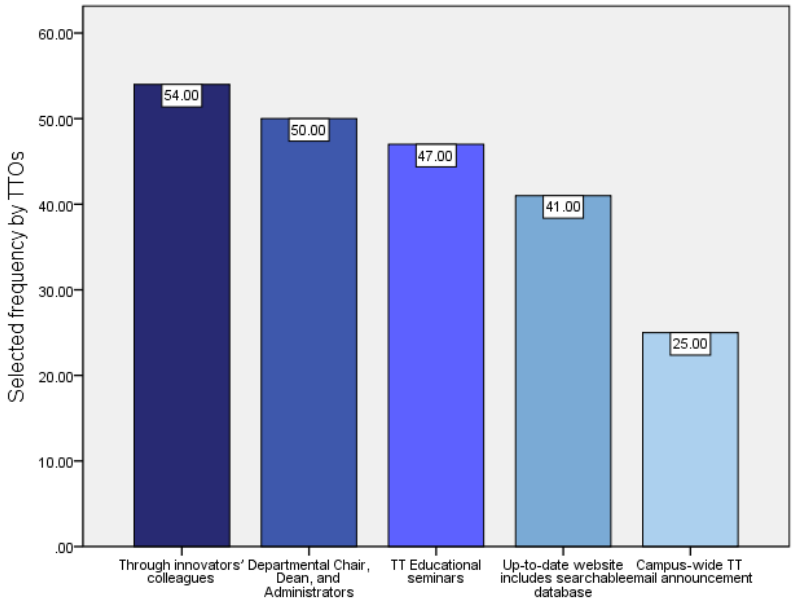

Figure 10. TTO Survey - Effective communication channels in FY 2015. Data source: TTO Survey, n=74. The findings are placed by the frequency of preference.

TTO performance measurement. Approximately 19% (13/70) of the TTOs strongly agreed effective implementation of outreach training programs should be included as TTOs' performance measurement and more than 60% (32/70) of responding TTOs agreed as indicated in Figure 11. Findings suggested that inclusion of implemented outreach programs in the TTOs' performance measurement might provide incentives for TTOs to enhance their performance.

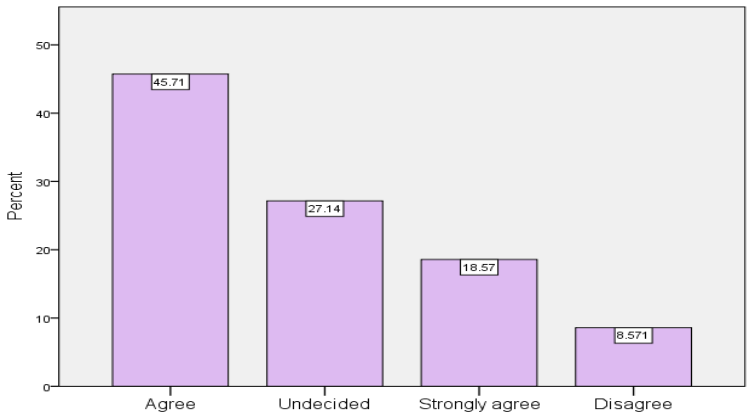

Figure 11. TTO Survey – Outreach programs should be included in TTO's performance measurement. Data source: TTO Survey, n=74, 4 TTOs skipped the questions. The findings are placed by the percent of preference.

Impacts of patent policy. More than 94% (66/70) of the responding TTOs considered their respective institution patent policy provided adequate incentive for faculty inventors in profit sharing. Moreover, more than 50% (34/68) of the TTOs (n=74, 6 skipped the question) considered their institution's recognition and reward system moderately impacted faculty innovators' decision to get involved in TT, and 13.2%

(9/68) of the TTOs indicated faculty are greatly influenced. However, more than one third of the TTOs indicated very little or no influence at all as shown in Figure 12.

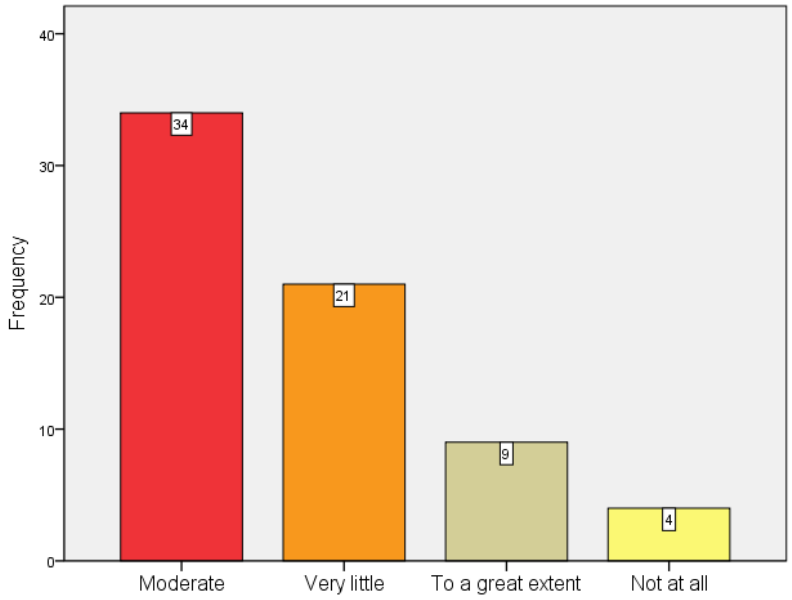

Figure 12. TTO Survey – Recognition and reward system impact innovators about technology transfer activities in FY 2015. Data source: TTO Survey, n=74. The findings are placed by the frequency of preference.

An institution's patent policy reflects its administration's supports and environment for cultivating creativity and innovation. The fact that more than 30 percent (21/68) of the TTOs indicated their institution's recognition and reward system provide very little influence in faculty participation of TT activities remains an area for university administration to examine their respective recognition and reward system for improvement.

The opposite opinions by the TTOs indicated there is no clear picture regarding the influence of patent policy on innovation outputs. However, one TTO elaborated:

> Policy rewards inventors with sharing of royalties [about]1/3 to inventors; 1/3 to College (resources support); 1/3 to TTO (sole source of TTO revenue). Patent applications and entrepreneurial actions are encouraged to be recognized (i.e. pat. publication scores points toward tenure), but not at all Colleges and Department's view patents as equal to a journal paper. Need for policy changes to encourage a culture of innovation and cutting edge scientific research.

Another TTO explained:

> We have some resources orchestrated at the University level, but departmental support is determined by the school and department. There is an effort to strengthen recognition of patent and invention disclosures as part of how a faculty member is evaluated for promotion and tenure.

A third TTO also offered:

> A word like "innovation" is a marketing term and doesn't mean anything specific. Faculty are "innovative" in conducting research and publishing academic papers. That has almost nothing to do with developing technology and getting it into products. The university system rewards good academic research, but not patentable inventions or technology licenses. So, faculty are not very motivated to assist tech transfer efforts.

Feedback about outreach programs. Upon qualitative cataloging and coding analysis of the TTO survey data related to well performed areas of respective outreach programs, the findings ranged from “overall is good” to “everything we have tried thus far has been very poorly attended.” Most TTOs stated their focus and achievements of faculty engagement was in areas such as new faculty, female faculty, and small groups of faculty at the departmental level, with approaches including face-to-face meetings at new faculty orientation, targeted woman innovator program, targeted one-on-one meeting, attending departmental meetings, and educational seminars and publication. The feedback included preferred programs offering opportunities for faculty with industry collaborations and contracts, networking opportunities, involvement in startup activities,

and grant funding for technology development. One TTO elaborated, “Our office has held individual consultations with more than 30 faculty members in the past 12 months.” A second TTO offered, “We have a targeted women innovator program, as well as targeted one-on-one outreach. We provide dashboards on activity to department chairs.” Further, a third one stated, “Attending department meetings is a particularly effective faculty education opportunity.” In addition, I-Corps program, which is one of the National Sciences Foundation programs to support technology commercialization, has been mentioned by a few TTOs as a major positive impact on getting more researchers engaged with startup companies.

Nine out of the 47 (%) TTO responders indicated communications with faculty about service programs offered and sharing past achievements is an area that can be improved upon. The findings indicated low attendance rate at trainings and seminars was a common concern and challenge. Similarly, concerns about funding for outreach and marketing as well as support from senior administration were also expressed. One TTO stated, “Need to find better ways to get adequate faculty attendance at educational events.” Similarly, another TTO reported, “we struggle to get inventors and potential inventors to attend training events.” One TTO offered:

> It is not a matter of improving outreach. It is a matter of having something to offer faculty that they care about. They don't care about licensing of their technologies. Reaching out to them with a message that is irrelevant to them is not useful.

Finally, one TTO elaborated:

> Executive level priority setting and systemic cultural change. Our most significant faculty is deans and chairs who equate technology transfer with patenting early stage discoveries rather than doing the follow-on work required for commercialization. Follow-on work often brings in sponsored research funding and supports researcher career development, but this is either not well

understood or some units don't consider commercialization-related funding (SBIR subcontracts for example) in promotion and tenure considerations.

The findings from the TTO survey point to the needs of senior management's acceptance and support to treat TT accomplishments and activities as equal to academic achievements. Further, the surveys suggested a need to establish an ecosystem to cultivate innovation.

Findings of the Innovator Survey

Research experiences and funding received. Based on the survey data reported by the 42 innovators, 95% (40/42) of these innovators have more than 20 years of academic research experiences, and their innovation outputs have been commercialized. Eighty-three percent (35/41) of the innovators have more than $5M in aggregated federal research funding in their careers and 9.8% (4/41) and 4.9% (2/41) have about $1M to $5M and roughly $250K-$1M research funding respectively in their careers. Findings confirmed that NAI fellow innovators who participated in the survey are well-funded, experienced, and successful researchers who have commercialized their innovations. Table 7 listed the summary information of the innovator participants.

Table 7
Detailed Summary Information of the 44 NAI Fellows who Participated and Reported in the Innovator Survey

Gender	Female	Male	Non-Binary		
# of inventors	12	30			
Years of Research Experiences	1 to 6	7 to 14	15 to 20	> 20	
# of inventors	0	0	2	40	
Federal Research Funding	$100,000, and < $250,000	$250,000, and < $1M	$1M, and < $5M	> $5M	
# of inventors	0	2	4	35	
Number of Report of Invention	< 10	10-30	31-50	51-100	>100

# of inventors	5	17	9	6	5
Technology Commercialization	Yes	No			
# of inventors	40	2			

Data source: Innovation Survey data collected in 2017

Report of invention. Leveraging the research funding, more than 60% (26/42) of the reported innovators have 10-50 reports of inventions, and roughly 12% each of the reporting innovators have less than 10 or more than 100 reports of invention.

Impact of outreach programs. Approximately 76% (42/44) of the innovators were aware of their respective university's outreach program. However, approximately 36% (15/42) reported such outreach programs did not influence their creativity and desire to invent and participate in TT. About 31% (13/42) reported they were moderately influenced. Interestingly, these findings contradicted the response from roughly 80% of the TTOs who considered training programs do influence faculty participation in TT activities. The discrepancy may be due to the difference in attitudes toward outreach by experienced faculty and novice faculty. In addition, 38% (16/42) of the responding innovators disclosed they never attend outreach programs and approximately 55% (23/42) reported "rarely" and "sometimes" attending the outreach program. Given the survey was aimed at the NAI researcher who were experienced innovators, the findings indicated that these experienced innovators were not interested in the outreach programs.

Effective aspects of outreach programs. Most of the responders selected opportunities for industrial contracts and collaborations (26/38, 68.4%) followed by in-person interactions with TT (23/38, 60.5%). Close to 50% of the 38 reported that innovators (six skipped the question) were interested in opportunities for networking, and

34.2% (13/38) stated interests in educational seminars and success stories as shown in Figure 13.

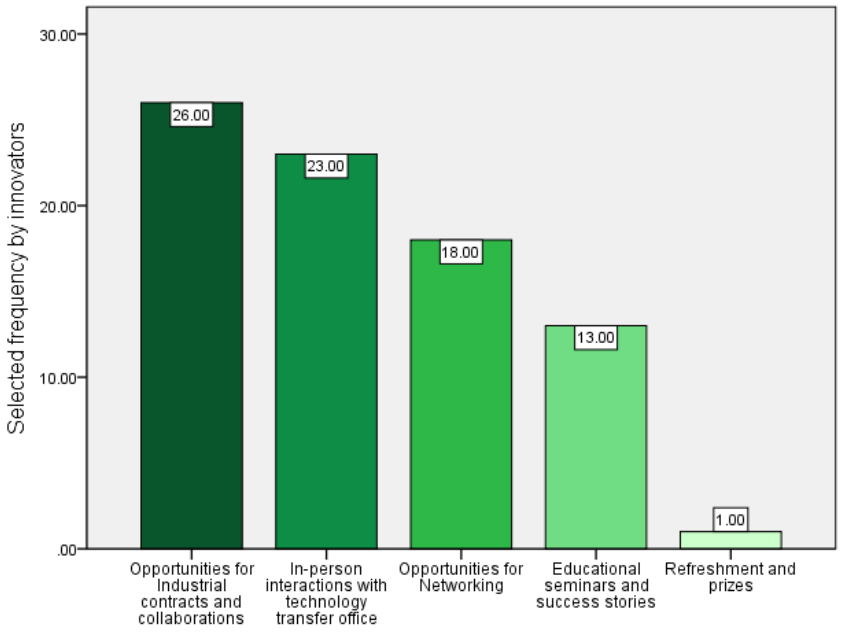

Figure 13. Innovator Survey – Desired aspects of outreach programs. Data source: Innovator Survey, n=44. The findings are placed by the frequency of preference.

In addition, one innovator elaborated, “Senior Management and Technology Transfer Offices need to be working it [to] create an ecosystem which fosters development as well as licensing and commercialization.” The finding suggested that facilitating technology development by TTOs be considered by university administration as part of TTOs’ functions and allocate resources for bridge funding in a technology development.

Effective communication channels. As shown in Figure 14, when offering multiple choices of effective communication channels to receive technology transfer related information, 59.5 % (22/37) selected “through up-to-date websites (including searchable database)" which provided the innovators convenience whenever they needed the information. This finding suggested TTOs might want to consider maintaining an up-to-date website with searchable database to share TT- related information with innovators. However, some TTOs indicated lack of resources to build websites despite the innovators’ preference. Colleagues were another preferred source for innovators to receive information, followed by campus-wide TT emails announcement. Interestingly, only 24.3% (9/37) selected TT educational seminars to receive information. Four innovators also indicated they often obtained information through one-on-one interactions with TTO personnel or patent lawyer. The findings also suggested experienced innovators required specific in-depth answers when they had question.

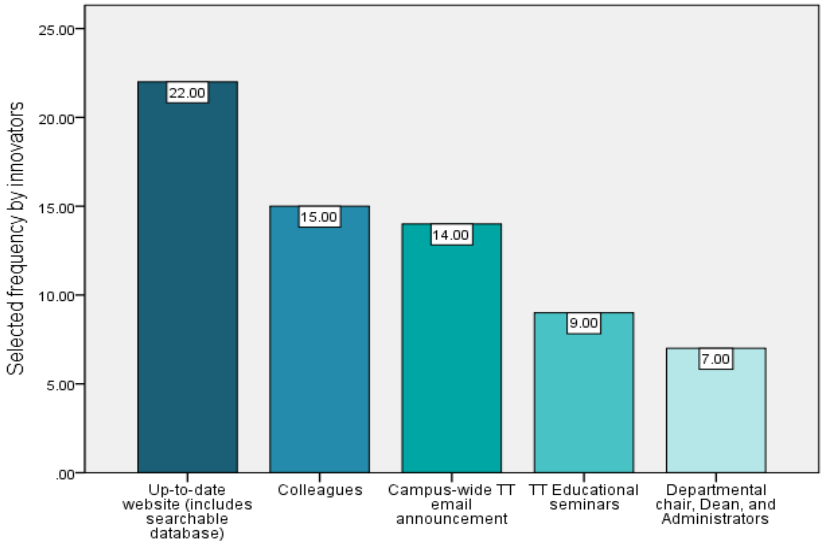

Figure 14. Innovator Survey – Desired communication channels with TTOs. Data source: Innovator Survey, n=44. The findings are splaced by the frequency of preference.

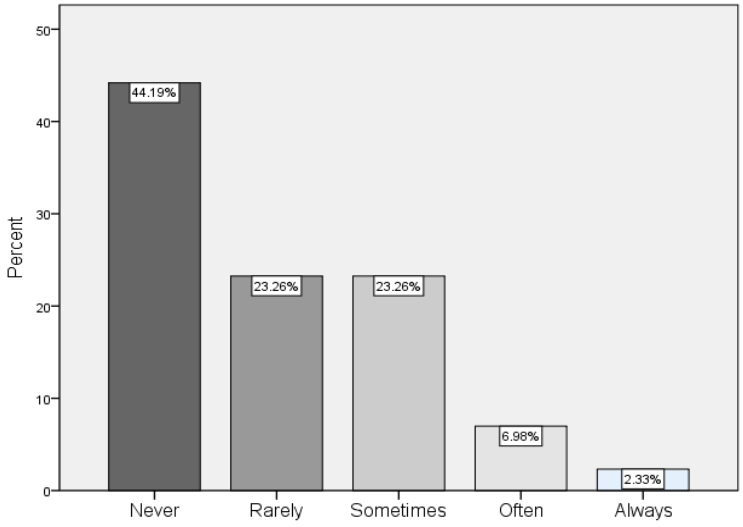

Figure 15. Innovator Survey – Frequency of using TTO website during the past six months. Data source: Innovator Survey, n=44. The findings are placed by the percent of preference.

Website usages. As shown in Figure 15, although more than 50% (22/37) of the innovators selected up-to-date website to obtain TT information, in fact only about 33% (14/43) of the innovators actually use the TTO's website as indicated by their responses: sometimes (23%), often (7%), and always (2.3%). Forty-four percent (19/43) reported they never used the website. The variance in responses may point to website information not being up-to-date or not easily searchable.

Preferred quality of TTO personnel. More than 90% of the responders (38/41) voiced TTO personnel's knowledge as being important. One innovator elaborated, "The most difficult is staff [in] these Offices who actually have experience in commercialization, most do not." In addition, accessibility, response time/follow up time, and one-on-one interactions were also valued by innovators as shown in Figure 16.

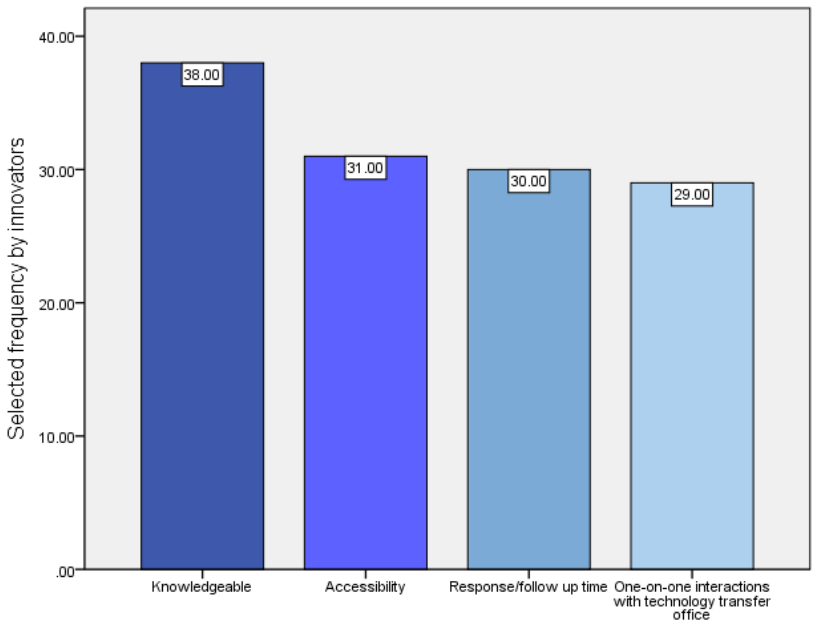

Figure 16. Innovator Survey – Innovators preferred TTO staff qualities. Data source: Innovator Survey, n=44. The findings are placed by the frequency of preference.

Patent policy. A university's patent policy provides guidelines about ownership of researchers' innovation output and a mechanism for profit sharing in the event such innovation outputs are commercialized. Most innovators reported they are familiar with their university's patent policy and approximately 61% (25/41) agreed such patent policies provide adequate profit-sharing mechanism to incentivize them. Although 34.2% (14/41) of the innovators reported moderate influence, 46.34% (19/41) and 17.07% (7/41) reported such reward systems and the recognition influenced them very little or not-at-all respectively to innovate. The findings discovered preferred forms of recognition and are listed in Figure 17.

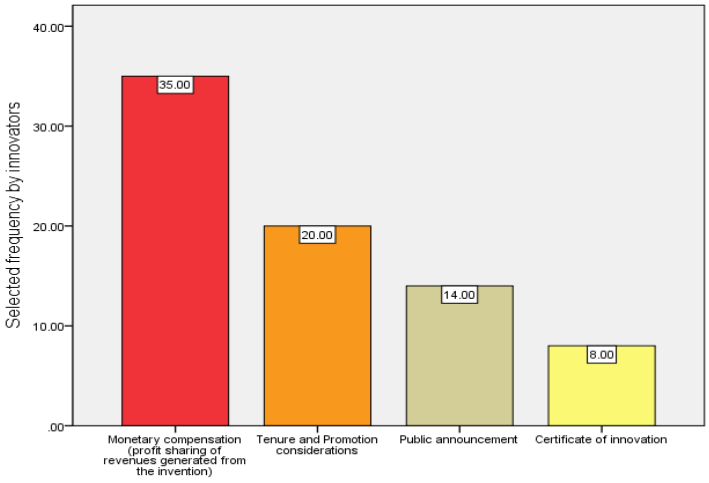

Figure 17. Innovator Survey – Innovators preferred forms of recognitions, n=44. The findings are placed by the frequency of preference.

While monetary compensation was indicated by more than 80% (35/40) of the innovators as a preferred form of recognition, 50% (20/40) also voiced their desires to

include TT-related activities as part of the promotion and tenure considerations. Similar findings were also identified from the TTOs' surveys and indicated the promotion and tenure consideration is important to incentivize the faculty to innovate. Such changes will require a culture change at the departmental level to build a supportive ecosystem to promote an innovative environment.

As one innovator elaborated:

> In my institution, at best a patent is considered comparable to a low-impact publication in academic advancement. Likewise, efforts in tech transfer have no weight whatsoever. It just goes to show what dolts my colleagues are. Plenty of people expect faculty to make innovations to spur economic development, they just don't want to give us credit for the time that takes. They may say we get rich off our inventions, but it is rarely the case, and often if we license our work rather than start a company, we don't make anything significant.

Another innovator stated, “The monetary reward incentives the report, not the conduct of the research or the discovery which is driven by more primary motivations, e.g., curiosity, academic ambition, etc.” Regarding patent policy, one innovator offered, “Good policy allows entrepreneurs to run with their ideas with the goal of technology development and when successful to appropriately allow the institution to share in the upside.”

Impediment to innovators’ creativity and innovation output. Upon qualitative cataloging and coding analysis of the innovators' survey data, the findings primarily voiced challenges that impeded innovators’ creativity and innovation output such as obtaining funding to support research activities, followed by departmental and institutional supports, time allowed for innovation, resources for patent filing, and bridge funding for technology development. One innovator stated, “Too much time is occupied to try to get funding, leaving very little time to do work.” Another innovator stated,

"Model for innovation and commercialization is unrealistic and wastes millions per school." Again, one other innovator offered:

> The challenge is not at the innovation stage. Bottleneck is at patent application stage where number of invention reports far exceeds budget of TT office and therefore it is a low yield and frustrating process unless a company already is interested and willing to support patent costs.

In addition, one innovator whom indicated interests in getting more involved in technology commercialization progress expressed, "[TTO] Failure to understand the role of the inventor in adding value to technology after patent is filed." TTOs may want to consider involving innovators more in the licensing and patent prosecution process as well as the decision-making strategy while balancing patent filing expense and budget and managing IP ownership issues. Finally, there was one positive report offered: "I am impressed by the support of creativity here [institution] and the opportunity to engage in "out-of-field" research and teaching activities." Some of the innovators suggested more staff and funding are needed for their respective TTOs.

Knowledgeable and aggressive staff with industry connections were also suggested for improvement of outreach programs. One innovator stated, "Hire qualified patent litigators! Improve face-to-face interactions with the innovators. Provide some flexibility for patent submissions from experienced innovators (i.e. submission of provisional patent disclosures by the innovator." As for the scope of the outreach program, one innovator offered, "Programs are often very broad in topic when more specific areas of education would be better." This finding is aligned with innovators' preference of one-on-one interactions with TTOs to seek in-depth answers/solutions to their questions. Similarly, another innovator elaborated:

> Need to use practical examples relevant to the particular audience - no good using an App or new drug if talking to a group of crop scientists, for example, who know about PVPs but not utility patents. I see a big problem at my institution on this topic - an untailored presentation just puts people off.

Finally, four innovators provided summary opinions of the TT activities at U.S. research universities. One stated:

> It seems that there are significant differences among universities and how effective their TT offices are. Also, some are considered by investors as easy to work with and others are considered not so easy to work with. I wonder how much this affects the probability of licensing technology.

This feedback is consistent with the one-on-one meeting and targeted consultation both TTO and innovators considered most effective to building relationships and enhancing communication. Another offered:

> Being in academia for over 40 years, it is clear to me that licensing activities by universities is hampered by the insistence of the institutes to retain ownership of the intellectual property. This has, in my experience, often prevented promising licensing opportunities with "Big Pharma" to break down. We need more open-mindedness and flexibility in negotiating with the pharmaceutical industry.

A third commented, “Your questions fail to consider inventors crossing work sectors (academia, company, government). Academia can benefit from stronger interactions at all stages of the process.” The finding indicated cross sectors external outreach is an area to be considered by TTOs. Finally, one innovator elaborated, “TT Offices are excellent at getting patents; however, they are unable to take patents to the next level of licensing.” This is consistent with responses of some innovators who feel TTOs need more staff who are aggressive in marketing effort.

Results and Interpretations

The results showed that based on the perspective of a TT professional, in-person interactions are considered the most effective outreach program followed by activities

that provide opportunities for industry contracts and collaborations to obtain research funding. With that said, managing such industry-academic relationships may be a challenge as one TTO explained, "Researcher engagement with industry problems - getting research faculty and staff to align their research plans with market needs has proven challenging." In addition, recruiting industry partners also presented as an issue for some TTOs as indicated in the findings. Although more than 70% of the responding 71 TTOs felt educational seminars and shared success stories were effective, some TTOs expressed their frustration of failing to have faculty attendances. More than 70% of the responded 70 TTOs reported that sharing TT-related information through innovator's colleagues and their department chairs, dean, and administrators are more effective followed by seminars, an up-to-date website, and searchable database. Both TTOs and innovators consider effective technology outreach programs to include one-on-one interactions and opportunities for industry contracts and collaborations.

Table 8
Preferred Technology Transfer Outreach Programs by Participated 74 TTOs and 44 Innovators

Central question - What is the relationship between TT outreach programs and innovation output at US research universities?

Research question 1. Based on the perspective of a TT professional, what are the types and characteristics of a TT outreach operation at selected universities?

Research question 2. Based on the perspective of an innovator, what are the desired features of TT outreach programs at selected universities?

Outreach Types	Responded TTOs	Frequency*	Responded Innovators	Frequency*
In-person interactions with faculty innovators	95.77%	68/71	60.53%	23/38
Opportunities for Industrial contracts and collaborations	84.51%	60/71	68.42%	26/38
Educational seminars and success stories	78.87%	56/71	34.21%	13/38

Opportunities for Networking	61.97%	44/71	47.37%	18/38
Refreshment and prizes	21.13%	15/71	2.63%	1/38
Communication Channels	Responded TTOs	Frequency*	Responded Innovators	Frequency*
Through innovators' colleagues	77.14%	54/70	40.54%	15/37
Departmental Chair, Dean, and Administrators	71.43%	50/70	18.92%	7/37
TT Educational seminars	67.14%	47/70	24.32%	9/37
Up-to-date website includes searchable database	58.57%	41/70	59.46%	22/37
Campus-wide TT email announcement	35.71%	25/70	37.84%	14/37

**Note.* Skipped responses have been removed from calculation of percent

However, there is a difference in preference regarding the effective communication channel in sharing the TT-related information by the TTOs and innovators' receiving such information. From the TTOs' point of view, through (a) the innovators' colleagues, (b) their department chair, dean, and administrators and (c) TT educational seminars are effective channels to distribute such information, while the innovators preferred an up-to-date website with searchable database, which can be used at their convenience, followed by receiving such information from their colleagues and campus-wide email announcements. A summary is listed in Table 8 to address the first two research questions.

Using Kahn's work on engagement theory (1990), the study used SPSS software and tested six null hypotheses proposed in Chapter 3 using findings from both the TTO survey and innovator survey to address the third research question of "To what extent does the relationship between TT outreach programs and innovator engagement impact innovation output?"

Hypothesis Testing

Null hypothesis 1. There is no association between TT outreach programs and IP inventory at U.S. research universities. IP inventory is presented by report of invention numbers. The researcher conducted an ANOVA test, and the analysis has revealed a statistically significant relationship between the reports of invention number and the frequency of conducting outreach program. The researcher has to reject null hypothesis 1 in that there is no association between TT outreach programs and IP inventory at U.S. research universities.

The mean report of invention numbers statistically differ by frequency of conducting outreach program. A follow-up post-hoc analysis was conducted to understand what groups have these differences. The results of a one-way ANOVA test indicated a statistically significant difference in ROI numbers based on the frequency of conducting outreach program $F(4,67) = 2.96$, $P < 0.05$. Post-Hoc Games-Howell tests indicated that TTOs who reported conducting outreach program once a year had significantly lower ROI numbers (M = 29) than TTOs that conducted outreach programs more than three times a year (M = 93) or monthly (M = 136). Therefore, the resulting conclusion is that the frequency of conducting outreach program did increase innovation output in the number of report of invention.

Null hypothesis 2. For null hypothesis 2 there is no association between TTOs' outreach programs and license revenue, as revealed by a one-way ANOVA analysis ($P > 0.05$). The results indicated there was no difference between the frequency of conducting outreach programs and license revenue received by the universities.

Null hypothesis 3. The researcher conducted a one-way ANOVA analysis to test null hypothesis 3 that there is no association between TT outreach programs and number

of full time TT employees, which includes support staff. The analysis revealed a statistically significant relationship between the number of full time TTO staff (FE), which include support staff, and the frequency of conducting outreach programs. A one-way ANOVA test indicated a statistically significant difference in TTOs' FE numbers based on the frequency of conducting outreach program $F(4,67) = 3.63$, $P < 0.05$. Post-Hoc Games-Howell test indicated TTOs who reported conducting outreach programs once a year had significantly lower FE number (M = 1.9) than TTOs that conducted outreach programs every other month (M = 7.4) and every month (M = 7.3). Post-Hoc Games-Howell tests further indicated TTOs who reported never conducting outreach program had significantly lower FE number (M = 1.1) than TTOs that conducted outreach programs every other month (M = 7.4) and every month (M = 7.3). University administrators' support and allocation of resources to engage sufficient full-time staff were reflected in the higher frequency of conducting outreach programs by TTOs. Thus, the researcher had to reject the null hypothesis that there is no association between TT outreach programs and the number of full time TT employees at U.S. research universities.

Null hypothesis 4. ANOVA analysis was conducted to test null hypothesis 4 that there is no association between university research funding level and TT outreach programs. A one-way ANOVA analysis result had a $P > 0.05$ and indicated the researcher failed to reject the null hypothesis in that the mean federal research-funding amount is the same for various frequencies of conducting outreach program. The researcher did not find evidence of an association between mean federal research funding amount and the frequency of conducting outreach program.

Null hypothesis 5. For this null hypothesis, there is no association between innovators' participation in TT outreach programs and innovators' research funding level. Results indicated a positive correlation with no statistical significant (Pearson's correlation coefficient = 0.22, $P > 0.05$). The researcher failed to reject the null hypothesis that there is no association between innovators' participation in TT outreach programs and innovators' research funding level. As listed in the findings, innovators spend much time seeking research funding and conducting research. There is a time constraint issue for innovators to attend outreach programs. Innovators preferred one-on-one interactions to seek answers on specific questions and participate in activities exploring opportunities for industry collaborations and contracts to secure funding.

Table 9
Summary of Null hypotheses Results

Null Hypotheses	ANOVA and Correlation Analysis Results*	Results
There is no association between TT outreach programs and intellectual property (IP) inventory at US research universities.	$F(4,67) = 2.96$, $P < 0.05$	The frequency of conducting outreach program did increase innovation output in the number of report of invention.
There is no association between TTOs' outreach programs and license revenue	One-way ANOVA analysis result has a $P > 0.05$	There was no difference between the frequency of conducting outreach programs and license revenue received by the universities.
There is no association between TT outreach programs and number of full time TT employees, which include support staff.	$F(4,67) = 3.63$, $P < 0.05$	University administrators' support and allocation of resources to engage sufficient full time staff were reflected in the higher frequency of conducting outreach programs by TTOs.
There is no association between frequency of conducting outreach programs and university Federal research funding amount.	One-way ANOVA analysis result has a $P > 0.05$	There was no difference of a university's Federal research funding amount and its frequency of conducting outreach programs.

There is no association between innovators' participation in TT outreach programs and innovators' research funding level.	Pearson's correlation coefficient = 0.22, *P*> 0.05	Innovators' participations in TT outreach programs had no correlation with his or her research funding levels.
There is no association between innovators' participation in TT outreach programs and report of invention.	Pearson's correlation coefficient = -0.238, *P*> 0.05	Innovators' participations in TT outreach programs had no correlation with total report of invention submitted by such innovators.

**Note.* Data source 2015 AUTM annual survey, 2017 Study TTO Survey, and 2017 Study Innovation Survey

Null hypothesis 6. Finally, using the IBM SPSS software correlation analysis program with the data from the innovator survey, for the null hypothesis 6, there is no association between innovators' participation in TT outreach programs and report of invention. Results indicated a negative low correlation with no statistical significant (Pearson's correlation coefficient= -0.24, $P > 0.05$). The researcher failed to reject the null hypothesis that there is no association between innovators' participation in TT outreach programs and report of invention. Innovators' participations in TT outreach programs have no correlation with total report of invention submitted by such innovators. This result confirmed the finding that experienced innovators who have commercialized innovation output preferred one-on-one interaction and obtain TT-related information from an up-to-date website and searchable database over attending outreach programs to seek information. Time constraints may be a factor that prevented innovators to attend the outreach programs. A summary of the ANOVA analyses results is listed in Table 9.

For the targeted innovators population who are experienced and seasoned researchers, there is no correlation between these innovators' report of inventions number and their federal research funding or their participation in outreach programs. However, using the IBM SPSS software correlation analysis based on the 2015 AUTM annual

report, report of inventions number is statistically significant correlated to federal R&D expenditures (very high strength), TTO size (very high strength) as well as the frequency of conducting outreach program (low strength). A summary is listed in Table 10.

Table 10
Association Between Report of Invention, Federal Research Expenditure, TTO Size, and Frequency of Conducting Outreach Programs

	Federal Research Expenditure	TTO size	Frequency of conducting outreach programs
Report of Inventions	Very high strength, Pearson Correlation coefficient = 0.975, *P* < 0.005	Very high strength, Pearson Correlation coefficient = 0.957, *P* < 0.005	Low strength, Pearson Correlation coefficient = 0.330, P < 0.005

*Data source: AUTM 2015 Annual Survey and TTO Survey

As indicated in Chapter 2, Xu, Parry, and Song (2011) examined the correlations between invention disclosures and the characteristics of TTO, federal funded R&D expenditures, TTO size and maturity, faculty size, faculty quality, and TTO independence funding. The authors found little research was conducted related to factors that effect invention disclosures. The authors argued larger TTOs have more knowledgeable TT agents who can build stronger faculty-TTO relationships and encourage more invention discourse submission with no mention about how to build such relationships. A quantitative method utilizing standard deviation and mean was used. Data were gathered from 123 TTOs' websites, the 2004 AUTM annual survey report, and the National Science Foundation (NSF). The finding was that federal R&D expenditures and TTO size positively correlated with the disclosure number.

The results of the present study based on AUTM 2015 annual survey and TTO is consistent with findings of Xu, Parry, and Song (2011) and adds to the knowledge that frequency of conducting outreach programs is positively correlated with report of invention numbers, despite the fact that results from the innovator surveys did not show such a correlation. This may be because the study target population encompassed experienced innovators with different preferences compared with the TTOs' outreach program participants. According to the feedback from the TTOs who participated in the study, TTOs were focusing on novice faculty, female faculty, and small groups at a departmental level covering general topics that may not be of interest to the experienced innovators. The difference may be due to the innovators' experiences, since experienced innovators indicated no interests in such activities. Experienced innovators preferred not to be bothered until they have specific questions and issues then they would prefer one-on-one in-depth consultation to resolve their questions.

Using the IBM SPSS software regression analysis, the result was shown in Figure 18 and an equation for the regression model for report of invention and frequency of conducting outreach programs can be expressed as:

Report of invention = 25.66 + 39.37 * Frequency of Conducting Outreach Program

Since the study data of the outreach frequency were collected with the range format (such as never, rarely, sometimes, often, and always), additional research is suggested to collect exact frequency number if further research interest is in using the frequency conducting outreach to predict or explain report of invention number.

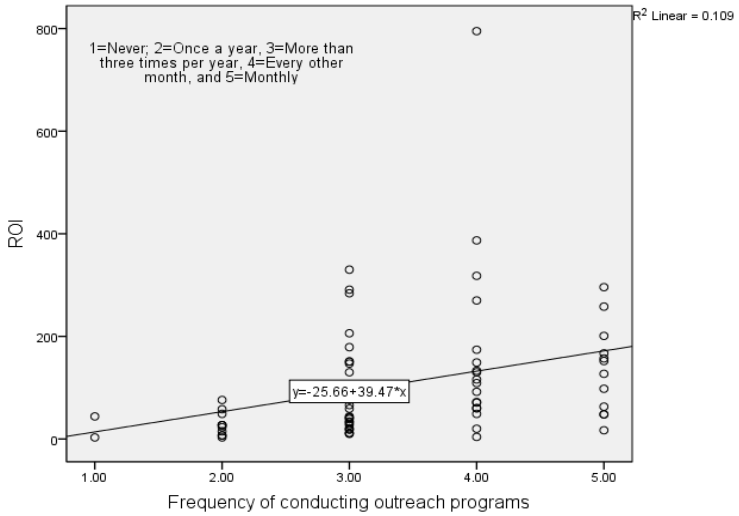

Figure 18. Regression graph - using frequency of conducting outreach programs to predict report of invention numbers. Data source: Innovator Survey, n=44.

TTO performance measurement. Amabile (2008) suggested the organizational work environment affects individual creativity. Management must take actions to foster innovation and resources allocated for innovation development and implementation (Amabile, 1988). Despite the potential for a positive impact of outreach programs on innovator engagement and innovation output, outreach is not included as one of the measures of effective implementation of TTO operations and function. The study results provided evidence that outreach should be considered by the university administration as one of the measures of effective implementation of TTO operations and function as agreed by the TTOs.

Patent policy. Synergistic extrinsic motivation related to university patent policy which recognizes and reward innovators' contribution to the innovation output had been examined (Amabile & Pratt, 2016). Most university patent policies included a faculty

reward system to recognize an innovator's contributions to the university and the research community. The study results, as indicated by both the TTOs and innovators, suggested considering faculty's technology commercialization accomplishments equal to academic achievements, and including such recognition in the patent policy for promotion and tenure considerations are important to a supportive working environment. Allocation of resources for TTOs for patent filing, operations, and marketing are essential as requested by both target populations. Finally, time allocated for innovation and support for seeking research funding are critical to establish an innovative culture.

Summary

As innovator engagement is essential for innovation output, building upon Kahn's (1990) engagement theory and Udwadia's (1990) multiple perspective model, the present study used a quantitative survey design that included two target populations: (a) TT professionals and (b) innovators at 163 U.S. research universities. Similarly, componential theory indicated a supportive work environment could systematically influence creativity (Amabile, 1988; Amabile & Mueller, 2008; Amabile & Pratt, 2016). The study results provide the knowledge that even with institutional level supports, the departmental supports are critical and required to establish a supportive work environment to secure innovation output.

The results indicated (a) the frequency of conducting outreach program did increase innovation output in the number of report of invention, (b) there was no association between mean license revenue amount and the frequency of conducting outreach program, (c) university administrators' support and allocation of resources to engage sufficient full time staff was reflected in the higher frequency of conducting

outreach programs by TTOs, (d) there was no association between mean federal research funding amount and the frequency of conducting outreach program, (e) there was no association between innovators' participation in TT outreach programs and innovators' research funding level, and (f) there was no association between innovators' participation in TT outreach programs and report of invention.

As listed in the findings, innovators spend a large proportion of their time seeking research funding and conducting research. There is a serious time constraint issue for the innovators to attend the outreach programs. Innovators preferred one-on-one interactions to seek answers for their specific questions and participate in activities that explore opportunities for industry collaborations and contracts to secure research funding. Experienced innovators who have commercialized innovation output preferred one-on-one interaction and obtain TT-related information from an up-to-date website and searchable database over attending outreach programs to seek information. Time constraints may be a factor that prevents experienced innovators from attending the outreach programs. Further, TTOs may want to consider involving innovators in the licensing and patent prosecution process as well as decision making strategy while balancing patent filing expense and budget and managing IP ownership issues. Thus, this research study addresses an important knowledge gap related to the effectiveness of TT outreach programs in supporting innovation engagement and encouraging innovation output.

Chapter 5: Conclusions and Recommendations

Introduction

Universities regard technology transfer as their "Third Mission," because they benefit from more than a billion dollars in annual revenue TT operations. TT is the process by which research intensive universities transfer scientific discoveries from an academic institution to companies and receive financial compensation. Although innovator engagement is a critical step towards encouraging innovation output, universities have not paid much attention to effectively implementing outreach programs to engage innovators. In addition, while a large body of literature has focused on downstream value-creation of technology commercialization, it has neglected to investigate the upstream innovation-creation process resulting in limited insights.

The purpose of this research study is to build upon Kahn's (1990) engagement theory and Udwadia's (1990) multiple perspective model to investigate the relationship between TT outreach programs and innovation output at U.S. research universities. The research design will include a quantitative internet survey method involving 163 U.S. research universities and 223 innovators. The researcher used inferential statistics and IBM SPSS quantitative software to analyze the survey findings and investigate the relationship and explore innovator engagement phenomenon focusing on the association between outreach programs and innovation output. By identifying preferred training programs and communication channels, impact of patent policy by both TTOs' and innovators' perspectives, this study aims to inform and guide university officials on effective outreach programs to increase innovation output.

Xu, Parry, and Song (2011) examined the correlations between invention disclosures and the characteristics of TTO, federal funded R&D expenditures, TTO size and maturity, faculty size, faculty quality, and TTO independence funding. However, the authors found little research was conducted related to factors that affect invention disclosures. The present study was aimed at narrowing this knowledge gap.

The TT outreach programs in the intended study covered both outreach training programs and communication channels between TT professionals and innovators. In addition, the study examined patent policy, which provides (a) profit sharing guidelines and (b) recognition and rewards system to incentivize innovators to participate in TT activities. Patent policy directly reflects supports at institutional level. The research study used a quantitative approach with cross-sectional survey methods and utilized validated measurement instruments with semi-structured open-ended and closed-ended questionnaires through web-based Survey Monkey across 163 U.S. research universities (Creswell, 2015; Russ-Eft & Preskill, 2009).

Quantitative and qualitative data were analyzed using IBM SPSS software package and qualitative cataloging and coding analysis techniques. The study used one-way and two-way analysis of variance (ANOVA) with subsequent Post hoc tests to test the correlation between communication channels, educational training programs, research funding, TT office size, and innovation output. In addition, the study used bivariable linear regression analysis to explain the relationship between outreach programs and innovation output variables (Creswell, 2015; Johnson & Christensen, 2014; Krathwohl & Smith, 2005; Ravid, 2015; Singh, 2007). The study categorized and coded the descriptive data from open-ended questions to develop themes. Overall, the results of

this study indicate a strong contribution to the engagement theory, multiple perspective model, and componential model of creativity and innovation in organizations.

The central question that guided the study was "What is the relationship between TT outreach programs and innovation output at U.S. research universities?" In this study, outreach programs included training seminars and communication channels. Innovation output included report of invention submitted by the innovators and the license revenue generated from commercialization of these report of inventions. In order to address this overarching question, the study collected data to provide the answers to the following questions:

- Based on the perspective of a TT professional, what are the types and characteristics of a TT outreach operation at selected universities?
- Based on the perspective of an innovator, what are the desired features of TT outreach programs at selected universities?
- To what extent does the relationship between TT outreach programs and innovator engagement impacts innovation output?

The research study used a quantitative survey method design, which included a convenience sampling pilot study at CUNY to validate the survey instruments and a random sampling study survey at 163 U.S. research universities. The study conducted surveys by email invitation and collected data through Survey Monkey. The study included two target populations: (a) the TT professionals and (b) the innovators at 163 U.S. research universities. It was necessary to avoid negative impacts to the relationship between innovators and their universities and yet accomplishing the data collection. The anonymous survey method with two targeted populations empowered innovators across

the 163 universities to answer the survey questions candidly which facilitates validity and avoids negative impact to innovators' working relationship with their respective universities. Such good working relationships are important to facilitate implementation of the effective outreach programs and ensuring innovative output (Hanson, Creswell, Plano Clark, Petska, & Creswell, 2005). In addition, the research study's open-ended and close-ended questionnaires provided flexibility for innovators and TTOs to elaborate their thoughts and suggestions (Singh, 2007).

The study analyzed the quantitative data with one-way and two-way ANOVA and bivariable regression analyses to investigate any relationship among variables such as outreach programs, number of reports of invention, funding, and innovator preferences. The researcher tested six hypotheses and addressed research questions utilizing inferential statistics. Additionally, the researcher coded and explored themes to understand the engagement phenomena from both perspectives.

The outcome of this research study provided important data related to the effectiveness of TT outreach programs in supporting innovation engagement and encouraging innovation output. Presently, there does not appear to be a formal guiding framework for TT offices to conduct effective outreach programs. Rather, most TT offices at U.S. research universities conduct ad hoc training programs that by themselves do not appear to be a definitive function of TT offices. Therefore, this study is important and timely as it addresses innovator engagement as a function of productive outreach programs.

Conclusions

The study concluded that TT outreach programs are positively associated with innovation output as in numbers of reports of invention, upon investigating the relationship between TT outreach programs and innovation output at U.S. research universities. "In-person interaction with faculty innovators", "Opportunities for industry contracts and collaborations", and "educational seminars and sharing of success stories" are all considered effective outreach from TTOs' perspective as concluded by the study results. In addition, for communication about TT, TTOs considered "through innovators' colleagues", "department chair, dean, and administrators", and "educational seminars" are effective followed by "up-to-date website and searchable database" and suggested, "targeted one-on-one interactions" as well.

The study concluded innovator-preferred aspects of the outreach are: (a) opportunities for industry contracts and collaborations, (b) in-person interactions with TTOs, and (c) opportunities for networking. Preferring the convenience to obtain information at their own timetable, the study concluded the desired communication channels for innovators are: (a) up-to-date website (with searchable database), (b) through colleagues, and (c) campus-wide email announcement. These channels accommodate experienced innovators' busy schedule and information can be reviewed when needed. In addition, experienced innovators seek to have one-one-one meetings with TTOs when they have specific questions rather than spending to attend training seminars. Further, various innovators also suggest TTOs support technology development and be involved with patent prosecution and technology commercialization process. The study also concluded resources were needed for technology development, marketing, startup activities, and outreach.

Table 11
Summary Perspectives Between Responding TTOs and Innovators

	TTO	Innovators	Aligned	Different
Outreach training programs-Types	"In-person interaction with faculty innovators", "Opportunities for industry contracts and collaborations", and "educational seminars and sharing of success stories"	(a) Opportunities for industry contracts and collaborations, (b) in-person interactions with TTOs, and (c) opportunities for networking.	X	X
Outreach training programs- Impact on participating in technology transfer activities	About 80% (60/71) considered moderate to great influences to faculty innovators	Roughly 62% considered not at all to very little and 38% agreed with moderate to a great extend		X
Communication	"Through innovators' colleagues", "Department chair, Dean, and administrators", and "educational seminars" are effective followed by "up-to-date website and searchable database" and suggested, "targeted one-on-one interactions".	(a) Up-to-date website (with searchable database), (b) through colleagues, and (c) campus-wide email announcement.	X	X
Patent policy impact - Creativity and involving in technology transfer	More than 63% indicated moderate to greatly influenced and more than one third indicated very little to no influence; and suggested including (a) tenue and promotion and (b) departmental support and recognition in patent policy	38% of the innovators considered outreach moderate to a great extend influenced their decision and about 62% considered outreach have no to very little influence.		X

More than one third of the TTOs indicated outreach has no influence to very little to inspire innovators' creativity and innovation. The study also concluded more than 63% of the TTOs indicated outreach moderate to greatly influenced faculty innovators' decisions in participating TT. However, only 38% of the innovators considered outreach moderate largely influenced their decision, and about 62% considered outreach to have no to very little influence. This discrepancy may be due to TTOs' outreach audiences including both experienced and not-so-experienced innovators and the study target

population is limited to experienced innovators. A summary of TTOs' and innovators' perspectives is listed in Table 11.

It is concluded that tenure and promotion was highly desired by both TTOs and innovators to be included in the patent policy. In addition, departmental supports to innovators and recognition of TT accomplishments to be equal as academic achievement are also critical to build an ecosystem to cultivate an innovation environment.

In addition, the study results concluded approximately 80% of the TTOs agreed that TTOs' outreach efforts should be included in the TTOs' performance measurement. Such consideration can be indications of the institution commitment in creating a supportive work environment for TTOs and hence provide incentives for TTOs to enhance their performance.

The study researcher concluded that the frequency of conducting outreach programs has a positive association with innovation output as in number of reports of invention and identified effective aspects outreach programs that were preferred by both TTO and innovators, thereby filling a knowledge gap in the current research landscape.

Recommendations

Recommendation 1

Given one third of the TTOs indicated their current institutions' recognition and reward system provided little influence in faculty participation of TT activities and supported by both TTOs' and innovators' suggestions, the researcher recommends universities consider assessing faculty's technology commercialization accomplishments and academic achievements equally. The researcher also recommends including such recognition of TT accomplishments in the patent policy for promotion and tenure

considerations. In addition, it is recommended that departmental resources and support be allocated to support innovators based on the interpretation about departmental support elaborated from various TTOs and innovators.

Recommendation 2

The study results suggested it is important to provide a supportive working environment. Allocation of resources for TTOs for patent filing, operations, and marketing are essential as requested by both TTOs and innovators. The researcher recommends universities allocate time for innovation and resources for seeking research funding to establish an innovative culture.

Recommendation 3

The results indicated innovators desire facilitating technology development by TTOs. Therefore, the researcher recommends universities consider including facilitating technology development and implementing outreach as part of TTOs functions, allocate resources to support the operation, and include such functions in TTO performance measurement.

Recommendation 4

Based on the results and interpretations, the researcher recommends that TTOs involve innovators more in licensing and patent prosecution process as well as decision making strategy while balancing patent filing expanse and budget.

Recommendation 5

Finally, the researcher highly recommends including undergraduate students, graduate students, post-doctoral students in outreach programs to cultivate an innovation

mindset in these up and coming future researchers to build an environment that supports creativity and innovation.

Further Research

There appeared to be a discrepancy between TTOs' and innovators' perspectives about how outreach programs influenced innovators' desire to participate in TT activities. According to the feedback from the TTOs participating in the study, for outreach programs TTOs were focusing on novice faculty, female faculty, and small group at departmental level covering general topics that are not of interest to the experienced innovators. Whereas, the survey mostly targeted experienced innovators who prefer to have specific questions and issues addressed in a one-on-one in-depth consultation. Further research is recommended to investigate the outreach preferences by novice innovators, junior faculty, post-doctoral fellows, and students.

Summary

The purpose of this quantitative research study was to investigate the relationship between TT outreach programs and innovation output at U.S. research universities. Thus, this research study filled an important knowledge gap related to the effectiveness of TT outreach programs in supporting innovation engagement and encouraging innovation output.

Based on the results and interpretations, the researcher recommends that TT accomplishments be considered as academic achievements and be included in the patent policy for tenure and promotion to provide incentives for innovators. In addition, allocation of resources for TTOs for patent filing, operations, and marketing are essential as well as allowing time for innovators to innovate and providing departmental level

support in addition to institutional support. Further, including effective outreach implementation and facilitating technology development as part of TTOs' performance measurement to encourage better performances. Finally, the researcher recommends including students in the outreach for an early start on developing innovation mindsets.

The frequency of conducting outreach programs has a positive association with innovation output as in number of report of invention. The study identified effective aspects outreach programs that are preferred by both TTO and innovators, thereby filling a knowledge gap in the current research landscape.

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Appendix A: Cover Letter Sample and Survey Instruments

Cover Letter to Innovators

Dear Dr. ABC:

My name is Katherine Chou. As part of my EdD research project at Drexel University, I am conducting a research survey. My goal is to investigate the relationship between technology transfer outreach programs and innovation output.

You have been selected to participate in this survey because you are a fellow of the National Academy of Inventors (NAI) and have substantially contributed to the innovation community. Your response to this survey can greatly enhance our understanding regarding desired technology transfer outreach programs that can potentially enhance your innovative endeavors.

It will take approximately 10-15 minutes to complete the survey. Please be assured that your participation in this research is voluntary and confidential. By clicking on the enclosed link, you consent to the survey and allow the study to compile your responses. Please understand that the use of the data will be limited to this research as authorized by Drexel University, although results may (hopefully) be represented in formats other than the dissertation, such as journal articles or conference presentations. You have the right to express concerns to me or to my advisor, Dr. Joy C Phillips.

Please complete the survey by September 30, 2017. Although you may receive follow-up emails with non-respondents, you will not be individually identified. Thank you for your time and participation in this study. I genuinely appreciate your perspective, as it will greatly assist me to establish a framework to inform and guide U.S. research universities regarding innovator engagement and innovation output.

Click the button below to start the survey. Please enjoy the five-dollar gift card upon completing the survey. Thank you for your participation!

Sincerely,

Katherine Chou
EdD Candidate
Drexel University
KC933@drexel.edu

Academic Advisor, Joy.Phillips@drexel.edu.

Innovator Survey Instrument

Thank you for participating in the survey. It will take approximately 10-15 minutes to complete the survey. Please answer each question completely and truthfully. The information you provide is confidential. Thank you for your help with the survey.

I. Demographics

1. What is your gender?
    a. Female
    b. Male

2. What is your number of years of academic research experience?
    a. 1 to 6 years
    b. 7 to 14 years
    c. 14 to 20 years
    d. More than 20 years

3. What is your total research funding in your career?
    a. $100,000 - $250,000
    b. $250,001 - $1,000,000
    c. $1,000,001 - $5,000,000
    d. Greater than $5,000,000

4. What is the total number of invention disclosures submitted by you? ____

5. Were your invention(s) licensed or commercialized?
    a. Yes
    b. No

II. Technology Transfer Outreach Programs

6. Does your technology transfer office conduct outreach programs?
    a. Yes
    b. No

7. To what extent do technology transfer training programs impact your creativity and your desire to invent and participate in technology transfer? (please circle one answer)

Not at all	Very little	Moderate	To a great extent

8. How often do you attend technology transfer training programs? (please circle one answer)

Never	Rarely	Sometimes	Often	Always

9. What are your desired aspects of technology transfer outreach programs? (Multiple choices)
    a. Educational seminars and success stories
    b. Opportunities for Industrial contracts and collaborations
    c. Opportunities for Networking
    d. In-person interactions with TT office
    e. Refreshment and prizes
    f. Others (please specify) _____

III. Communication Channels

10. What are your preferred channels of communication for information related to technology transfer? (Multiple choices)
    a. Up-to-date website (includes searchable database)
    b. TT Educational seminars
    c. Campus-wide TT email announcement
    d. Colleagues
    e. Departmental chair, Dean, and Administrators
    f. Other (please specify) _____

11. In the past 6 months, how often did you use the technology transfer office website to find information related to your ideas and technology commercialization? (Please circle one answer)

Never	Rarely	Sometimes	Often	Always

12. What aspects would you consider important about the technology transfer office/personnel? (Multiple choices)
    a. Accessibility
    b. Knowledgeable
    c. Response/follow up time
    d. One-on-one interactions with TT office
    e. Others (please specify) _____

IV. Recognition and reward from the innovator's perspective

13. Are you familiar with your Institution's patent policy?
    a. Yes
    b. No
14. To when extent do you agree that the current patent policy has an adequate profit-sharing mechanism that incentivizes you? (Please circle one answer)

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree

15. To what extent does the recognition and reward system impact your decision to innovate? (Please circle one answer)

Not at all	Very little	Moderate	To a great extent

16. Indicate the forms of recognition that you refer (Multiple choices)
    a. Monetary compensation (profit sharing of revenues generated from the invention)
    b. Public announcement
    c. Certificate of innovation
    d. Tenure and Promotion considerations

17. What are the challenges that impede your creativity and innovation output (e.g. resources, departmental support, policy and etc.)?_____
18. Please list any improvements for technology transfer outreach programs. _____.

End of the survey – Please proceed to print out the gift card
Thank you.

Please contact Katherine Chou at kc933@drexel.edu if you have any questions about this survey. Thank you.

Technology Transfer (TT) Survey Instrument

Thank you for participating in the survey. It will take approximately 10-15 minutes to complete the survey. Please answer each question completely and truthfully. The information you provide is confidential. Thank you for your help with the survey.

Please contact Katherine Chou at kc933@drexel.edu if you have any questions about this survey. Thank you.

I. Demographics

1. What is your gender?
   - **a.** Female
   - **b.** Male

2. What is the size of your technology transfer office (including supporting staff)?
   - a. up to 5
   - b. 6, and up to 10
   - c. 11, and up to 15
   - d. 16 and up to 25
   - e. More than 25

3. What is the total institutional federal research funding in FY 2015?
   - **a.** Less than $40M
   - b. $40M, up to $75M
   - c. $75M, up to $150M
   - d. $150M, up to $200M
   - e. More than $200M

4. Does your institution conduct technology transfer outreach program?
   - a. Yes
   - b. No

5. What is the total institution's number of report of invention in FY 2015?
   - **a.** Less than 25
   - b. 25, up to 50
   - c. 50, up to 100
   - d. 100, up to 200
   - e. More than 200

6. What is the total institution's license revenue in FY 2015?
   - **a.** Less than $250,000
   - b. $250,000, up to $1M
   - c. $1M, up to $5M
   - d. $5M, up to $10M
   - e. More than $10M

II. Technology Transfer Outreach Training Programs

7. What you consider as effective aspects of technology transfer outreach programs? (Multiple choices)
    a. Educational seminars and success stories
    b. Opportunities for Industrial contracts and collaborations
    c. Opportunities for Networking
    d. In-person interactions with faculty innovators
    e. Refreshment and prizes
    f. Others (please specify) _____

8. How often does your office conduct outreach training programs? (please circle one answer)

Never	Rarely Once a year	Sometimes More than three times per year	Often Every other months	Always Monthly

9. To what extent do you consider technology transfer training programs impact faculty innovator's desire to participant in technology transfer? (please circle one answer)

Not at all	Very little	Moderate	To a great extent

10. What are effective communication channels to share information about technology transfer with potential inventors? (multiple choices)
    a. Up-to-date website includes searchable database
    b. TT Educational seminars
    c. Campus-wide TT email announcement
    d. Through innovators' colleagues
    e. Departmental Chair, Dean, and Administrators
    f. Other (please specify in the space) _____

III. Recognition and reward

11. Do you consider TT performance measurement should include effective implementation of outreach training programs?

Strongly disagree	Disagree	Undecided	Agree	Strongly agree

12. Do you consider the current institution patent policy provide adequate profit-sharing that incentives faculty inventors?

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree

13. To what extent the institution's recognition and reward systems impact faculty innovators' decision in involving with technology transfer? (please circle one answer)

Not at all	Very little	Moderate	To a great extent

14. Does the institution paten policy facilitate faculty inventors' creativity and innovation output (e.g. resources, departmental support, policy etc.)?
    _____

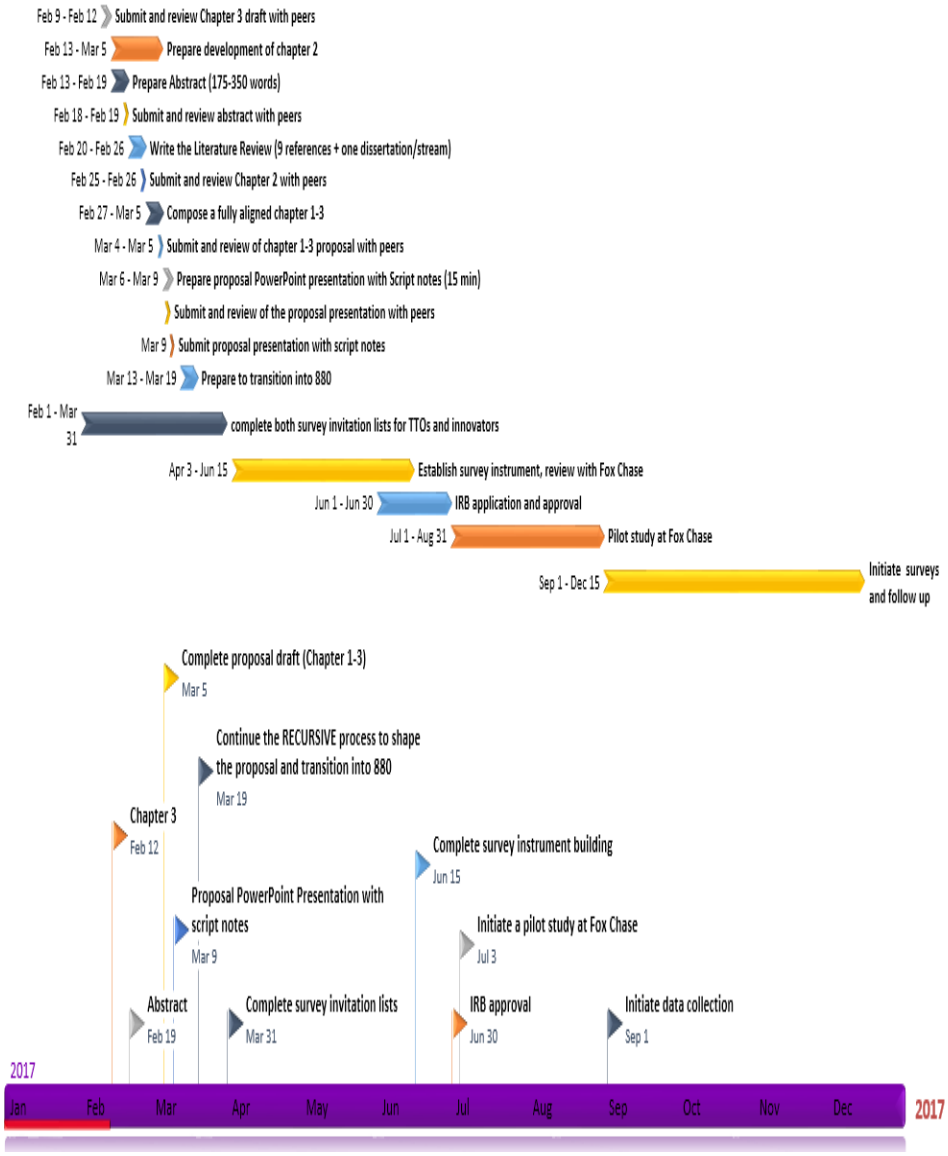
15. Please list an area where the technology transfer outreach programs is doing particularly well. _____

16. Please list an area where the technology transfer outreach program can be improved.

    _____

End of the survey
Thank you.

Appendix B: Timeline



Appendix C: Innovator Survey Data

1. **What is your gender?**

Answer Choices	Responses	
Female	28.57%	12
Male	71.43%	30
Non-binary/third gender	0.00%	0
	Answered	**42**
	Skipped	**2**

#2. What is your number of years of academic research experience?

Answer Choices	Responses	
1 to 6 years	0.00%	0
7 to 14 years	0.00%	0
15 to 20 years	4.76%	2
More than 20 years	95.24%	40
	Answered	**42**
	Skipped	**2**

#3. What is your total research funding in your career?

Answer Choices	Responses	
$100,000 - $250,000	0.00%	0
$250,001 - $1,000,000	4.88%	2
$1,000,001 - $5,000,000	9.76%	4
Greater than $5,000,000	85.37%	35
	Answered	**41**
	Skipped	**3**

#4. What is the total number of invention disclosures submitted by you?

Answered	**42**
Skipped	**2**

Respondents	Response Date	Responses
1	Nov 13 2017 12:24 PM	55
2	Oct 31 2017 11:46 AM	20-30

SPSS	1	<10	5
	2	10-30	17
	3	31-50	9

	Oct 31 2017		4		
3	11:39 AM	40+		51-100	6
	Oct 31 2017		5		
4	11:35 AM	25		>100	5
	Oct 31 2017				
5	11:34 AM	6			
	Oct 25 2017				
6	05:29 PM	30			
	Oct 24 2017				
7	04:57 PM	4			
	Oct 24 2017				
8	12:21 PM	22			
	Oct 24 2017				
9	12:16 PM	5			
	Oct 24 2017				
10	10:15 AM	50+			
	Oct 24 2017				
11	09:52 AM	30-40			
	Oct 17 2017				
12	04:09 PM	100			
	Oct 17 2017				
13	01:49 PM	5			
	Oct 17 2017				
14	11:57 AM	~10			
	Oct 17 2017				
15	10:59 AM	12			
	Oct 17 2017	~50 issued US			
16	10:05 AM	Patents			
	Oct 17 2017				
17	09:57 AM	more than 50			
	Oct 14 2017				
18	02:11 PM	150			
	Oct 12 2017				
19	01:02 AM	14			
	Oct 11 2017				
20	07:45 PM	1			
	Oct 11 2017				
21	04:39 PM	6			
	Oct 11 2017				
22	04:21 PM	15			
	Oct 11 2017				
23	01:31 PM	20			
	Oct 11 2017				
24	01:28 PM	30			
	Oct 11 2017				
25	12:23 PM	100			
	Oct 11 2017				
26	11:56 AM	~12			
	Oct 11 2017				
27	11:46 AM	297			
	Oct 11 2017				
28	11:45 AM	50			
	Oct 11 2017				
29	11:39 AM	30			
	Oct 10 2017				
30	08:48 AM	Three			

31	Oct 06 2017 01:43 PM	No idea, but I have 31 issued patents
32	Oct 05 2017 02:31 PM	6
33	Oct 05 2017 11:40 AM	Approximately 15
34	Oct 05 2017 11:11 AM	5
35	Oct 05 2017 09:45 AM	3
36	Oct 05 2017 08:50 AM	50
37	Oct 05 2017 08:30 AM	12
38	Oct 05 2017 07:44 AM	more than 30
39	Oct 05 2017 03:53 AM	~30
40	Oct 04 2017 11:10 PM	50
41	Oct 04 2017 11:05 PM	>10
42	Oct 04 2017 11:02 PM	25

#5. Were your invention(s) licensed or commercialized?

Answer Choices	Responses	
Yes	95.24%	40
No	4.76%	2
	Answered	**42**
	Skipped	**2**

#6. Does your technology transfer office conduct outreach programs?

Answer Choices	Responses	
Yes	76.19%	32
No	23.81%	10
	Answered	**42**
	Skipped	**2**

#7. To what extent do technology transfer training programs impact your creativity and your desire to invent and participate in technology transfer? (please circle one answer)

Answer Choices	Responses	
Not at all	35.71%	15
Very little	26.19%	11
Moderate	30.95%	13
To a great extent	7.14%	3

Answered	**42**
Skipped	**2**

#8. How often do you attend technology transfer training programs? (please circle one answer)

Answer Choices	Responses	
Never	38.10%	16
Rarely	35.71%	15
Sometimes	19.05%	8
Often	7.14%	3
Always	0.00%	0
	Answered	**42**
	Skipped	**2**

#9. What are your desired aspects of technology transfer outreach programs? (Multiple choices)

Answer Choices	Responses	
Educational seminars and success stories	34.21%	13
Opportunities for Industrial contracts and collaborations	68.42%	26
Opportunities for Networking	47.37%	18
In-person interactions with technology transfer office	60.53%	23
Refreshment and prizes	2.63%	1
Other (please specify)		1
	Answered	**38**
	Skipped	**6**

Respondents	Response Date	Other (please specify)
1	Oct 17 2017 10:07 AM	Senior Management and Technology Transfer Offices need to be working it create an ecosystem which fosters development as well as licensing and commercialization

#10. What are your preferred channels of communication for information related to technology transfer? (Multiple choices)

Answer Choices	Responses	
Up-to-date website (includes searchable database)	59.46%	22
TT Educational seminars	24.32%	9
Campus-wide TT email announcement	37.84%	14
Colleagues	40.54%	15
Departmental chair, Dean, and Administrators	18.92%	7
Other (please specify)		6
	Answered	**37**
	Skipped	**7**

Respondents	Response Date	Other (please specify)
1	Oct 17 2017 04:11 PM	I don't understand this question - it is ambiguous, so I don't think you really know what you are looking for. I already know most of the facts I need, if I need more info I get it from my licensing officer or other staff
2	Oct 17 2017 01:51 PM	Direct contact with office of technology transfer
3	Oct 17 2017 11:01 AM	direct one-on-one meetings with TT officials
4	Oct 11 2017 04:42 PM	Email, personal contact.
5	Oct 06 2017 01:46 PM	I get most information through personal interaction with lawyers.
6	Oct 04 2017 11:15 PM	Tech transfer officer

#11. In the past 6 months, how often did you use the technology transfer office website to find information related to your ideas and technology commercialization? (Please circle one answer)

Answer Choices	Responses	
Never	44.19%	19
Rarely	23.26%	10
Sometimes	23.26%	10
Often	6.98%	3
Always	2.33%	1
	Answered	**43**
	Skipped	**1**

#12. What aspects would you consider important about the technology transfer office/personnel? (Multiple choices)

Answer Choices	Responses	
Accessibility	75.61%	31
Knowledgeable	92.68%	38
Response/follow up time	73.17%	30
One-on-one interactions with technology transfer office	70.73%	29
Other (please specify)		3
	Answered	**41**
	Skipped	**3**

Respondents	Response Date	Other (please specify)
1	Oct 24 2017 09:54 AM	Experience
2	Oct 17 2017 10:09 AM	The most difficult is staff these Offices with folks who actually have experience in commercialization.. most do not
3	Oct 11 2017 04:42 PM	Legal and other expertise as to whether invention has legs

#13. Are you familiar with your Institution's patent policy?

Answer Choices	Responses	
Yes	97.62%	41
No	2.38%	1
	Answered	**42**
	Skipped	**2**

#14. To what extent do you agree that the current patent policy has an adequate profit-sharing mechanism that incentivizes you? (Please circle one answer)

Answer Choices	Responses	
Strongly Disagree	9.76%	4
Disagree	12.20%	5
Undecided	17.07%	7
Agree	36.59%	15
Strongly Agree	24.39%	10
	Answered	**41**
	Skipped	**3**

#15. To what extent does the recognition and reward system impact your decision to innovate? (Please circle one answer)

Answer Choices	Responses	
Not at all	17.07%	7
Very little	46.34%	19
Moderate	34.15%	14
To a great extent	2.44%	1
	Answered	**41**

Skipped	**3**

#16. Indicate the forms of recognition that you prefer (Multiple choices)

Answer Choices	Responses	
Monetary compensation (profit sharing of revenues generated from the invention)	87.50%	35
Public announcement	35.00%	14
Certificate of innovation	20.00%	8
Tenure and Promotion considerations	50.00%	20
Other (please specify)		5
	Answered	**40**
	Skipped	**4**

Respondents	Response Date	Other (please specify)
1	Oct 17 2017 04:16 PM	In my institution, at best a patent is considered comparable to a low-impact publication in academic advancement. Likewise, efforts in tech transfer have no weight whatsoever. It just goes to show what dolts my colleagues are. Plenty of people expect faculty to make innovations to spur economic development, they just don't want to give us credit for the time that takes. They may say we get rich off our inventions, but it is rarely the case, and often if we license our work rather than start a cmpany, we don't make anything significant.
2	Oct 17 2017 10:11 AM	Good policy allows entrepreneurs to run with their ideas.. with the goal of technology development and when successful to appropriately allow the institution to share in the upside
3	Oct 11 2017 01:32 PM	To change faculty culture, P&T must be supported in this reagrds.

4	Oct 06 2017 01:52 PM	My inventions are commercialized and provided to the users who need them.
5	Oct 04 2017 11:27 PM	The monetary reward incentives the report, not the conduct of the research or the discovery which is driven by more primary motivations, e.g., curiosity, academic ambition, etc

#17. What are the challenges that impede your creativity and innovation output (e.g. resources, departmental support, policy and etc.)?

Answered	**35**
Skipped	**9**

Respondents	Response Date	Responses
1	Oct 31 2017 11:52 AM	Resources, departmental, and institutional support
2	Oct 31 2017 11:39 AM	In general, the expense of filing patents creates a barrier, although I have generally been successful in crossing that barrier.
3	Oct 25 2017 05:31 PM	Time
4	Oct 24 2017 04:59 PM	None for me.
5	Oct 24 2017 12:26 PM	Lack of resources for pilot studies, bridging, or for the tech transfer office
6	Oct 24 2017 12:20 PM	The challenge is not at the innovation stage. Bottleneck is at patent application stage where number of invention reports far exceeds budget of TT office and therefore it is a low yield and frustrating process unless a company already is interested and willing to support patent costs.
7	Oct 24 2017 10:18 AM	very little impedance today, in the past it was conflict of interest rules
8	Oct 24 2017 09:55 AM	none any more - I am retired.
9	Oct 17 2017 04:16 PM	our tech transfer office has a totally lame mechanism to facilitate faculty startup companies. fortunately, my collaborator is in Michigan, which has a great ecosystem (seed funds, incubators) and we are starting our company there.
10	Oct 17 2017 01:53 PM	research funding
11	Oct 17 2017 12:02 PM	resources

12	Oct 17 2017 11:07 AM	research funding
13	Oct 17 2017 10:03 AM	POLICY
14	Oct 14 2017 02:18 PM	Model for innovation and commercialization is unrealistic and wastes millions per school.
15	Oct 12 2017 01:08 AM	lack of department support
16	Oct 11 2017 07:47 PM	work is hard and slow
17	Oct 11 2017 04:45 PM	Extramural grant funding. Intramural grant funding.
18	Oct 11 2017 01:35 PM	Need more aid in locating potential licensees.
19	Oct 11 2017 01:32 PM	Lack of Department and college support.
20	Oct 11 2017 12:26 PM	Venture funding difficult (as it should be).
21	Oct 11 2017 12:00 PM	Resources Institutional support Patent Office submission policies Involvement in licensing decisions
22	Oct 11 2017 11:58 AM	resources, contacts, and time
23	Oct 11 2017 11:52 AM	Lack of funding, resources and time.
24	Oct 11 2017 11:50 AM	Too much time is occupied to try to get funding, leaving very little time to do work.
25	Oct 10 2017 08:55 AM	Having been a faculty member at USF for 54 years, I am impressed by the support of creativity here and the opportunity to engage in "out-of-field" research and teaching activities.
26	Oct 06 2017 01:52 PM	Resources available to file patents. Expertise for market evaluation and technology transition planning.
27	Oct 05 2017 02:38 PM	Lack of recognition of the importance technology. Lack of start-up funds to get new ideas launched. Lack of access to industry partners due to lack of institutional outreach
28	Oct 05 2017 11:50 AM	None at this time.

29	Oct 05 2017 11:49 AM	Time constraints due to institutional and departmental duties; antiquated institutional policies that impede commercial involvement.
30	Oct 05 2017 08:53 AM	stupid rules and stupid administrators
31	Oct 05 2017 08:32 AM	lack of funding, lukewarm departmental support
32	Oct 05 2017 07:48 AM	financial support
33	Oct 04 2017 11:27 PM	Resources And now time as I am chair of my department
34	Oct 04 2017 11:11 PM	Tech transfer office reluctance to license technology back to inventor. Failure to understand of role of inventor in adding value to technology after patent is filed.
35	Oct 04 2017 11:04 PM	Limited resource in the Office of Tech Transfer.

#18. Please list any improvements for technology transfer outreach programs.

Answered	**25**
Skipped	**19**

Respondents	Response Date	Responses
1	Oct 31 2017 11:52 AM	Need more aggressive technology transfer personnel
2	Oct 31 2017 11:39 AM	Greater funding would be helpful.
3	Oct 25 2017 05:31 PM	More personnel are needed.
4	Oct 24 2017 04:59 PM	More ability to drive patents forward by the University.
5	Oct 24 2017 12:26 PM	Programs are often very broad in topic when more specific areas of education would be better
6	Oct 24 2017 10:18 AM	Some more focus on experienced inventors as opposed to students or first time inventors
7	Oct 17 2017 04:16 PM	look at groups like Spartan Innovations at MSU - we are working with them and I would hold them up as a model
8	Oct 17 2017 11:07 AM	TT officials should be more aggressive in discussing their services face-to-face with small groups of faculty.

9	Oct 17 2017 10:03 AM	Schools are not up to the task. Mostly luck makes most programs profitable. The answer here is complex but one o have found a solution to but my School does not buy into
10	Oct 14 2017 02:18 PM	They should know about technologies developed in different departments and invite industry representatives to conferences/seminars to give them information about various technologies.
11	Oct 12 2017 01:08 AM	Enhanced legal / patent / market expertise on site.
12	Oct 11 2017 04:45 PM	Our TT works fairly well.
13	Oct 11 2017 01:35 PM	Regular one-one meeting with the inventors to see what they want.
14	Oct 11 2017 01:32 PM	Hire qualified patent litigators! Improve face-to-face interactions with the innovators Provide some flexibility for patent submissions from experienced innovators (i.e. submission of provisional patent disclosures by the innovator)
15	Oct 11 2017 12:00 PM	Need to use practical examples relevant to the particular audience - no good using an App or new drug if talking to a group of crop scientists, for example, who know about PVPs but not utility patents. I see a big problem at my institution oon this topic - an untailored presentation just puts people off.
16	Oct 11 2017 11:52 AM	Make administrators understand the value of tech transfer.
17	Oct 11 2017 11:50 AM	USF is uniquely supportive.
18	Oct 10 2017 08:55 AM	Close the gender gap in inventorship.
19	Oct 06 2017 01:52 PM	Requires proactive participation by TT office personnel. Lack of sufficient personnel to handle outreach, need more full time personnel who have worked with industry
20	Oct 05 2017 02:38 PM	Better marketing to faculty
21	Oct 05 2017 11:50 AM	The answer to this question is entirely dependent upon institutional policies. The tech transfer outreach programs and university policies are out of step at my institution.
22	Oct 05 2017 11:49 AM	get out of the way
23	Oct 05 2017 08:53 AM	better outreach

24	Oct 05 2017 07:48 AM	Consideration of patents for promotion/tenure
25	Oct 04 2017 11:11 PM	???

#19. Any Additional comments and feedback?

Answered **11**

Skipped **33**

Respondents	Response Date	Responses
1	Oct 31 2017 11:39 AM	Technology transfer is too often considered to be exclusively a money-making activity by universities. But, I think it should rather be viewed as part of the mission to publish work and make it available. Without patenting, companies are often not willing to take up technologies as they fear that others will undermine their investments.
2	Oct 17 2017 11:07 AM	It seems that there are significant differences among universities and how effective their TT offices are. Also, some are considered by investors as easy to work with and others are considered not so easy to work with. I wonder how much this affects the probability of licensing technology.
3	Oct 12 2017 01:08 AM	no.
4	Oct 11 2017 04:45 PM	no
5	Oct 11 2017 01:35 PM	Need aid in locating possible industrial partners while the technology is being developed.
6	Oct 11 2017 12:00 PM	Being in academia for over 40 years, it is clear to me that licensing activities by Universities is hampered by the insistence of the Institutes to retain ownership of the intellectual property. This has, in my experience, often prevented promising licensing opportunities with "Big Pharma" to break down. We need more open-mindedness and flexibility in negotiating with the pharmaceutical industry.
7	Oct 11 2017 11:50 AM	no
8	Oct 10 2017 08:55 AM	Dr. Paul Sanberg is a USF Treasure
9	Oct 06 2017 01:52 PM	Your questions fail to consider inventors crossing work sectors (academia, company, government). Academia can benefit from stronger interactions at alll stages of the process.
10	Oct 05 2017 02:38 PM	TT Offices are excellent at getting patents, however they are unable to take patents to the next level of licensing.

11	Oct 05 2017 08:53 AM	nothing

Appendix D: Technology Transfer Office Survey Data

#1 What is your gender?

Answer Choices	Responses	
Female	32.43%	24
Male	66.22%	49
Non-binary/third gender	1.35%	1
	Answered	**74**
	Skipped	**0**

#2 What is the size of your technology transfer office (including supporting staff)?

Answer Choices	Responses	
up to 5	44.59%	33
6, and up to 10	20.27%	15
11, and up to 15	18.92%	14
16 and up to 25	8.11%	6
More than 25	8.11%	6
	Answered	**74**
	Skipped	**0**

#3 What is the total institutional federal research funding in FY 2015?

Answer Choices	Responses	
Less than $40M	13.51%	10
$40M, up to $75M	17.57%	13
$75M, up to $150M	16.22%	12
$150M, up to $200M	12.16%	9
More than $200M	40.54%	30
	Answered	**74**
	Skipped	**0**

#4 Does your institution conduct technology transfer outreach program?

Answer Choices	Responses	
Yes	83.56%	61
No	16.44%	12
	Answered	**73**
	Skipped	**1**

#5 What is the total institution's number of report of invention in FY 2015?

Answer Choices	Responses	
Less than 25	21.62%	16
25, up to 50	18.92%	14
50, up to 100	27.03%	20
100, up to 200	20.27%	15
More than 200	12.16%	9
	Answered	**74**
	Skipped	**0**

#6 What is the total institution's license revenue in FY 2015?

Answer Choices	Responses	
Less than $250,000	21.62%	16
$250,000, up to $1M	22.97%	17
$1M, up to $5M	31.08%	23
$5M, up to $10M	10.81%	8
More than $10M	13.51%	10
	Answered	**74**
	Skipped	**0**

#7 What you consider as effective aspects of technology transfer outreach programs? (Multiple choices)

Answer Choices	Responses	
Educational seminars and success stories	78.87%	56
Opportunities for Industrial contracts and collaborations	84.51%	60
Opportunities for Networking	61.97%	44
In-person interactions with faculty innovators	95.77%	68
Refreshment and prizes	21.13%	15
Other (please specify)		4
	Answered	**71**
	Skipped	**3**

Respondents	Response Date	Other (please specify)
1	Nov 07 2017 12:27 PM	community business development
2	Oct 24 2017 10:01 AM	Pitch competitions
3	Oct 10 2017 01:25 PM	All of these are important. Technology outreach has to be prepared to do all of these.

4	Oct 10 2017 11:03 AM	Opportunities for funding, all of the above are marginal

#8 How often does your office conduct outreach training programs? (please circle one answer)

Answer Choices	Responses	
Never	2.78%	2
Rarely, Once a year	15.28%	11
Sometimes, More than three times per year	41.67%	30
Often, Every other months	23.61%	17
Always, Monthly	16.67%	12
	Answered	**72**
	Skipped	**2**

#9 To what extent do you consider technology transfer training programs impact faculty innovator's desire to participant in technology transfer? (please circle one answer)

Answer Choices	Responses	
Not at all	0.00%	0
Very little	15.49%	11
Moderate	63.38%	45
To a great extent	21.13%	15
	Answered	**71**
	Skipped	**3**

#10 What are effective communication channels to share information about technology transfer with potential inventors? (multiple choices)

Answer Choices	Responses	
Up-to-date website includes searchable database	58.57%	41
TT Educational seminars	67.14%	47
Campus-wide TT email announcement	35.71%	25
Through innovators' colleagues	77.14%	54
Departmental Chair, Dean, and Administrators	71.43%	50
Other (please specify)		6
	Answered	**70**
	Skipped	**4**

Respondents	Response Date	Other (please specify)
1	Oct 24 2017 11:06 AM	We find that reaching out to the faculty members directly is usually the most effective.
2	Oct 17 2017 12:36 PM	We hold a lunch once a year and invite all faculty to join us with a patent attorney sponsor at every table
3	Oct 17 2017 11:15 AM	one-on-one targeted meetings

4	Oct 17 2017 10:11 AM	Up to Date searchable website and campus-wide email communications would be great and effective tools; however, we do not have funds to upgrade our website and don't have support (approval) for sending out campus wide email messages.
5	Oct 10 2017 03:33 PM	One on one conversations
6	Oct 10 2017 12:17 PM	one on one interaction with inventors

#11 Do you consider TT performance measurement should include effective implementation of outreach training programs?

Answer Choices	Responses	
Strongly disagree	0.00%	0
Disagree	8.57%	6
Undecided	27.14%	19
Agree	45.71%	32
Strongly agree	18.57%	13
	Answered	**70**
	Skipped	**4**

#12 Do you consider the current institution patent policy provide adequate profit-sharing that incentives faculty inventors?

Answer Choices	Responses	
Strongly Disagree	0.00%	0
Disagree	1.43%	1
Undecided	4.29%	3
Agree	52.86%	37
Strongly Agree	41.43%	29
	Answered	**70**
	Skipped	**4**

#13 To what extent the institution's recognition and reword systems impact faculty innovators' decision in involving with technology transfer? (please circle one answer)

Answer Choices	Responses	
Not at all	5.88%	4
Very little	30.88%	21
Moderate	50.00%	34
To a great extent	13.24%	9
	Answered	**68**
	Skipped	**6**

#14 Does the institution patent policy facilitate faculty inventors' creativity and innovation output (e.g. resources, departmental support, policy etc.)?

Answered	**51**
Skipped	**23**

Respondents	Response Date	Responses
1	Nov 08 2017 08:17 AM	Yes.
2	Nov 07 2017 07:38 PM	Yes - our policy is not an obstacle.
3	Nov 07 2017 01:12 PM	Policy rewards inventors with sharing of royalties ~1/3 to inventors; 1/3 to College (resources support); 1/3 to TTO (sole source of TTO revenue). Patent applications and entrepreneurial actions are encouraged to be recognised (i.e. pat. publication scores points toward tenure), but not at all Colleges and Dept's view patents as equal to a journal paper. Need for policy changes to encourage a culture of innovation and cutting edge scientific research.
4	Nov 07 2017 11:14 AM	We have some resources orchestrated at the University level, but departmental support is determined by the school and department. There is an effort to strengthen recognition of patent and invention disclosures as part of how a faculty member is evaluated for promotion and tenure
5	Nov 07 2017 09:35 AM	yes
6	Nov 01 2017 03:27 PM	yes
7	Oct 31 2017 01:06 PM	Sometimes
8	Oct 31 2017 12:57 PM	Currently the patent policy does not really serve this purpose, however, we are in the process of implementing course buy-out opportunities, consideration of commercialization activities towards tenure, and system-wide gap funding grant programs.
9	Oct 31 2017 12:15 PM	It provides for funds from licenses to flow back to the inventors personally and to their lab
10	Oct 28 2017 09:19 AM	Patent policy is appropriately generous but doesn't affect output
11	Oct 25 2017 02:56 PM	Yes, but we could do better.
12	Oct 25 2017 10:52 AM	yes, very generous revenue sharing 50%
13	Oct 24 2017 11:38 AM	Facilitate, no, support, yes.

14	Oct 24 2017 11:32 AM	Not necessarily.
15	Oct 24 2017 11:24 AM	No
16	Oct 24 2017 10:41 AM	yes
17	Oct 24 2017 10:35 AM	yes
18	Oct 24 2017 10:21 AM	Yes
19	Oct 24 2017 10:03 AM	Yes, but it doesn't require it and it's not formally part of the tenure and promotion process.
20	Oct 20 2017 12:28 PM	IP policy is fairly good, but promotion and tenure decisions do not at all take into account commercialization.
21	Oct 19 2017 08:18 AM	Neutral
22	Oct 18 2017 10:23 AM	no because not enough revenue goes to their lab or their use here on campus
23	Oct 18 2017 10:14 AM	Somewhat, for those faculty who are motivated by the incentives provided
24	Oct 17 2017 04:19 PM	yes, to some degree
25	Oct 17 2017 03:30 PM	Yes
26	Oct 17 2017 02:41 PM	The patent policy is designed with the exclusive goal of facilitating creative output by faculty inventors.
27	Oct 17 2017 12:46 PM	It doesn't facilitate but it encourages. Other programs facilitate.
28	Oct 17 2017 12:40 PM	The University covers patent costs and rewards inventors with 45% of the proceeds
29	Oct 17 2017 12:02 PM	Yes
30	Oct 17 2017 11:17 AM	The patent policy can provide additional incentive for creativity and innovation. It does not facilitate it.
31	Oct 17 2017 10:49 AM	Support at the department level is critical.
32	Oct 17 2017 10:21 AM	I don't think it has much of an effect. The royalty distribution to inventors is generous (50%); however, we have had only a few successes, so the policy's impact is minimal.
33	Oct 17 2017 10:18 AM	Yes, internal grants provided as an aspect of commercialization efforts.
34	Oct 16 2017 07:31 PM	Not sure there is a causal effect.
35	Oct 16 2017 06:22 PM	Not sure. but we're hoping to move in that direction.
36	Oct 16 2017 05:18 PM	No. The bigger impact has been sustaining NIH funding
37	Oct 13 2017 11:56 AM	It does not have as much effect as desired. Faculty, especially, new faculty are focused on research, publications and staying on tenure track.
38	Oct 11 2017 07:01 AM	Varies by departmental priorities.

39	Oct 10 2017 09:38 PM	yes
40	Oct 10 2017 03:38 PM	A word like "innovation" is a marketing term, and doesn't mean anything specific. Faculty are "innovative" in conducting research and publishing academic papers. That has almost nothing to do with developing technology and getting it into products. The university system rewards good academic research, but not patentable inventions or technology licenses. So faculty are not very motivated to assist tech transfer efforts.
41	Oct 10 2017 03:03 PM	Question is poorly worded
42	Oct 10 2017 01:29 PM	Neutral. Neither encourages nor discourages.
43	Oct 10 2017 12:21 PM	This question doesn't make sense
44	Oct 10 2017 12:03 PM	Unclear.
45	Oct 10 2017 11:52 AM	The patent policy is supportive, but our promotion and tenure policy is not supportive of tech transfer.
46	Oct 10 2017 11:45 AM	I don't think there is a relationship between our patent policy and creativity and items like department support are not covered in our patent policy.
47	Oct 10 2017 11:34 AM	not sure
48	Oct 10 2017 11:25 AM	Yes, it can be considered as a factor in the promotion and tenure process
49	Oct 10 2017 11:05 AM	no incentive, not pat of tenure and promotion process
50	Oct 10 2017 11:01 AM	Yes
51	Oct 10 2017 10:58 AM	Very little

#15 Please list an area where the technology transfer outreach programs is doing particularly well.

Answered	**49**
Skipped	**25**

Respondents	Response Date	Responses
1	Nov 08 2017 08:17 AM	Engaging new faculty, particularly increasing number of female inventors.
2	Nov 07 2017 07:38 PM	We are consistently meeting every incoming faculty member each year to introduce our office and our services.
3	Nov 07 2017 01:12 PM	Industry Research Contracts - Identifying and growing strategic areas of scientific excellence and innovation.

4	Nov 07 2017 11:14 AM	Announcements of TT opportunities like the Germinator program of BioStrategy Partners or QED by the University City Science Center certainly correlate with an surge in disclosures. The Practical Knowledge Series produced by BioStrategy Partners provide a continues engagement opportunity along with great content. Further presentations to faculty meetings have also been helpful.
5	Nov 07 2017 09:35 AM	College of Engineering
6	Nov 01 2017 03:27 PM	I-Corps program
7	Oct 31 2017 01:06 PM	Focus on faculty service and face-to-face meetings with faculty
8	Oct 31 2017 12:57 PM	Soliciting, facilitating and increasing industry-sponsored research and other engagement opportunities (internships, etc.)
9	Oct 31 2017 12:15 PM	We get more than double the number of disclosures a school our size normally has
10	Oct 28 2017 09:19 AM	One-on-one work with faculty to help develop lab-to-market strategies
11	Oct 25 2017 02:56 PM	We regularly meet one-on-one with individual researchers.
12	Oct 25 2017 10:52 AM	Teaching a course on Technology Commercialization in the MBA program
13	Oct 24 2017 11:38 AM	We are an NSF I-Corp Site, this has been a successful program.
14	Oct 24 2017 11:32 AM	College of Engineering and the Medical College
15	Oct 24 2017 11:24 AM	Meeting with college deans and department heads on a regular basis to update them on the technology transfer activities of their faculty.
16	Oct 24 2017 10:41 AM	engagement
17	Oct 24 2017 10:21 AM	Chemistry/BioChemistry
18	Oct 24 2017 10:03 AM	We developed a series of handouts that describes our processes and provides timelines. these have been very helpful and have been well-recieved
19	Oct 24 2017 10:03 AM	Lunch and learn seminars and networking events
20	Oct 19 2017 08:18 AM	Proactively meeting faculty new to the university
21	Oct 18 2017 10:23 AM	Grant programs to fund promising technologies
22	Oct 18 2017 10:14 AM	targeted outreach to connect specific departments with industry partners
23	Oct 17 2017 04:19 PM	Programs where we promote various technologies and their inventors to the campus community and to various partner organizations.
24	Oct 17 2017 03:30 PM	Overall it is good

25	Oct 17 2017 02:41 PM	Faculty engagement - our office has held individual consultations with more than 30 faculty members in the past 12 months.
26	Oct 17 2017 12:46 PM	Educating grad students and post-docs.
27	Oct 17 2017 12:40 PM	Our lunch has between 100 and 150 attendees every year.
28	Oct 17 2017 11:17 AM	We have a targeted women innovator program, as well as targeted one-on-one outreach. We provide dashboards on activity to department chairs.
29	Oct 17 2017 11:17 AM	Attending department meetings is particularly effective faculty education opportunity.
30	Oct 17 2017 10:21 AM	Presenting on TT during new faculty orientation. It's a great opportunity to meet new faculty face to face and begin to form and nurture a relationship.
31	Oct 17 2017 10:18 AM	Helping with research that has commercial potential.
32	Oct 16 2017 07:31 PM	First time inventors
33	Oct 16 2017 06:22 PM	everything we've tried thus far has been very poorly attended.
34	Oct 16 2017 05:18 PM	Fostering interest in spinoff companies
35	Oct 13 2017 11:56 AM	Citing existing success stories for tech transfer to start-ups or existing companies.
36	Oct 12 2017 10:11 AM	Education on intellectual property and the TTO process.
37	Oct 11 2017 07:01 AM	Direct interaction with individual faculty.
38	Oct 10 2017 09:38 PM	working with staff innovators
39	Oct 10 2017 03:38 PM	We have good relationships with specific faculty, who are mostly motivated by our ability to help them get sponsored research contracts.
40	Oct 10 2017 03:03 PM	Research sandpits where we do faculty matchmaking.
41	Oct 10 2017 01:29 PM	Working with faculty on translational research, providing small grant money to move inventions forward.
42	Oct 10 2017 12:21 PM	What do you mean by "area"?
43	Oct 10 2017 12:03 PM	Undergraduate technology challenge.
44	Oct 10 2017 11:52 AM	Establishing productive relationships with inventors.
45	Oct 10 2017 11:34 AM	not sure
46	Oct 10 2017 11:25 AM	I-Corps has been a major positive impact on getting more researchers engaged with start-up companies.
47	Oct 10 2017 11:13 AM	Translational Research funding
48	Oct 10 2017 11:05 AM	SBIR seminars and help with applications
49	Oct 10 2017 10:58 AM	New innovators

#16 Please list an area where the technology transfer outreach program can be improved.

Answered	**47**
Skipped	**27**

Respondents	Response Date	Responses
1	Nov 08 2017 08:17 AM	More communication to create awareness about programs offered.
2	Nov 07 2017 07:38 PM	We aren't giving enough presentations across campus to tell our story - we are a very successful office for our size of research dollars, but we need to spread the word about our past accomplishments.
3	Nov 07 2017 01:12 PM	TTO is a self supporting unit of the University with little funding to support outreach and marketing activity. Provide the TTO unit a Univ. supported operations budget.
4	Nov 07 2017 11:14 AM	Technology Showcases have been used well to demonstrate technologies on campus to colleagues but it has been hard to bring outside industry partners to those events. So organizing them to include several as speakers might help bring more onto the campus
5	Nov 07 2017 09:35 AM	College of Sciences
6	Nov 01 2017 03:27 PM	every area
7	Oct 31 2017 01:06 PM	Seminars are high effort, low return. Grad students come for free lunch, faculty not at all.
8	Oct 31 2017 12:57 PM	Web presence, written procedures, back office - all areas. Also, use of consultants for transactional / case management work (in the process of growing this).
9	Oct 31 2017 12:15 PM	We need more marketing activities
10	Oct 28 2017 09:19 AM	Earlier and more frequent involvement of faculty with outside experts who can validate commercial relevance
11	Oct 25 2017 02:56 PM	We need to spend more time in activities that engage multiple researchers in each activity, e.g., presenting at departmental and college faculty meetings.
12	Oct 25 2017 10:52 AM	Faculty meeting involvement
13	Oct 24 2017 11:38 AM	Would be helpful if efforts in TT by faculty can count toward promotion and tenure. It should not be a requirement, but there should be recognition for those who engage.
14	Oct 24 2017 11:32 AM	College of Communications
15	Oct 24 2017 11:24 AM	Educating faculty innovators on the technology transfer process.
16	Oct 24 2017 10:41 AM	efficiency

17	Oct 24 2017 10:35 AM	generic IP 101 programs
18	Oct 24 2017 10:21 AM	Liberal Arts
19	Oct 24 2017 10:03 AM	we struggle to get inventors and potential inventors to attend training events.
20	Oct 24 2017 10:03 AM	All of them
21	Oct 20 2017 12:28 PM	We don't have the sufficient headcount/resource to run effective outreach
22	Oct 19 2017 08:18 AM	Need to find better ways to get adequate faculty attendance at educational events.
23	Oct 18 2017 10:23 AM	Basic education to understand IP policy once a faculty member joins; funding for mentoring for faculty
24	Oct 18 2017 10:14 AM	sharing success stories
25	Oct 17 2017 04:19 PM	T2 is still not well recognized on campus but that is changing. We recently received an NSF I-Corps site grant and that has helped us gain much more recognition on campus.
26	Oct 17 2017 02:41 PM	Researcher engagement with industry problems - getting research faculty and staff to align their research plans with market needs has proven challenging.
27	Oct 17 2017 12:40 PM	We need better license compliance
28	Oct 17 2017 11:17 AM	We need more TT cheerleaders on campus.
29	Oct 17 2017 10:21 AM	It would be great if we had the funding and the support of the senior administration to host innovation showcases to feature our technologies to industry partners.
30	Oct 17 2017 10:18 AM	Industry interaction, including industry sponsored research funds.
31	Oct 16 2017 07:31 PM	Obligating faculty participation. Faculty self select based on personal bias as opposed to a comprehensive understanding of commercialization.
32	Oct 16 2017 06:22 PM	all.
33	Oct 16 2017 05:18 PM	Encouraging more disclosures.
34	Oct 13 2017 11:56 AM	We need more marketing. Bayh-Dole provided the rights to commercialization but did not provide funds for patenting and marketing activities for IP.
35	Oct 12 2017 10:11 AM	Outreach to industry.
36	Oct 11 2017 07:01 AM	Executive level priority setting and systemic cultural change. Our most significant faculty is deans and chairs who equate technology transfer with patenting early stage discoveries rather than doing the follow-on work required for commercialization. Follow-on work often brings in sponsored research funding and supports researcher career development but this is either not well understood or some units don't consider commercialization-related funding (SBIR subcontracts for example) in promotion and tenure considerations.

37	Oct 10 2017 09:38 PM	faculty reward
38	Oct 10 2017 03:38 PM	It is not a matter of improving outreach. It is a matter of having something to offer faculty, that they care about. They don't care about licensing of their technologies. Reaching out to them with a message that is irrelevant to them is not useful.
39	Oct 10 2017 01:29 PM	Providing better transparency to our inventors on what the status of all their inventions are with respect to patenting, marketing, licensing, and the like.
40	Oct 10 2017 12:21 PM	Same comment
41	Oct 10 2017 12:03 PM	Reaching areas of the university that have not traditionally participated in technology transfer.
42	Oct 10 2017 11:52 AM	Marketing to potential licensees.
43	Oct 10 2017 11:45 AM	Just need to conduct more outreach activities and trainings.
44	Oct 10 2017 11:34 AM	work with the business college
45	Oct 10 2017 11:25 AM	More licensing managers to work the disclosures that come in. Quick and good response to faculty on new disclosures brings more disclosures.
46	Oct 10 2017 11:05 AM	Senior leadership making it a priority
47	Oct 10 2017 10:58 AM	strategy

#17 Any Additional comments and feedback?

Answered	**11**
Skipped	**63**

Respondents	Response Date	Responses
1	Nov 07 2017 01:12 PM	Culture change needed at the top - deans, dept. heads and administration can do much more to reward and encourage faculty for industry engagement and innovations in research. Provide policy that motivate and reward entrepreneurial faculty.
2	Nov 07 2017 09:35 AM	na
3	Oct 24 2017 11:38 AM	None
4	Oct 24 2017 11:24 AM	With a very limited staff it is difficult to implement outreach programs.
5	Oct 24 2017 10:35 AM	'revenue sharing' at Universities is not profit-sharing (question 12)
6	Oct 24 2017 10:21 AM	No
7	Oct 17 2017 04:19 PM	See the response to #16.

8	Oct 17 2017 11:17 AM	There are many, many grammatical and some spelling errors. It doesn't make me take this survey seriously. You should check your work or have others check it.
9	Oct 17 2017 10:21 AM	We receive very little support (financial and personnel) to conduct technology transfer marketing activities. There's very little, if any, recognition by senior administration that technology transfer requires marketing and outreach.
10	Oct 13 2017 11:56 AM	Research VP's want $'s for research and will not focus on IP rights. The goals are orthogonal as are the fact that tech transfer is not a part of faculty rewards leading to tenure. TTO's in universities are swimming upstream and funding $'s for research are not being met with $'s for real commercialization on the other side. If a company spent this much money on research and did not launch successful products, the VP Sales and the VP for Marketing would be fired.
11	Oct 10 2017 12:03 PM	No.