

STRUCTURING TECHNOLOGY TRANSFER OFFICES FOR FACULTY ENGAGEMENT
AND SUCCESS

by

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(Under the Direction of James C. Hearn)

ABSTRACT

This basic qualitative study explored faculty perceptions of the role, effectiveness, and success of their institutional Technology Transfer Offices (TTOs). The rapid growth and development of technology and knowledge-based economies have emphasized the increasingly vital link between research universities and industry, and American universities are under pressure to promote technology transfer (tech transfer).

This study specifically examined the perceptions of U.S. faculty selected based on specific institutional, academic, and demographic characteristics, and engaged in high-level scientific research endeavors. The overarching research question guiding this study is: How do faculty who are engaged in high-level scientific research endeavors articulate their perceptions of their institutional TTO? Specific subquestions that also help guide this study include: How do faculty define the role of their institutional TTO? and How do faculty describe the overall effectiveness of their TTO and evaluate TTO success?

The literature review noted several studies had evaluated the performance of TTOs; however, these studies are predominantly grounded in quantitative analysis, focused on measurable outcomes of tech transfer, and mainly related to monetary values. This dissertation

sought to explain how TTOs can be better structured to facilitate faculty engagement and success, and to address a gap in the literature. The subtleties and nuances of faculty perceptions captured through a qualitative assessment is this study's contribution to the literature on tech transfer.

A combination of theories was used to provide a grounding for scientific research, academic careers, institutional theory, and organizational effectiveness theory. Faculty participants in this study were deemed a constituency of TTO stakeholders, and thus, the overall effectiveness of TTOs was correlated to faculty satisfaction with the state of affairs. To this end, the TTO capability continuum was devised to abridge the predominant data collected and to surmise faculty desires of a TTO.

INDEX WORDS: Technology transfer, Patents, Licensing, Scientific research, Academic careers, Intellectual property, Commercialization, Invention, Bayh-Dole Act, AUTM, Innovation, Boundary spanning, Institutional theory, and Organizational effectiveness theory

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DEDICATION

For Kadi, Yeani, and Miatta. Thank you for your love and support. We did it!

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CHAPTER 1

INTRODUCTION

U.S. universities are under pressure to promote and deliver economic development; technology transfer (i.e., tech transfer) is a critical determinant in this mission (Villani et al., 2017). The rapid growth and development of technology and knowledge-based economies have emphasized the increasingly vital link between research universities and industry (Tseng et al., 2018). University leaders establish Technology Transfer Offices (TTOs) to pursue the translation of scientific research into economic development and generate revenues (Rothaermel et al., 2007).

The new focus on tech transfer has generally been a welcome development for university administrators because it promises new revenues when traditional revenue sources are under increasing pressure (Phan & Siegel, 2006). According to the Association of University and Technology Managers (AUTM), university tech transfer contributed \$1.7 trillion to the U.S. Gross Industrial Output, \$591 billion to U.S. Gross Domestic Product (GDP), and supported 5.9 million jobs since 1996 (AUTM, 2021). Among the various channels available for economic development, the patenting and licensing of inventions have attracted significant attention in the higher education community (O'Shea et al., 2008). As the gap between academic laboratories and the marketplace has shrunk, universities have become more adept at engaging with industry (Tseng et al., 2018).

In a knowledge society, universities need to interact closely with industry and government to ensure socioeconomic development. Etzkowitz et al. (2000) referred to this intermingling of university, industry, and government (with multiple linkages to advance

economic and social development through innovation strategy) as the triple helix of innovation. It implies the breaking down of traditional organizational, cultural, and normative barriers that, in the past, have separated these spheres to the detriment of economic competitiveness and technological progress (Etzkowitz et al., 2000).

TTOs serve as a bridge between the faculty (suppliers) and industry (customers) who operate in distinct environments. Without effective management of this relationship, customer needs, supplier capabilities, and interests may not be adequately communicated. TTOs deploy the appropriate communication with both stakeholder groups to forge alliances between faculty and firms. Tech transfer is a multistep process that starts with patenting inventions or discoveries by faculty in their labs. This preliminary step of patenting indicates an exploitation of this knowledge, and the patented invention may be licensed for contracted royalties (Jensen & Thursby, 2001). Many universities have established specialized structures to support tech transfer (Clarysse et al., 200) and have created supportive internal rules and procedures (Thursby et al., 2001).

For this study, a TTO was defined as any university or university foundation unit responsible for obtaining patent protection for university inventions; and licensing the patented inventions. Within university TTOs, essential functions include receiving and evaluating invention disclosures from faculty, submitting patent applications and maintaining patents, marketing and negotiating inventions to potential industry partners, and receiving royalty incomes (Slaughter & Leslie, 1997). University inventions are often in the early stages of development and require substantial investment; therefore, TTOs need to identify industrial partners willing to make high-risk investments (Slaughter & Leslie, 1997).

Universities have always served as a significant source of knowledge creation, and the increasing commercialization of this knowledge demonstrates an immense value proposition to firms (Kobarg et al., 2018). As university connectivity with industry has intensified, studies have shown the patents licensed by universities to industry are of a higher quality than what firms could create internally (Wirsich et al., 2016). Firms seek university alliances to improve their knowledge base and acquire an enhanced technological performance or a competitive advantage (Kobarg et al., 2018.) As a result of the benefits provided by university patents and alliances, businesses have been cutting back on in-house research and development and increasing their reliance on external sources of knowledge and technology as a way of reducing the costs and risks of research. Without a strong partnership with universities, some private institutions lose competitive advantages in particular areas to those institutions with access to university partnerships (Hewitt-Dundas, 2013).

An extensive database of patent applications for 35 OECD (Organisation for Economic Co-operation and Development) countries and China between 1992 and 2014 revealed at least half of all industrial inventions took place within 30 kilometers of a higher education institution (OECD, 2019). This result highlights how valuable universities are for the growth and development of industry in surrounding regions. Feldman et al. (2002) identified positives to university tech transfer beyond monetary rewards, including demonstrating university capabilities to advance technology and advancing economic growth for local and national economies. Also, universities increasingly include their TTO organizations as a tool for recruiting prospective faculty members. These prospective faculty members often seek meetings with TTO officials to determine the university's suitability for their tech transfer ambitions (Feldman et al., 2002). Slaughter and Leslie (1997) listed a range of tech transfer benefits, which

include improved relations with the general public, industry, and government agencies; increased prestige for the institution and increased reputation for the individual researchers; spillovers to basic research, spillovers to teaching; consulting opportunities for faculty; and job opportunities for graduates.

Along with faculty and industry, TTOs complete a trio to make tech transfer possible. Therefore, this critical relationship between faculty and TTOs is worthy of study for anyone interested in university tech transfer. This study's focus on tech transfer differs from other forms of engagement between universities and industry for research, consulting, and networking (Perkmann & Walsh, 2008). With the awareness that faculty collaboration is necessary for the success of tech transfer; and to address a gap in the literature relating to faculty perceptions of the role, effectiveness, and success of their institutional TTO, this basic qualitative study sought to make a valuable contribution to this subset. This study specifically examined the perceptions of U.S. faculty engaged in high-level scientific research endeavors, with an emphasis on faculty who have the highest probability of engaging in tech transfer.

The overarching research question that guided this study is: How do faculty who are engaged in high-level scientific research endeavors articulate their perceptions of their institutional TTO? Specific subquestions that also helped guide this study include:

1. How do faculty define the role of their institutional TTO?
2. How do faculty describe the overall effectiveness of their TTO and evaluate TTO success?

I have provided an overview of tech transfer in higher education and some factors contributing to the phenomenon's rise. Next, I will review the extant literature relevant to tech transfer and present the theoretical frameworks that inform this research. Following the theory, I

will outline the research methodology for this qualitative case study and culminate with the findings and conclusions.

CHAPTER 2

LITERATURE REVIEW

Introduction and Definitions

The focus of this research was on university tech transfer; therefore, it is helpful to begin the literature review with the definition of tech transfer and a brief history of the Bayh-Dole Act of 1980. This act changed U.S. universities' dynamics concerning the ownership of intellectual property—a central topic for this study. TTO literature frequently points to staffing as a determinant for TTO success; thus, I discuss TTO archetypes and staffing competencies. Afterward, I review the literature on the perceptions of faculty who engage in tech transfer, followed by an exploration of the American Association of University Professors (AAUP) position concerning intellectual property (IP). I delve into literature and data on patent licensing income, which remains the most widely used indicator of TTO success. Lastly, I review extant literature on TTO effectiveness and tech transfer criticisms before offering concluding thoughts on the literature review.

This literature review discusses research generated predominantly during the past 20 years relating to tech transfer in higher education. Tech transfer refers specifically to the process of transferring rights in inventions from one entity to another, usually conveyed through a license for commercialization (Siegel et al., 2003). According to the World Intellectual Property Organization (WIPO, 2021), intellectual property refers to creations of the mind, such as inventions, literary and artistic works, designs, symbols, names, and images used in commerce. Patents are the government's legal grants that give an inventor exclusive use (usually 20 years) in exchange for full disclosure of the invention to the public. They are awarded when an

invention is found useful, novel, and nonobvious. Examples include processes, machines, compounds, plants, articles of manufacture, designs, and new uses (Bray & Lee, 2000).

The patent system in the United States is established in the U.S. Constitution which states that the legislative branch “promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries” (USPTO, 2021). According to U.S. patent law, the invention cannot be patented if the invention was described in a publication or available to the public before the effective filing date of the claimed invention (USPTO, 2021). After the patent application is made, the inventors are free to present their findings and publish their work without risking the viability of the patent. The U.S. Patent and Trademark Office (USPTO) lists three types of patents:

- Utility patents may be granted to anyone who invents or discovers any new and useful process, machine, or manufactured product.
- Design patents may be granted to anyone who invents a new and original design for a manufactured product.
- Plant patents may be granted to anyone who invents or discovers and asexually reproduces any distinct and new variety of plants (USPTO, 2021).

For this study, I defined TTO as any university unit responsible for obtaining patent protection for university inventions and licensing the patented inventions. Licensing agreements are defined as the sale of the rights to university inventions to a company in return for upfront fees and ongoing royalty payments contingent upon the technology’s commercial success (Bray & Lee, 2000). The company may want the IP to enhance their current process or product, or they want the IP to strategically block others (Bray & Lee, 2000). AUTM offers a thorough description of tech transfer:

Universities and research institutions are fertile ground for inventions that change the way we live. Google, vitamin D-fortified milk, life-saving vaccinations, cancer treatments—they are just a few of the thousands of inventions that each year make the world a better place. But having an idea—even a revolutionary one—isn't enough.

Universities and research institutions need help growing and advancing those discoveries to a final product or service—and that is where technology transfer fits in. Technology transfer, and the professionals who work in the field, change the world one discovery at a time. They're responsible for successful innovation management, corporate engagement, protecting and licensing inventions to companies, new venture creation and incubation, and economic development. Simply put, if innovation or start-up has its roots in a non-profit entity—like a university, hospital, or government lab—it's considered a tech transfer success. (AUTM, 2021)

The Bayh-Dole Act of 1980 (also referred to as Patent and Trademark Amendments Act of 1980) was a significant milestone for university research in the United States to promote university developed technology (GAO, 1978). Before the Bayh-Dole Act, the U.S. Government owned all rights to intellectual property developed using federal funding. Before enacting Bayh-Dole, the U.S. government had accumulated 28,000 patents, but fewer than 5% of those patents were commercially licensed (GAO, 1978).

With the passage of the Bayh-Dole Act, universities gained intellectual property rights, and this legal change facilitated the transfer of royalty revenues to the universities (Mowery et al., 2001). There was a favorable response to the Bayh-Dole Act, and the number of TTOs increased rapidly during the mid-1980s and early 1990s (Mowery et al., 2001). By 1998, every Carnegie I and II U.S. research university had tech transfer offices and adopted standard tech

transfer practices (Mowery et al., 2001). Before 1980, fewer than 250 patents were issued to U.S. universities each year. In 2019, AUTM survey of U.S. university licensing activity showed a different story; approximately 200 TTOs participating in the survey reported 26,000 invention disclosures, 17,000 patent applications filed, and 9,300 licenses issued (AUTM, 2019).

The Bayh-Dole statute states each organization that receives a federal grant may elect to retain title to any invention. If a contractor does not elect to retain the title, the Federal agency may consider and grant requests for retention of rights by the inventor (Patent and Trademark Laws Amendment, 1980). Key provisions of the statute are as follows:

- The university is entitled to retain ownership of any inventions created as a result of federal funding unless the funding agency informs the university upfront that the agency will retain title to inventions derived from the funded projects because of specifically identified exceptional circumstances or other specified conditions.
- When a university innovator discloses the creation of an invention derived from federally funded research, the university has 2 months from that date to disclose that information to the appropriate federal agency. The university also must patent all inventions it elects to own and commercialize.
- The university must attempt to develop and commercialize the invention. If an attempt is not made, the federal government retains the right to control the invention. The government also may take control of the invention for other reasons, such as a need to alleviate health or safety concerns. This provision is referred to in the law as the government's "march-in" rights.
- The university must provide the U.S. government with a nontransferable, irrevocable, paid-up, nonexclusive license to use the invention.

- In granting a license to use the invention, the university also generally must prioritize small businesses while maintaining the fair-market value of the invention.
- When granting an exclusive license, the university must ensure that the invention will be “manufactured substantially” in the United States.
- Excess revenue must support research and education.
- The university must share a portion of the royalties with the inventor(s).

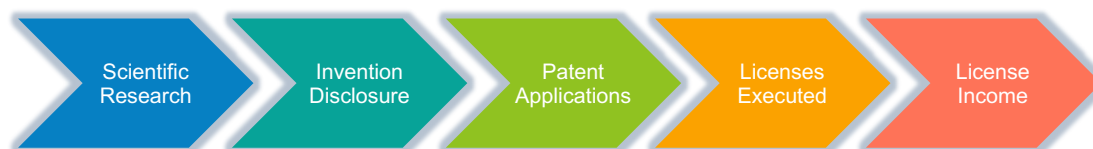
The U.S. Constitution grants inventors ownership of inventions they make. As such, universities use invention assignment clauses in employment contracts to clarify the legal ambiguity. Without an invention clause, the employee would typically hold the patent for any inventions. In the absence of a written agreement, an employee will own an invention they make under common law unless the employee was explicitly hired to invent and provided means and direction to make the invention (Mowery et al., 2001).

Summary of the Patent and Licensing Process

Tech transfer from a research university is comprised of several steps, as illustrated in Figure 1. The first step in the process is an invention disclosure, a declaration from faculty to the TTO about a scientific discovery. The second step is the patenting of that discovery by the TTO. Once the innovation is patented, the university assumes intellectual property ownership and can license the innovation to businesses. Further steps involve executing licensing agreements and earning licensing income.

Figure 1

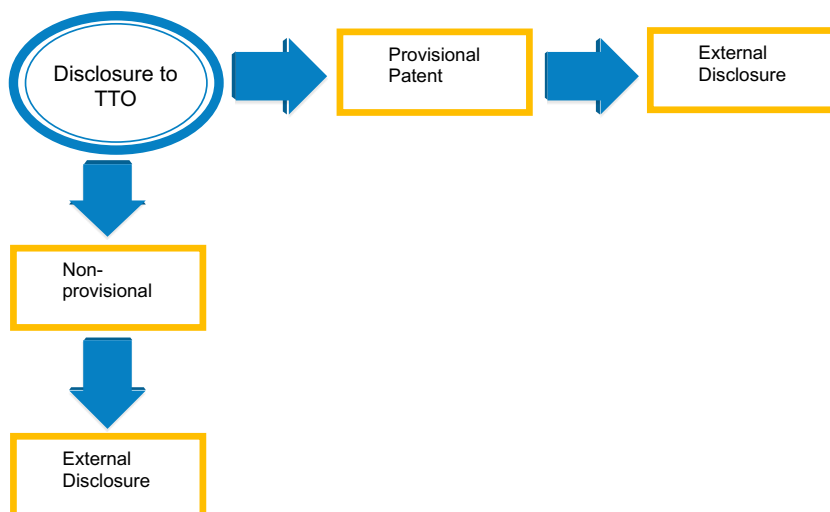
Patent and Licensing Process



The internal disclosure by the faculty to the TTO is a write-up on the concept and supporting data that further substantiates the innovation (see Figure 2). Disclosure details include design strategy, key features of the innovation, and data pointing to the practicality of the concept. The faculty inventor typically completes the disclosure form and gathers information to help the TTO determine the appropriate course of action (Mowery et al., 2001). Once a provisional patent application has been filed, the faculty can disclose the discovery while retaining protection. The provisional application can be converted to a nonprovisional application no later than 12 months after its filing. Eighteen months after the nonprovisional is filed, the patent application is published (USPTO, 2021). Filing a provisional provides protection for the invention but does not start the clock on the 20-year patent term. This is a major benefit for filing a provisional since the patent term is calculated from the date the nonprovisional application is filed.

Figure 2

Invention Disclosure and Patenting Decision



The TTOs decision to file a nonprovisional patent requires greater deliberation because the costs associated with the filing can eventually reach hundreds of thousands of dollars (Mowery et al., 2001). A key feature of patent filings is the prior art. Prior art refers to the scientific and technical information that existed before the effective date of a patent application and is used to assess the patentability of an invention (USPTO, 2021). For well-funded research institutions, the decision to file a patent depends on the commercial potential and the likelihood the patent will be issued. To this end, the TTO needs to conduct market research and promote the invention to companies.

This study focused on the patenting and licensing of inventions, including the boundary-spanning activities, of TTOs vis-à-vis faculty and industry. Figure 1 and Figure 2 excludes other TTO services, including start-up formation and financing. In this literature review and the study in general, I homed in on faculty engaged in scientific endeavors with patenting potential. By “faculty” or “scientists,” this study targeted those involved in “hard” fields like chemistry, physics, biology, engineering, etc., with social scientists entirely excluded. Although commercialization or the conversion of university intellectual property into economic development can take many forms, this study was limited to the processes and practices in TTOs.

TTO Archetypes, Staffing, and Capability

Link et al. (2008) described three vital organizational functions performed by TTOs: information processing, coordination, and incentive alignments. Information processing defines the interaction between scientists and the TTO to understand the invention and its potential. The coordination function builds upon the information processing by linking the scientist to the market. Lastly, incentive alignments, or royalty and equity distribution, refer to the institutional formula for allocating licensing revenue derived from the invention.

Typically, the TTO director reports to a vice president, vice provost, or vice chancellor for research. In examining the implications of TTO structure, scholars have found the choice of organizational structure influences TTO performance by shaping the flow of resources, reporting relationships, degree of autonomy, incentives, and tech transfer strategy (Bercovitz et al., 2001). Markman et al. (2005) described three TTO archetypes, which vary by the degree of autonomy granted at the institutional level: traditional university structure, nonprofit 501(c)1 research foundation, and for-profit private venture extension.

Traditional University Structure

A traditional TTO is an integral department in a university's administrative structure, usually reporting to the Provost or Vice President for Research. Such TTOs are supervised by an assistant or vice president of the university and are typically funded by the research office. Under this structure, the TTO comprises untenured university staff with the primary role of pursuing conventional licensing opportunities for royalty income. A university administration's direct and often substantial oversight limits TTO management's autonomy in decision making, licensing strategies, and incentive systems.

Nonprofit Research Foundation 501(c)1

TTOs function as independent nonprofit units or part of separately constituted research foundations outside the university's administrative structure under these arrangements. Such research foundations have their board of directors chaired by the university president. Private universities and many sizeable multisystem state universities create nonprofit research foundations to grant faculty greater autonomy to conduct research and license new technology. TTOs, under the nonprofit research foundation structure, enjoy a separate budget from their affiliated universities and greater freedom in choosing licensing strategies. Nonprofit research

foundations enjoy more flexibility than the traditionally structured TTO in granting compensation and incentives to personnel with pay levels that can sometimes exceed the university grade system.

During this study, I had the privilege of having several conversations with Dr. Charles Knapp, who served as the president of the University of Georgia for a 10-year period ending in 1997. At the time of this discussion, Dr. Knapp served as president emeritus of the University of Georgia and director of the Doctor of Education (EdD) program in higher education management. With this illustrious experience, Dr. Knapp offered invaluable insight on nonprofit research foundations. Using the context of public universities, and especially those considered “flagship” or elite public institutions, Dr. Knapp explained that forming nonprofit research foundations as entities separate from the university was a common strategy to keep revenues out of the reach of state legislatures. Thus, any revenue generated by the TTO would not be included in the state formula for allocating resources to the institution and also inaccessible for diversion into other state mandates.

For-Profit Private Ventures

The for-profit private ventures are focused on economic development and creating start-up companies. These ventures feature an independent CEO and a board with substantial intellectual property law, management, and venture capital experience. Private venture operations were most aggressive at creating startups, raising capital, and enjoying the most significant autonomy for licensing strategies, compensation systems, and the ability to hold equity in start-up companies designed to exploit licensed technologies.

The WIPO (2011) stated TTOs should ideally have a combination of competencies successfully perform their essential functions, including legal, technical, and commercial

guidance with a multidisciplinary approach. The experience, infrastructure, size, networks, and personnel are characteristics of TTOs that can enhance tech transfer (WIPO, 2011). The importance of a balanced skill set of managers, scientists, and lawyers within the TTO personnel is also noted by Siegel et al. (2003).

The empirical studies have shown TTO performance, as measured by the number of invention disclosures, is significantly shaped by labor division in the TTO (Bercovitz et al., 2001). In practice, TTO officials often struggle with a lack of financial and human resources and may exhibit a lack of competency in these areas (Siegel et al., 2003). Most universities are unprepared to fund and provide the required resources in assembling a multidisciplinary team of lawyers, scientists, and other commercial managers (Siegel et al., 2003).

Although many new offices will poach experienced tech transfer officers from other established institutions, newer offices go through the same maturation processes and growing pains as the more established offices (Greenbaum & Scott, 2010). Smaller offices are likely to do more harm than good through suboptimal licensing practices resulting in technology that becomes shelved by an exclusive licensee and inaccessible for utilization by the inventor. Additionally, other licensed aggressive patenting quickly consumes limited resources (Greenbaum & Scott, 2010). Reinforcing the resource constraint is Swamidass and Vulasa's (2009) survey of TTOs, which found 72% of TTOs had a total staff count of three or fewer staff members and 75% of the survey respondents claimed they failed to process more than 26% of the inventions due to insufficient processing capacity in the TTO.

Perceptions of Faculty in Relation to Technology Transfer

Lee (1996) studied U.S. academics' perceptions of tech transfer and concluded most academics favored tech transfer but opposed severe commercialization such as start-up

assistance or equity investment in new technology firms. Krabel and Mueller (2009) and Bowie (1993) indicated scientists who believe science is a public good are significantly less likely to pursue tech transfer. Bowie explained disdain is linked to perceptions that transactions with industry partners inevitably lead to dictates on research direction. Many “purists” believe faculty engaged in tech transfer do not share, are secretive about their work, and have nondisclosure agreements that muffle research (Campbell et al., 2000, 2002).

Markman et al. (2005) noted instances wherein faculty choose not to disclose their research results to their TTOs if it conflicted with their tenure and promotion policies, delayed publication, and hindered their overall professional advancement. Furthermore, Nelsen (2007) found faculty chose not to disclose inventions when they perceived their TTO was engaging in unethical behaviors such as favoritism in investment decisions or failing to meet faculty expectations. In addition to this, Aldridge and Audretsch (2010) reported 30% of scientists bypass their institutional TTO and use a backdoor route to commercialize their research. Siegel et al. (2003) also found TTO officials often encountered difficulties convincing faculty to disclose their inventions.

Contrary to these negative perceptions, several studies have concluded faculty believe tech transfer can increase their prestige and reputation (Moutinho et al., 2007; Owen-Smith & Powell, 2001; van Rijnsouwer et al., 2008). Jensen and Thursby (2001) and D’Este and Perkmann (2011) also demonstrated greater monetary rewards motivate faculty to commercialize. Stuart and Ding (2006) also noted patents may not be necessarily remunerative but provide academics with visibility and status in the world of commerce that may lead to invitations to join corporate advisory boards. Contrasting with faculty who do not engage with industry, faculty who engage

with industry believe they should receive higher university salaries (Campbell & Slaughter, 1999).

Scientific productivity is generally positively related to the industry, which suggests that the most successful scientists are also those who pursue tech transfer (Bekkers & Bodas Freitas, 2008; Haeussler & Colyvas, 2011). Other studies detailed that faculty inventors publish more and higher quality papers than their nonpatenting colleagues (Azoulay et al., 2007; Breschi et al., 2007; Fabrizio & Di Minin, 2008.) Haeussler and Colyvas's (2011) findings demonstrated faculty are more likely to engage with industry if their departmental colleagues value patents, although the opposite is true if the same colleagues emphasize traditional academic values. Bercovitz and Feldman (2008) and Stuart and Ding (2006) concluded academics are more likely to be entrepreneurial if departmental colleagues of the same rank are entrepreneurial.

AAUP Position on Intellectual Property

To support the discussion on faculty perceptions of tech transfer, I explore the official position of the American Association of University Professors (AAUP) on IP. This exploration will form a basis for the voice of the academe as a strategic constituency. The AAUP position unabashedly promotes faculty ownership of inventions and argues that the Bayh-Dole Act did not mandate that universities own, or have a first right to hold, inventions made with federal support. Nor did the Act require that faculty commercialize such inventions. The AAUP position is buoyed by the *Stanford v. Roche* case filed in district court in 2005. Stanford sued Roche for infringing on patents covering diagnostic tests for HIV infection; the tests were originally owned by Stanford University (*Stanford v. Roche*, 2011). Roche counterclaimed it jointly owned the patents due to an agreement that a Stanford faculty member signed when he researched Cetus.

Cetus was a biotechnology company that invented PCR testing that was later acquired by Roche (*Stanford v. Roche*, 2011).

When the faculty member joined Stanford, he had signed an agreement whereby he agreed the university would own any inventions he made. The Stanford lab in which the faculty member worked had been developing HIV tests and wanted to try the new PCR method. The faculty member subsequently went to work at Cetus to learn the technique. As is a standard business practice, Cetus had the faculty member sign a confidentiality agreement before allowing him into their facilities. After completing his training at Cetus, the faculty member returned to Stanford where he tested the HIV measurement technique. Subsequently, Stanford filed several patent applications related to the procedure and secured three patents to the HIV measurement process. Stanford's research related to the HIV measurement technique was funded by the National Institutes of Health (NIH), subjecting the invention to the Bayh-Dole Act. Accordingly, Stanford disclosed the invention to the government, granted the government a nonexclusive, nontransferable, paid-up license to use the patented procedure, and formally notified NIH that it elected to retain title to the invention.

Stanford alleged Roche's HIV detection kits were infringing on its three patents and relied on the language of the Bayh-Dole Act to support its dispute with Roche. The case moved from the district court, the federal circuit, and then lastly, Stanford appealed to the Supreme Court based on its argument that Bayh-Dole overrides normal ownership of inventions. The Supreme Court decided in June 2011 that U.S. patent rights have always initially vested in "the inventor" and that the nonspecific language of the Bayh-Dole Act does nothing to change the original setup. Therefore, the Supreme Court's decision reassured inventors and all those involved in the practice of law involving inventions that their longstanding belief that the

ownership rights in inventions belong first and foremost to inventors is correct. The AAUP offered a comprehensive position on managing university generated inventions in their July–August 2014 bulletin. Key points of this opinion are found in the following excerpt:

One fundamental principle should be clear: inventions are owned initially by their inventors. That principle is established in both the US Constitution and federal patent law. As the US Supreme Court affirmed in its 2011 decision in *Board of Trustees of Leland Stanford Junior University v. Roche Molecular Systems, Inc. (Stanford v. Roche)*, faculty inventors in a university setting are also the initial owners of their inventions. Ownership of patent rights that may attach to an invention, however, may be transferred to another party by a written instrument. Thus, control of patent rights may be distinguished from ownership, since the initial patent owner may choose to enter a contract with (or transfer title to) another entity that manages those patent rights on his or her behalf. A university may become the owner of patent rights in a faculty invention by voluntary assignment, as was the case at most universities prior to 1980.

For many years university policies recognized that faculty members owned their intellectual property but required that they share profits with the institution when patentable intellectual property was commercialized. The AAUP regards such policies as fair and reasonable, so long as the faculty inventor or creator determines whether and how the work is to be marketed. Faculty members should have the right to distribute some work—software being a common example—for free if they choose.

A fundamental problem that arises from university ownership of patent rights to faculty inventions is that it tends to create institutional conflicts of interest between the university's governance role and its financial and competitive interests in exploiting patented inventions for its own benefit. It is all too easy for universities to conflate royalty income with their public service mission to enhance economic growth while failing to perceive, or to acknowledge, the conflict that arises with respect to other institutional responsibilities and the university's longstanding commitment to the broad dissemination of knowledge.

Inventions—despite distinctions often drawn in university policy statements—are a natural out-growth of scholarly activities. The scholarly nature of university-based inventions does not simply disappear with the addition of a potential patent or other intellectual property rights. Thus, the fundamental rights of faculty members to direct and control their own research do not terminate when they make an invention or other research discovery; these rights properly extend to decisions involving invention management, intellectual property licensing, commercialization, dissemination, and public use. Faculty inventor “assignment” of an invention to a management agent, including the university that hosted the underlying research, should be voluntary and negotiated, rather than mandatory, unless federal statutes or previous sponsored-research agreements dictate otherwise. Faculty inventors and investigators retain a vital interest in the disposition of their research inventions and discoveries and should, therefore, retain rights to negotiate the terms of their disposition. The university, or its management agents, should not undertake intellectual property development or take legal actions that directly or indirectly affect a faculty

member's research, inventions, instruction, or public service without the faculty member's or inventor's express consent.

Faculty members have a collective interest in how university inventions derived from academic research are managed. Through shared governance, they also have a responsibility to participate in the design of university protocols that set the norms, standards, and expectations under which faculty discoveries and inventions will be distributed, licensed, and commercialized. (AAUP, 2014)

Patent Licensing Revenues

Bray and Lee (2000) reported university licensing fees charged to companies typically range from \$10,000 to \$50,000 (but can be as high as \$250,000) while royalty rates generally are 2%–5% (but can be as high as 15%). The deals negotiated between universities and industry may differ based on either side's bargaining power and either party's relative sophistication, experience, and resources (Bray & Lee, 2000). Consequently, universities adopt standard industry specific royalty rates and negotiate fees and milestone payments (Bray & Lee, 2000). Thursby and Thursby (2001) found the role of faculty inventors was critical for the TTO to find industrial partners for the invention. Fifty-eight percent of TTO respondents indicated faculty inventor contacts helped market the technology to companies (Thursby & Thursby, 2001). Significant announcements from several universities have inspired the patent licensing phenomenon. Enormous successes include:

- Gatorade's high energy drink developed by a University of Florida faculty has generated more than \$250 million in royalties by 2015 (Lacey, 2015).
- Northwestern University's \$1 billion in royalties for Lyrica, an anti-seizure drug (Andes, 2016).
- Emory University's \$540 million revenue from the patent covering Emtrivia, an anti-retroviral drug (Emory University, 2019).

- Columbia University's patents on inserting foreign DNA into cells brought a total of \$790 million by 2013 (Arenson, 2000).
- Michigan State University has earned \$160 million over the life of two cancer-related patents (Rogers et al., 2000).
- Stanford University earned \$143 million for the recombinant DNA gene-splicing patent (Rogers et al., 2000).

Despite the notable exceptional successes, the distribution of licensing revenues is highly skewed, with a few big commercial hits generating significant returns for a few universities. Well-known licenses are the exceptions rather than the rule, and multi-million-dollar successes are sporadic at well-funded research institutions and are almost nonexistent for most universities (Feldman et al., 2002). Only a tiny subset of invention disclosures generate any licensing interest, and fewer still generate substantial monetary rewards (Feldman et al., 2002). A common philosophy in university tech transfer is for every 100 invention disclosures, only one commercially successful product will result (Matkin, 1994).

Most universities cannot afford to patent all the inventions disclosed by faculty; consequently, evaluating inventions is crucial to assess technologies that appear most practical and profitable (Matkin, 1994). Bray and Lee (2000) noted university inventions are typically early stage inventions with high technical and market uncertainty, requiring considerable follow-up research and additional development costs. Jensen and Thursby (2001) found only about 12% of university licensed inventions are ready for commercialization.

Thursby and Thursby's (2001) survey of industry licensing executives found 66% of executives had not licensed intellectual property from universities because of several compelling reasons: university research was generally at too early a stage of development; university

research was not aligned with industry; university refusal to transfer ownership to the company; university policies regarding delay of publication were too strict; and concerns about obtaining faculty cooperation for further development of the technology.

Criticisms of Technology Transfer

Shifting Academic Agendas

Some critics have observed the quest for tech transfer shifts academic agendas toward more applied topics at the expense of basic science's long-term benefits (Murray & Stern, 2007). Blumenthal et al. (1996), in their study of U.S. life science faculty, showed academics with industry support are more likely to report that the project's commercial potential influences their choice of the research topic. Conversely, Hicks and Hamilton (1999) found the share of basic research relative to the percentage of applied research at U.S. universities remained unchanged for 15 years after the Bayh–Dole Act was passed (1980–1995), while university patenting increased significantly. Thursby and Thursby (2002) found university licensing increases were primarily due to universities' more considerable tech transfer efforts rather than changes in research direction.

Public Access to Knowledge

Toole and Czarnitzki (2010) observed tech transfer might impede knowledge accumulation in the public domain. Huang and Murray (2009) found similar results by concluding that increased academic patenting may slow the unrestricted dissemination of scientific knowledge and that open science rules are being jeopardized. Greenbaum and Scott (2010) conveyed letting universities and TTOs take control of IP was counterproductive. Instead, they argued it would be best to leave it to individual or public ownership.

Hammerstedt and Blach (2008) described how it is often necessary for a scientist to get legal assistance (often through a detailed material transfer agreement) to obtain a reagent from another scientist and moaned the loss of the personal relationships that were sufficient in years passed. Heller and Eisenberg (1998) criticized how people might underuse scarce resources because too many owners can block each other. The thrust of Heller and Eisenberg's (1998) research was that the act of conferring monopolies in discoveries through patents inevitably increases prices and restricts use. Heller and Eisenberg (1998) also described a tragedy wherein privatization solves one problem but causes another.

Fiscal Considerations

Mowery et al. (2001) found a small number of inventions drive most TTO patent license revenues, and few institutions can recoup their TTO operations expenses. Greenbaum and Scott (2010) lamented the underfunding and understaffing of TTOs, coupled with the drain on limited university resources. The AUTM 2019 data corroborate Gewin (2005), who found most TTOs fail to cover their expenses, do not have the resources to patent technology, do not have licensing revenue streams, and those that are successful are well resourced.

AUTM 2019 data confirm patent licensing revenue streams for most TTOs remain elusive. Total university licensing revenues of \$2.5 billion account for only 3% of the annual university R&D (research and development) funds of \$77 billion. The data conclude the top 5 earning institutions netted 38% of all licensing revenues. The top 15 earning institutions netted 67% of all licensing revenues. TTO patent license revenues are a highly exclusive affair, with the wealth concentrated in a handful of universities.

Trune and Goslin's (1998) analysis of the financial profitability of TTOs concluded the majority of TTOs were unprofitable (*vis-à-vis* TTO operating costs) but acknowledged many

universities do not operate their TTOs with an underlying profit motive. For some universities, tech transfer is necessary to support research faculty pursue commercialization even if their programs lose money (Trune & Goslin, 1998). Notwithstanding this uncertain outlook for TTO patent license revenues, universities remain pressured to expand their tech transfer activities.

With most universities at a net financial loss on TTO operations, researchers should ask why many universities continue to increase their sponsorship of TTOs. This literature review suggests that tech transfer has become a matter of prestige for most institutions. American universities are navigating a global economy and seeking to foster their role as incubators of new ideas, technology, and scientific development (Olcay & Bulu, 2017). Universities aim to demonstrate a commitment to innovation and economic development by deploying the relevant TTO operations. Consequently, TTOs are increasingly viewed as necessary administrative services and expenses, not a university profit center.

Concluding Thoughts on the Literature Review

The literature review noted several studies had evaluated the performance of TTOs; however, these studies are predominantly grounded in quantitative analysis of significant outputs such as licensing income, startups, and patents using statistical methods (Anderson et al., 2007; Kim et al., 2008; Siegel et al., 2003). These studies were focused on measurable outcomes of tech transfer, which are mainly related to monetary values. Still, this literature review revealed scant evidence of the qualitative evaluation of faculty perceptions of TTO effectiveness in a manner that could inform the structuring of TTOs for faculty engagement and success. The absence of literature in this subset presented an opportunity to make a valuable contribution to the academe.

CHAPTER 3

THEORETICAL FRAMEWORK

This chapter discusses the theoretical underpinnings of this study and explains these theories' application to address the research questions. As previously stated, the overarching research question that guided this study was: How do faculty who are engaged in high-level scientific research endeavors articulate their perceptions of their institutional TTO? Specific subquestions include:

1. How do faculty define the role of their institutional TTO?
2. How do faculty describe the overall effectiveness of their TTO and evaluate TTO success?

I will lead with a discussion on the scientific research paradigm that informs this study. This discussion aims to provide a deeper understanding of the scientific research environment and the scientific community framework in the United States. Following the scientific research paradigm, I explore the academic career paradigm, an endeavor to codify universities and explain academic life structure and the ideology of academic achievement. Exploring these two paradigms serves as a precursor to a discourse on institutional theory and organizational effectiveness theory. Collectively, these four theoretical segments help explain the findings of this study.

Tolbert (1985) suggested organizational phenomena are much too complex to be described adequately by any single theoretical approach. Current research on organizations could benefit significantly if researchers combine multiple perspectives to provide more complete explanations of the behaviors under study (Tolbert, 1985). Scholars can provide a more complex

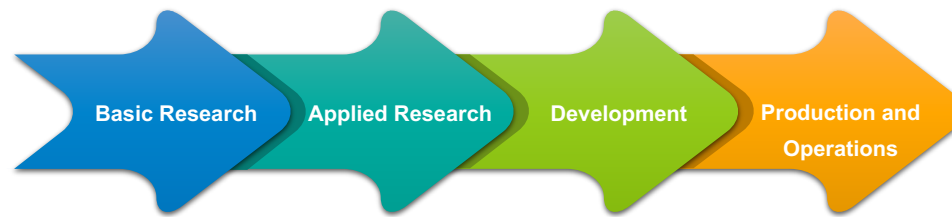
depiction of administrative change in higher education institutions by applying various theories (Birnbaum, 1988). Universities respond differently to changes in the institutional environment, and the combination of these theories allows us to examine many different factors that determine the responses to change.

Scientific Research Paradigm

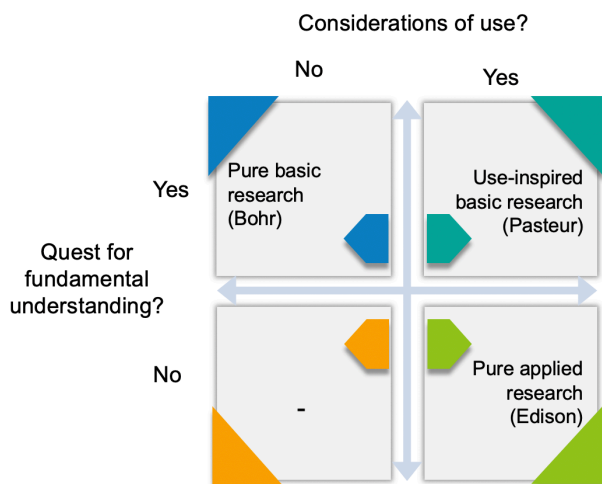
In the United States, the theoretical formation of scientific research is grounded in the influential report, *Science, the Endless Frontier*, which was released in 1945 by Vannevar Bush, who served as President Franklin D. Roosevelt's director of the wartime Office of Scientific Research and Development (Stokes, 1997). The report responded to President Roosevelt's request for a post-WWII vision on maintaining investment in scientific research. Bush's report laid the framework for the dichotomy between "basic" and "applied" science and serves as a blueprint for the scientific community and the basis for tech transfer (Stokes, 1997). Bush (1945) stated:

Basic research is performed without thought of practical ends. It results in general knowledge and an understanding of nature and its laws. This general knowledge provides the means of answering a large number of important practical problems, though it may not give a complete specific answer to any one of them. The function of applied research is to provide such complete answers. The scientist doing basic research may not be at all interested in the practical applications of his work, yet the further progress of industrial development would eventually stagnate if basic scientific research were long neglected.

This linear model of technological sequence proposed by Bush is illustrated in Figure 3.

Figure 3*Technological Sequence*

Stokes (1997) also described basic research as directed toward a more complete understanding of nature, its laws, and what is unknown, whereas applied research focuses on applying the known, to action the feasibility of scientific or engineering development, for practical use. An early report of the National Science Foundation commented on this sequence from basic research to technology, which birthed the technology transfer expression (Stokes, 1997). Bush (1945) explained those who invest in basic research would capture its return in technology as scientific advancements are converted into technological innovation by tech transfer processes. Although Bush's tenets on scientific research remain the prevailing paradigm in the United States, they have attracted a segment of critics who deem the linear one-dimensional approach insufficient to capture the varying ranges of scientific research. Consequently, new models are frequently proposed, including Stokes, who presented a quadrant model illustrated in Figure 4.

Figure 4*Quadrant Model of Scientific Research*

According to Stokes (1997), there is no reason to think of scientific research only in dichotomous terms because there can be many degrees of commitment to these two goals. The upper left quadrant is explained by Niels Bohr's quest for a model atomic structure, which was a voyage of discovery even though many of his ideas eventually made a significant impact on the world. The upper right-hand quadrant illustrates the extension of understanding but is also inspired by considerations of use. Louis Pasteur's combined drive toward understanding and use, and for whom the term pasteurization was derived and credited for saving countless lives, is a perfect encapsulation of this quadrant. The lower right quadrant is exemplified by Thomas Edison's pursuit of commercially profitable electric lighting. Stokes admonished the lower left-hand quadrant is not vacant but illustrates research inspired neither by the goal of understanding nor the purpose of use. The investigator's curiosity may drive this quadrant about particular things (Stokes, 1997).

Academic Career Paradigm

What follows in this segment is an exploration of academic careers grounded in a model posited by Hermanowicz (2009). In his foundational study, *Lives in Science: How Institutions Affect Academic Careers*, Hermanowicz investigated how institutions affect academic careers. This longitudinal research spanned a decade and demonstrated many highly differentiated careers in the academic profession. The achievement ideology operates more strongly in academia than in other domains (e.g., industry, government, or religion). This exploration of Hermanowicz provides a basis for assessing how the institution type and the faculty career phase impact faculty engagement with TTOs. Higher education is a socially regularized system comprised of research, teaching, and service functions. There are premiums assigned to these roles, most notably to research, among the institutional types. Universities were codified into three types of institutions (Elites, Pluralists, and Communitarians) to explain the structure of academic life and the distinct academic worlds they represent.

The *elite* academic world consists of institutions, typically private research universities and some prestigious public research universities, with the highest premium on research. The overall institutional goal of these elite institutions is to gain additional prestige through the research and scholarly achievements of faculty. These institutions compete vigorously against their peers to recruit faculty recognized as stars in their respective fields.

The *pluralist* world consists of those institutions that place a premium on both research and teaching, typically consisting of public research universities. Despite these institutions also pursuing additional prestige through faculty research and scholarly achievement, this is not a supreme goal. Such institutions typically employ a faculty that is broader in their goals and its achievements. This university type lacks the resources to compete with elites; consequently,

accomplished faculty will be a distinct minority. Pluralist faculty have varied demands, including mass teaching and service to communities and states.

The *communitarian* world consists of institutions that place a premium on teaching. Faculty in this type of institution may engage in research; however, teaching is the overriding organizational goal. As a result, only in rare cases do highly accomplished researchers work in this type of institution.

Elites, pluralists, and communitarians focused centrally on scientific research in their early careers, expecting this would translate into promotion and tenure. This was true across all individuals, even those at institutions where teaching was emphasized. The scientists were socialized and trained to place a premium on research to advance their academic careers. Nearly all scientists had entertained the idea of making an incredible discovery at some point in their careers.

The recognition sought by scientists in early career phases unfolds differently during subsequent stages of their careers. This aspiration requires sustained effort to deliver on researchers' socially ascribed role in the elite world, including publication demands and other research quality measures. Through the early phases of a career, the dream of great attainment carried immense power and importance in defining the academic and academic career vision. At mid-career, the pursuit of outstanding achievement is more closely reconciled with capability and opportunity, and the intense aspirations of early careers are stabilized.

Late careers fully develop differences among scientists' careers. For elites, their careers focus on research, although professional aspirations are not as lofty as they once were. Among pluralists, the direction of the late-career was a combination of research and teaching or exclusively teaching. For communitarians, teaching was their principal focus at the late-career

phase. Professional aspirations tied to research were no longer present as their institutions could not sustain them. Publication patterns are central to understanding science because through publication, research is communicated, verified, and archived. Inequality in publication becomes ever more expansive throughout scientific careers, with elites having the highest, communitarians the lowest, and pluralists being in between. Hermanowicz (2009) found ample evidence of cumulative advantage in which early success determines the arc of the career.

Institutional Theory

Institutional theory has been investigated across the social sciences and is deployed to examine organizations from microinteractions to global macro networks. The institutional theory explains establishing rules, norms, and routines, as authoritative guidelines for social behavior (Scott, 2005). March and Olsen (2009) described the collection of rules and practices that make an institution possible and further noted the organizational, financial, and staff capabilities. Harris (2013) noted institutional theory is frequently used and helps understand the relationship between higher education and the environment.

DiMaggio and Powell (1983) described a process of organizational homogenization or isomorphism as structured organizations deal with uncertainty and constraint. DiMaggio and Powell explained, as a field becomes well established, it inevitably pushes toward homogenization. This theory may explain why universities adopt similar constructs to compete in higher education tech transfer phenomena. DiMaggio and Powell discussed three mechanisms through which isomorphic institutional change occurs:

1. *Coercive isomorphism* is derived from political influence and concerns over legitimacy. It is the consequence of formal and informal pressures on organizations

exerted by other organizations that they depend on and by cultural expectations from the society within which the organizations function.

2. *Mimetic isomorphism* results from standard responses to uncertainty. Uncertainty is a powerful force that encourages imitation, as demonstrated when organizational technologies are poorly understood and ambiguous goals. Consequently, organizations may model themselves on other organizations.
3. *Normative isomorphism* is associated with professionalization and the collective struggle of members of an occupation to define the conditions and methods and establish a rational base for their occupational autonomy.

Meyer and Rowan (1977) identified risk in isomorphism and summarized the adaptation of the institutional environment, as opposed to adherence to technical aspects, is a tradeoff to maintain legitimacy. Meyer and Rowan's discourse identified organizations driven to incorporate the practices and procedures defined by prevailing rationalized concepts of organizational work and institutionalized in society, with the primary aim of increasing their legitimacy and survival prospects, rather than the efficacy of the acquired practices and procedures (Meyer & Rowan, 1977).

Harris (2013) suggested less prestigious institutions follow the strategic direction laid down by institutions with the reputational and political capital to engage in innovative activity. Consequently, as institutions follow the lead of prestigious universities, there is a convergence upon a single organizational model. Also, colleges and universities focus on prestige-maximizing structures and activities to improve their standing, demonstrated by faculty behaviors, actions, and institutional reward structures.

Hearn and Heydinger (1985) described how organizations survey their environment and select certain trends to inform strategic decision making. Although institutional theory remains a prevailing construct for institutional actions, Harris (2013) suggested it fails to make precise predictions on the empirical literature and does not account for innovations and risk-taking led by less prestigious institutions. Senge (2013) critiqued institutional theory for mainly ignoring the wider institutional setting of organizational activity beyond the economic sphere.

Organizational Effectiveness Theory

Schein (1985) defined organizational culture as a limited set of beliefs, values, and assumptions shared by an organization's members. The underlying values influence organizational members' behavior by guiding decision making and behavior (Schein, 1985). Tierney (1988) offered that organizational culture reflected what is done and how and reflected who is involved.

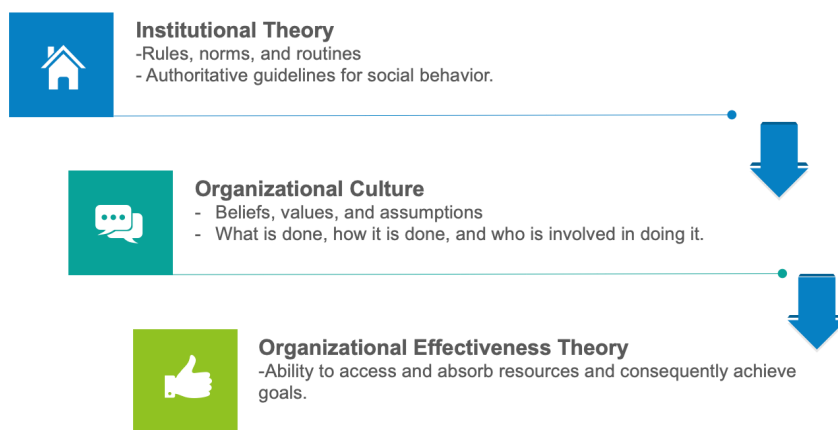
Cameron (1978) described organizational effectiveness as an organization's ability to access and absorb resources and achieve its aims. Tierney (1988) blamed the lack of understanding about organizational culture for the challenges that face higher education. Tierney further opined the goal of understanding organizational culture is to regulate cultural conflict and facilitate goal attainment. Wherein institutional theory establishes schemas, rules, norms, and routines as authoritative guidelines for social behavior, organizational effectiveness theory builds upon the organization's culture concerning decisions and actions by securing the resources to achieve organizational goals (Cameron, 1978; Scott, 2005; Tierney, 1988).

Cameron and Bilimoria (1985) differentiated the framework of organizational effectiveness from those of quality, efficiency, and excellence. Quality is defined as the absence of errors; efficiency is a ratio of inputs to outputs similar to cost-benefit analysis; and excellence

includes management ideologies such as long-term strategic planning, employee empowerment, leadership support, and a focus on customer needs. Bozeman (2000) declared the many concurrent processes involved in the tech transfer process make it challenging for students of tech transfer. Further, the impacts are usually difficult to separate from other parts of organizational life. Therefore, determining the meaning of tech transfer effectiveness proves daunting. Consequently, tech transfer effectiveness can span several purposes, including economic, political, and resource impacts (Bozeman, 2000).

Bozeman (2000) described how organizations participate in technology transfer reflexively or by a directive but lack any regard for the impacts of technology transfer. Despite these challenges, Bozeman posited the emphasis on effectiveness stimulates healthy controversy and serves as a reality check. However, Bozeman warned the researcher to remain vigilant to prevent distortion of results.

The terms “efficiency” and “effectiveness” were used interchangeably in tech transfer literature. For this study, I suggest efficiency studies are straightforward because they measure the productivity of the tech transfer activity based on available quantitative data. In contrast, effectiveness studies are nuanced and ambiguous as they touch on the activity's qualitative aspect. O'Keefe (1982) and Bozeman (1994) contended a lack of agreement on the conceptualization of tech transfer effectiveness is one obstacle to its study. Figure 5 illustrates the constructs of institutional theory, organizational culture, and organizational effectiveness theory.

Figure 5*Illustration of Theoretical Constructs*

Despite the difficulties and paradoxes associated with evaluating effectiveness in higher education, Cameron and Bilimoria (1985) concluded the debate on effectiveness will continue because there is an ongoing need to assess institutions' effectiveness. The extant literature categorizes different organizational effectiveness models, and I will briefly deliberate on four dominant categories.

The *Goal Approach* focuses on the output to measure operating objectives like profit, innovation, and product quality (Schermerhorn et al., 2004). This approach assumes a general agreement on specific goals. It is suitable for evaluating an organization's effectiveness when an accurate and precise measurement of the results exists (Altschuld & Zheng, 1995). Cameron and Bilimoria (1985) argued the usefulness of the goal approach is limited for most universities by its reliance on measurable, time-bound goals. DiMaggio and Powell (1983) observed universities have ambiguous technologies and hard to define goals; they engage in activities like teaching that are difficult to characterize, replicate, and produce outputs like educated students whose quality is difficult to determine.

The *System Resource Approach* explains organizational effectiveness as obtaining necessary resources from the organization's environments (Schermerhorn et al., 2004). Cameron (1981) demonstrated the system resource approach could be practical when a strong relationship exists between an organization's resources and its goods or services. Further, this approach is appropriate when there is a clear connection between the resources received and the institution's primary task. The desired results must be identified to determine which resources are needed to attain them (Cameron & Bilimoria, 1985).

The *Process Approach* encapsulates the transformation process by correlating the resources used to generate the services provided or goods produced (Schermerhorn et al., 2004). Cameron (1981) stipulated the flow of information is on a horizontal and vertical basis. This higher education approach aims to fulfill the objectives by providing timely and sufficient information to students and faculty.

The *Strategic Constituency Approach*, also known as the *Stakeholder Approach*, covers the organization's impact on the main stakeholders and their interests (Schermerhorn et al., 2004). The strategic constituency is defined as the people connected to the organization in different capacities, including the customers or users, the resource providers, the organizational output facilitators, and other supporters and dependents (Cameron, 1981). Based on this approach, effectiveness is measured by the organization's strategic constituencies' minimal satisfaction (Cameron, 1981).

Justification for Selecting the Strategic Constituency Approach

The summary of dominant organizational effectiveness models provides a high-level view of organizational effectiveness theory while being mindful that the sector evolves, and new approaches and models are frequently proposed. The extant literature unequivocally identifies

the goal approach and the system resource approach as quantitative by design, emphasizing measures and metrics (Cameron, 1981; Schermerhorn et al., 2004). The use of quantitative input and output measures of effectiveness will not reveal the entire performance story because new thoughts and discoveries cannot be observed (Altschuld & Zheng, 1995).

The process approach and strategic constituency approach offer nuance and qualitative assessment capacity (Altschuld & Zheng, 1995; Cameron, 1981; Schermerhorn et al., 2004). The process approach, with its emphasis on information flows, was insufficient for this study. It was imperative to select an organizational effectiveness approach that was entirely aligned with the study's research methodology and specifically suitable for a grounding in primary qualitative research. The strategic constituency approach was ideal for this study as it emphasizes social references and indicates the extent to which stakeholder needs are satisfied.

Dalton and Dalton (1998) explained the strategic constituency approach is helpful in academic and research environments where cost-benefit relations are not easily defined. Furthermore, the strategic constituencies approach directs attention to defining the goals and expectations of relevant internal reference groups and taking effective action to ensure their attainment (Dalton & Dalton, 1998). Cameron (1978) stated the organization's significant decision makers or the dominant coalition should be the sources of organizational effectiveness criteria. The dominant coalition is the most likely group to specify the cause-and-effect relationships in an organization and the preferred hierarchy of outcomes. Furthermore, a consensus among members of the dominant coalition can be employed as a vehicle for obtaining data on effectiveness (Cameron, 1978).

According to Rogers et al. (2000), university tech transfer stakeholders are faculty inventors, the TTO, and firms. The dominant coalition is assumed to know each administrative

aspect under investigation at the institutional level (Cameron, 1978). Altschuld and Zheng (1995) suggested the satisfaction of constituent groups indicates an organization's effectiveness. The strategic constituency approach is vital for its reliance on concepts of social responsibility and external legitimacy, which provide a means of determining the extent to which stakeholder groups have their needs satisfied (Altschuld & Zheng, 1995). Dalton and Dalton (1988) suggested the stakeholder approach possesses the additional benefit of the social responsibility concept. In an era of shrinking governmental resources for university research, evaluating how responsive an organization is to society and the accountability of research activities and outcomes regarding public expectations is useful (Dalton & Dalton, 1988).

Limitations of Organizational Effectiveness Theory

Altschuld and Zheng (1995) argued a lack of standard measurement can be applied to all universities and suggested there should be an understanding and integration of the organization's essential characteristics into the evaluation framework. Altschuld and Zheng warned people may hold varying meanings of the term *effectiveness*. As the extant literature does not present a unified perspective of what effectiveness is and how it should be identified, this study approached organizational effectiveness as an overall description of the state of affairs rather than a measurement, and I maintained flexibility in recognizing the context of each stakeholder.

Weiss (1983) noted stakeholders may not be objective observers because there is a risk that some may want data to validate their positions. It may be difficult to identify hidden agendas because stakeholders may judge a program's effectiveness mainly from their expectations, thereby providing subjective verdicts (Weiss, 1983). Inversely, institutions can ignore specific strategic constituencies' demands and survive quite well (Cameron & Bilimoria, 1985). Despite these limitations, Altschuld and Zheng (1995) determined the strategic constituency approach is

more effective for research organizations that lack easily defined cost-benefit indicators. Cameron (1978) recommended a limited domain of effectiveness be specified; thus, organizational effectiveness in this study was measured by the stakeholders' satisfaction with institutional characteristics relating to patenting and licensing activities, including the boundary-spanning activities of TTOs vis-à-vis the stakeholders and industry.

CHAPTER 4

METHODOLOGY

This dissertation was a basic qualitative study that sought to explain how TTOs can be better structured to facilitate faculty engagement and success. The perceptions faculty hold of their institutional TTOs are critical in determining faculty willingness to engage in tech transfer. Therefore, this study aimed to address a gap in the literature relating to faculty perceptions of the role, effectiveness, and success of their institutional TTO. As established in Chapter 1, this study examined the perceptions of U.S. faculty engaged in high-level scientific research endeavors.

The literature review noted previous studies relating to the evaluation of TTO performance were focused on quantitative measurements of outputs. This qualitative assessment considered the subtleties and nuances of faculty perceptions. The overarching research question that guided this study was: How do faculty who are engaged in high-level scientific research endeavors articulate their perceptions of their institutional TTO? Specific subquestions included:

1. How do faculty define the role of their institutional TTO?
2. How do faculty describe the overall effectiveness of their TTO and evaluate TTO success?

In this chapter, I form the basis for my research design and the rationale for my sample selection. This is followed by a discussion on the processes by which I collected the data, analyzed the data, and attended to issues of validity and reliability as they related to my findings. The chapter concludes by discussing the biases and assumptions inherent in this study and the limitations of the study's findings.

Study Design

In situations where the topic of study does not have a single objective answer, qualitative methods offer utility. Creswell and Creswell (2018) suggested if truth is considered socially constructed and subjective, using a qualitative approach is justified. Creswell and Creswell further argue that multiple realities can exist including those of the researcher, individuals under investigation, and the reader or audience interpreting the study. Basic qualitative research includes understanding how people make sense of their lives and experiences (Merriam & Tisdell, 2016). Researchers who subscribe to this theory believe that human behavior cannot be understood in the context of natural science laws and that people create and associate their subjective meanings as they interact with the broader world (Merriam & Tisdell, 2016).

Miles et al. (2020) suggested the very nature of the conversational style of qualitative methods brings the researcher directly in touch with participants and provides a means of getting beneath the surface of attitudes and behaviors, leading to a depth of understanding of issues in the study context. According to Miles et al., words often prove far more convincing to a reader than pages of summarized numbers. Qualitative methods do not attempt to measure, count, or classify; instead, they try to capture the whole nature of social reality through descriptive analysis that focuses on the details and meanings of people's words and actions. Therefore, qualitative research is usually informal and semistructured, allowing people to contribute and share their views in a conversational and friendly format.

Although a broadly distributed survey might obtain some faculty perceptions, such a method would be incapable of capturing the nuance for each perspective. It would fail to elicit new thoughts and themes. The study's research questions pursued an understanding of how faculty define their TTO, the justifications and motivations for engaging in tech transfer, the

policies and factors that influence faculty relationship with the TTO, and an exploration of what a successful TTO looks like. Given these considerations, in-depth, individual interviews with selected participants using a semistructured, open-ended protocol were considered the most appropriate method for this study to gather rich contextual information. This methodological approach is consistent with Pérez-Nordtvedt et al. (2008), who suggested studies on tech transfer need to move beyond quantitative survey measures to fully capture the richness and social context of the tech transfer process.

The interview protocol allowed me to cover particular questions and have purposeful conversations; yet, the study did not intend to explore participants' experience in an ethnography. I established the interview protocol's validity through a review by a panel of four experts comprised of faculty who engage in applied research. I solicited two of the four experts to study and suggest revisions to the interview protocol to ensure that it would produce comprehensive responses to answer the research questions. This led to several iterations of the protocol to address feedback on omitted items or unclearly stated questions.

Furthermore, I piloted the interview protocol with the other two experts in the panel, both in the physical sciences and engineering domain. Thus, there was a differentiation between the experts consulted on the interview protocol draft and those who participated in mock interviews. These mock interviews helped gauge the effectiveness of the interview protocol in eliciting the desired information. I quickly learned the number of questions I initially prepared would be challenging to complete in my initial estimate of 30-minute interviews. I also learned from the mock interviews that a handful of questions elicited deep contextual responses, rendering other questions repetitive. I then calibrated the interview protocol and increased my planned interview

session to 45 minutes per participant. I envisioned that the planned session was long enough to obtain great insights but not too long to be a burden to the study participants.

During the study, I resided in Saudi Arabia while the participants were spread across the United States; thus, conducting the interviews remotely was a practical decision to circumvent logistical challenges. These logistical challenges were exacerbated by the COVID-19 global pandemic, which further hampered my ability to travel. Musselwhite et al. (2006) described several advantages of telephonic data collection, including using human resources efficiently, widening the net the researcher may cast for participants, facilitating efficient data collection, and taking detailed notes of an interview without making participants feel uncomfortable. In addition to this, Brannen (1988) observed participants will have less fear and will be more truthful if they conclude that there is little chance of future interactions with the interviewer after completing the research.

Sample Selection

Fundamentally, this study focused on faculty engaged in applied scientific research projects, commonly the engineering departments and life sciences departments, who were likely to produce new intellectual property. I defined the target population as faculty employed in research universities in the United States who are actively involved in scientific research and have had an engagement with their TTO concerning an invention. The criteria for selecting faculty were intrinsically tied to transforming scientific research from university labs into patentable technologies. All participants had an ongoing relationship with their institutional TTO or had previously engaged with TTO on patent matters. Although the study collected primary participant data such as faculty rank, date PhD was awarded, and other factors, the study itself was not designed to stratify faculty by tenured faculty, race, or gender.

In addition to the individual participant profile, the institution type was embedded in the criteria. The faculty selected for this study were employed at institutions with active tech transfer programs, and those institutions participate in the annual Association of University Technology Managers (AUTM) survey. AUTM has surveyed its members since 1991 on various tech transfer processes, and these survey results are the primary source of data used to gauge university tech transfer activity. Although this is a qualitative study, having AUTM data available allowed me to traverse faculty perceptions of their TTO and the publicly reported university metrics and rankings.

Participant Selection Process

I asked for help from faculty at my workplace, some of whom I have known for many years. This network supported me by personally introducing me to their friends and colleagues across the United States that met the target population profile. The reason for relying on personal introductions was to circumvent the usual unresponsiveness to requests for participation in a research study. Having a private introduction vastly improved my odds of involvement compared to contacting the target population directly, with no influence. In qualitative research, scholars typically use purposive sampling because they are likely to produce contextually rich and relevant data sets and fit well with the topic studied (Denscombe, 2003).

Scientific discipline is an essential variable for faculty engagement with businesses because applied research fields, such as engineering, make tech transfer activities more likely (Bekkers & Bodas Freitas, 2008; Boardman, 2009; Ponomariov, 2008). Faculty in multiple disciplines are well positioned to recognize and act upon innovation opportunities (Shane, 2000). The faculty's affiliation with unique entities in their universities, such as multidisciplinary science centers, positively influences industrial engagement (Bozeman & Gaughan, 2007). For

all of these reasons, my primary strategy was speaking to faculty who possessed these qualities at my institution and requesting a link to their collaborators and colleagues in the United States that had similar attributes. At the time of this study, I was fortunate to be employed at a well-funded research institution, working with reputable faculty who possess a global outlook.

I was honored by the scale of participation that I received. In response to my appeal, some faculty contacted a single colleague in the United States, others contacted several colleagues. Guest et al. (2006) found saturation often occurs around 12 participants in homogeneous groups. The researcher reaches saturation when subsequent interviews or observations no longer generate new learning. I aimed for a minimum of 12 participants to achieve saturation based on the literature in qualitative research. Further, Crouch and McKenzie (2006) proposed fewer than 20 participants in a qualitative study help researchers build and maintain a close relationship and improve information exchange.

The faculty I solicited for assistance (my supporters) sent out a total of 24 email requests to their colleagues, kindly requesting the recipients participate in my study. Some potential participants were engaged in exciting research projects but had no interaction with their institutional TTO. Out of these 24 email requests, my follow-up resulted in 18 scheduled interviews. I believe the study was enriched by focusing on faculty who had experiences with TTO that could be described and critiqued. Following the introductory email from my supporters to potential study participants, I responded with a brief statement of appreciation for the introduction. I stated I would contact the potential study participants directly. Afterward, I emailed the potential study participants a formal introductory letter and attached a study consent letter for their perusal. The Introductory Letter for Interview Participants and the Study Consent Letter are included in Appendix C and D. Once the participant offered consent, the next step was

to schedule the interview. The notice of exemption from my Institutional Review Board is included in Appendix B.

Data Collection

As described in the Study Design section, the data collection method employed for this study was interviewing. The semistructured interviews revolved around an interview guide, which allowed for consistency in data collection while also leaving room to deviate from the protocol. The open-ended questions allowed flexibility to have purposeful probing conversations about the emergent themes (Alvesson & Skoldberg, 2000; Denscombe, 2003). See Appendix A for the Interview Protocol.

The interview protocol was purposefully designed to allow participants to broadly describe their relationship with the TTO and elaborate on interactions with TTO personnel, specifically the varied skill sets they encounter. Additionally, interviews were designed to elicit and assess TTO policies and the impact on the participants' desire to engage in tech transfer. All interviews were conducted via Zoom and digitally recorded and transcribed via Zoom. Participants were gracious with their time amid a pandemic and I was mindful of my privilege and good fortune to gain this level of participation. Therefore, each interview session was strictly capped at 45 minutes.

Zoom transcriptions contain distortions based on speech patterns, and interview questions were often clustered with the participant responses. As such, the raw interview transcript required editing to arrive at a document that could be read easily. I decided to clean the raw Zoom transcript to an acceptable standard rather than hire a transcription service to convert audio recordings to transcripts. There were two reasons for this decision; firstly, as a fledgling researcher with no prior experience with such services, I was uncomfortable with making a

random selection of providers and taking risks on the quality of work. Secondly, I believed the exercise of cleansing transcript files would bring me closer to the content and allow for an immersion in the themes emerging from the interviews. Lastly, this allowed for greater data security as Zoom recordings of interviews, raw transcripts, and cleansed finalized transcripts were never sent to anyone.

Data Analysis

The analysis of the qualitative semistructured interviews followed the recommended steps in the existing literature: summarizing the data to become familiar with it, coding the data, presenting, and drawing conclusions (Miles et al., 2020). This process primarily included the coding of individual interview data to identify significant themes and categories. For this purpose, I used MAXQDA, a qualitative data analysis software application, to manage and separate the data according to various types. It was also used for coding, cross-checking, and searching the interview data. Using a qualitative data analysis software application to support the qualitative interview data enhanced my data analysis process's efficiency.

Interview transcripts were uploaded into MAXQDA where I proceeded to apply inductive coding in which descriptive codes were developed as data were analyzed. I conducted two cycles of coding as recommended by Miles et al. (2020). I applied codes to chunks of content in the first coding cycle, followed by a second cycle that used pattern codes to group initial codes into broader themes. The coding process was based on research questions, theoretical framework, and literature review to structure my understanding of the more significant meaning of data. The MAXQDA application is versatile and allowed for maintaining a codebook with definitions, drafting memos on themes identified from the data, unexpected observations, and decisions regarding the data.

Validity and Reliability

Creswell and Creswell (2018) suggested validity in qualitative research is demonstrated by the researcher's efforts to ensure the accuracy of the study's findings. Given the multiple sources of evidence gathered via interviews, I established and adhered to an interview protocol, guaranteeing a consistent and comprehensive raw data capture by using MAZQDA as a data management platform. I also maintained consistency with code definitions and used memos to track my decisions. Therefore, I am confident that future researchers would arrive at the same conclusions met in this study and comprehend how the conclusions were drawn.

Bias, Assumptions, and Limitations

I am aware that a researcher's experiences, thoughts, and opinions can influence qualitative research findings. Therefore, a researcher needs to identify bias and mitigate the impact of that bias on the study's results. My training, work experiences, and internationalization intensified my interest in tech transfer. My experience influences this study's concept as director of operations for an academic division at an elite research institution in Saudi Arabia. The institution is considered among the global top ten, when quality and productivity (citations per faculty) is measured. Saudi Arabia is increasingly devoting financial resources to scientific research ecosystems with the explicit goal of innovation and economic development.

My position enabled me to develop a professional relationship with faculty engaged in translating their research activities into technologies useful to the industry. I have observed some of the immense challenges and frustrations of faculty as they interface with our institutional TTO. This experience inspired my dissertation to explore faculty perceptions of TTOs. There is undoubtedly a self-interest in the design of my research project. I hope to illuminate findings that can aid my work and support my interactions with faculty. I am a proponent of university tech

transfer and economic development in general, and consequently, there is an innate bias toward the topic under study. As such, I remained consciously aware throughout the process, sought to interpret results unbiased, and consistently checked for alternative explanations.

Throughout the study, I assumed the study participants were forthright and honest in their responses and clearly understood the study's objectives. This study focused on the patenting and licensing of technologies, with attention to the boundary spanning activities of TTOs vis-à-vis faculty and industry. Interview questions were crafted with this emphasis in mind and the discussions were moderated accordingly. Therefore, this study did not investigate start-up formation, venture capital activities, partnerships with industry, or other functions that the TTO might offer. As the interviewer, I strived to maintain the conversation around the core TTO function of patenting and licensing technologies.

CHAPTER 5

FINDINGS

Overview of the Findings Chapter

This chapter summarizes my observations from interviewing a select group of high-achieving faculty engaged in scientific research and technology transfer. For this study, a TTO was defined as any university or university foundation unit responsible for obtaining patent protection for university inventions and licensing the patented inventions. It has been my privilege to inquire: How do faculty who are engaged in high-level scientific research endeavors articulate their perceptions of their institutional TTO? Specific subquestions included:

1. How do faculty define the role of their institutional TTO?
2. How do faculty describe the overall effectiveness of their TTO and evaluate TTO success?

To address the overarching question of how faculty perceptions of TTOs are framed, I deployed qualitative methods to obtain various opinions and commentary from the study participants. I reviewed and analyzed topic themes from these discussions, and I now present several findings, to which I offer some recommendations in the conclusion chapter. The results and recommendations address the study's objectives of forming a basis for evaluating the effectiveness of TTOs and understanding how they can be organized to facilitate faculty engagement and success.

Technology transfer is often described as a linear process where scientific research is performed, inventions are disclosed, patents are granted, licenses are executed, and income is earned. However, the participants in this study revealed the process of technology transfer is

much more complex. As I interviewed this esteemed group of faculty, I learned how TTO structures interact with faculty member's jobs, help them, torment them, support them, frustrate them, and impact them positively and negatively in many more ways.

This business of identifying suitable technologies to patent and finding companies willing to make the high-risk investment in early stage university inventions is never going to be easy. In addition to this, there are tremendous resource inadequacies, which lead to TTOs being in unenviable positions. Limited budgets can only patent limited discoveries; faculty are bound to be frustrated. The technology transfer process has varying goals, knowledge, and skills whereas faculty perceptions vary based on their individual experiences. The recommendations found in this section follow commonalities extracted from interviews to offer structural guidance.

To present findings and recommendations that are useful I began with a literature review on TTOs and institutional structures. The literature review was absolute whereby I confirmed the scale of university resources drives the rate of patent and licensing activities in university technology transfer. Furthermore, although the literature identified most TTOs as understaffed and inadequately resourced, researchers and authors often recommended the solution for universities was to increase budgetary allocations to TTOs.

I find it unlikely that the TTOs already facing shrinking budgets will secure substantial increases in budget allocations from university finances. Therefore, I hope to draw a line wherein my observations, findings, and recommendations consider the wide-ranging university resources and capabilities. To this end, I devised a conceptualization of usefulness for implementing the thesis recommendations across a wide array of university types due to my knowledge that specific recommendations can have varying responses across a diverse range of universities.

I will consider that most universities are burdened by TTO expenses and refrain from making blanket recommendations to expand TTO budgets. Despite acknowledging resource limitations, this study aspires to eliminate some of these challenges and support the conversion of more university research into products and economic development. Notwithstanding the variety in university resources and TTO capabilities, this study was approached with the conceptual framework that the goal of a university TTO is to facilitate the transfer of innovations into the public domain and to benefit society.

Faculty Profile

In Chapter 4, I identified faculty as the key strategic constituency for TTOs and aimed to illustrate the extent to which stakeholder needs are satisfied. In summary, the study's findings represent a codification of the faculty's general state of affairs. Faculty selected for this study possessed a wide range of doctoral, training, and research expertise. The cohort was predominantly comprised of full professors at their respective institutions, with only two participants ranked as associate professors. The faculty participants interest in tech transfer varied from disinterested to highly interested, and their experience with the patenting and licensing of inventions varied from the amateur to the highly experienced.

By measurement of the year when the participant earned a PhD, the depth of experience ranged from a high of 51 years to a low of 11 years. To demonstrate the notable scientific accomplishments of the cohort, I used Google Scholar to extract the publishing records measured by the number of academic papers and the number of citations. The faculty profile is displayed in Table 1. It includes a Yes (Y) or No (N) determination if the participant has at least one patent granted as the lead inventor and a secondary decision if one invention has been licensed.

All participants had at least one patent successfully filed as the lead inventor (a range of 1 to 50 provisional patents). Eleven of the 18 participants had experienced licensing at least one invention to industry. To maintain anonymity, I withheld data sets for the year the PhD was earned and faculty rank. Additionally, I rounded the number of academic papers to the closest hundred and citations to the nearest thousand. I present a high-level summary of participant background information to demonstrate alignment with sample selection methodology.

Table 1

Profile of Faculty Participants

Profile of Faculty Participants						
No.	Participant Pseudonym	Program of PhD Degree	Academic Papers	Citations	Patent	License
1	Charles Macauley	Chemical Engineering	900	46,000	Y	Y
2	Andrei Mayo	Physics	100	6,000	Y	N
3	Kevin Mattias	Chemistry	2,300	160,000	Y	Y
4	William Hart	Mechanical Engineering	100	1,000	Y	N
5	Mohamed Hisham	Chemistry	800	41,000	Y	Y
6	George Calvin	Organic Chemistry	300	32,000	Y	Y
7	Pascal Thomas	Physics	200	2,000	Y	N
8	Randy Freeman	Chemistry	200	3,000	Y	Y
9	Claire Tasapoulo	Plant Biology	200	10,000	Y	N
10	Kim Noor	Biomedical Sciences	100	3,000	Y	Y
11	Mansoor Qureshi	Materials Science	500	6,000	Y	Y
12	Larry Becht	Chemistry	1,000	37,000	Y	Y
13	Lee Zuckerman	Polymer Science	200	11,000	Y	Y
14	Stephen Wang	Mechanical Engineering	200	5,000	Y	N
15	Sudipta Kaviraj	Polymer Science	400	17,000	Y	Y
16	Charles Ling	Polymer Science	200	11,000	Y	N
17	Bakari Camara	Mechanical Engineering	400	6,000	Y	N
18	Veera Ramanathan	Chemical Engineering	400	3,000	Y	Y

The benchmarks for success in academia are different from the business world. As a result of this, faculty described the process of acquiring competence in patent filing procedures and managing the accompanying administrative burden as critical barriers to success. In addition to internal procedures, faculty also have to respond to challenges from patent attorneys concerning the prior art. Faculty participants frequently described the documenting of the prior art as the most grueling piece of the patent filing process.

In this study, every TTO retained patent attorneys to draft its patent applications. The faculty described a very labor-intensive process and cautioned it must be conducted with professionalism and sensitivity. Typically, the TTO officer arranges for the faculty to meet with the attorney to explain the invention and supply other information. Many university contracted patent attorneys have a technical background: bachelor's or master's degrees in STEM (i.e., science, technology, engineering, and math) disciplines and can understand scientific concepts, but they are not experts in the field. They need a full explanation of the invention, how it is made and used, and how it uniquely solves a problem.

Interviewees commonly described using content from draft manuscripts or abstracts to provide background to frame the innovation's significance on the invention disclosure forms. For faculty at well-funded institutions, their TTOs generally filed a provisional patent unless there appeared to be no commercial potential for the technology or if it is not patentable. It offers the faculty the freedom to publish and provides the university a year to gather data for a more formal, nonprovisional patent. It also allows a window of opportunity for the TTO to market the invention to industry, with the idea of inking licensing agreements that could cover nonprovisional patent filing costs.

The faculty participants explained, with time and experience, they gained expertise in the invention disclosure and patenting processes. This study was enriched by participants who have been at their respective institutions for decades and served as the inaugural cases for their TTO licensing activities. Their recollection of the fledgling TTO and the evolution into its current form was informative and often depicted a steep learning curve overcome with a concerted effort and commitment over decades.

University and TTO Profile

Fifteen unique institutions employed the 18 participants in the study. There were two faculty participants in 3 of the 15 universities each, giving the total participants of 18. The faculty were not informed of any other participants in their institution, and each participant was guaranteed anonymity as an individual and for the institution. While the institutions represented varied, public universities accounted for 14 participants. Of the public institutions, half were public land grant universities.

The universities cut across a swathe of the United States, with the Midwest and Northeast represented by five participants each, closely followed by the Southeast with four participants, the Southwest with three participants, and lastly, one participant on the West Coast. As one would expect from the study design methods, 16 of the 18 participants represented institutions that are designated *R1 – Doctoral Universities: Very High Research Activity* in the Carnegie classification scheme. As shown in Table 1, the Carnegie classification aligned positively with Hermanowicz’s classification scheme; R1 represents Elites, and R2 represents Pluralists.

Lastly, the research prowess of the institutions in this study was illustrated by the half of the study participants representing universities that are members of the prestigious American Association of Universities (AAU). I withheld the data set for AAU membership to maintain institutional anonymity and presented a broad overview of the institutions covered in this study.

Table 2*Profile of the Universities*

Profile of the Universities					
No.	Participant Pseudonym	Institution Control	US Region	Carnegie Classification	Hermanowicz Classification
1	Charles Macauley	Public	Midwest	R1	Elites
2	Andrei Mayo	Public	Southwest	R1	Elites
3	Kevin Mattias	Private	Northeast	R1	Elites
4	William Hart	Public	Midwest	R2	Pluralists
5	Mohamed Hisham	Public	Midwest	R1	Elites
6	George Calvin	Public	Northeast	R1	Elites
7	Pascal Thomas	Public	West	R1	Elites
8	Randy Freeman	Public	Northeast	R2	Pluralists
9	Claire Tasapoulo	Public	Southeast	R1	Elites
10	Kim Noor	Public	Southeast	R1	Elites
11	Mansoor Qureshi	Public	Southwest	R1	Elites
12	Larry Becht	Public	Southwest	R1	Elites
13	Lee Zuckerman	Private	Midwest	R1	Elites
14	Stephen Wang	Public	Southeast	R1	Elites
15	Sudipta Kaviraj	Public	Southeast	R1	Elites
16	Charles Ling	Private	Northeast	R1	Elites
17	Bakari Camara	Public	Northeast	R1	Elites
18	Veera Ramanathan	Public	Midwest	R1	Elites

As described in the introduction for this chapter, it would be expected a large research university that attracts substantial funding would achieve larger patenting and licensing outcomes relative to a university with lesser resources. Scale is vital in assessing the impact of research universities; however, quantitative outcome measures are insufficient to address TTO efficiency as perceived by faculty. Therefore, in evaluating TTOs, a primary consideration was to determine the appropriate balance between absolute and relative measures of success.

To support my interviews with faculty candidates, I researched their respective TTO organizations, emphasizing TTO policy, personnel, and public filings and rankings. One objective of this pre-interview research was to form a foundation of the scale of TTO capabilities and resources, which would aid my interviewing. I devised a codification of the TTO size based on a count of the staff listed on the official TTO website. However, I first had to define which personnel to count. I achieved this by outlining a roster of job titles relevant to patent and

licensing activities. I searched through the TTO staff lists to extract job titles containing a variant of the following key terms: IP, patent, licensing, technology, and innovation. Table 3 illustrates the outline of TTO job titles selected in my count of TTO staff.

Table 3

Classification of TTO Job Titles

IP / Patent
IP Officer
IP Manager
IP Marketing Analyst
IP Marketing Officer
Patent Specialist
Licensing
Senior Licensing Manager
Senior Technology Licensing Specialist
Technology Licensing Specialist
Technology Licensing Officer
Licensing Officer
Licensing Analyst
Licensing Associate
Technology / Innovation
Technology Strategy Manager
Technology Portfolio Manager
Technology Manager
Technology Analyst
Innovation Fellow

Using the classification of TTO job titles enabled the codification of TTO size, as demonstrated in Table 4. Smaller TTO offices are likely to do more harm than good through suboptimal licensing practices and aggressive patenting, which quickly consumes limited resources (Greenbaum & Scott, 2010). The TTOs in this study were predominantly large or full-sized staff, with 12 of the 18 TTOs, coded Tier 1 or Tier 2. The codification of TTO size is illustrated in Table 4.

Table 4*Codification of TTO Size*

Description	Label	Code
Staff count above ten	Large-sized staff	Tier 1
Staff count between five and ten	Full-sized staff	Tier 2
Staff count less than five	Small-sized staff	Tier 3

Following the identification and counting of relevant TTO staff, I developed a high-level evaluation of the skills and experiences possessed by the TTO staff. I started with the individual staff profiles on TTO websites that often described the responsibilities, qualifications, and achievements of TTO Staff. A sample of TTO staff profiles from various institutions are included in Table 5 with the individual names anonymized as “X” and institution name or TTO anonymized with “Y.” I shortened descriptions to ensure that a Google search of the sample staff profile did not land on the respective institution or TTO website.

Table 5*Sample of TTO Staff Profiles*

Sample TTO Staff Profiles	
1	As a Licensing Officer, X is responsible for managing a portfolio of Y intellectual property, reviewing invention disclosures for patentability and commercial potential, securing patent rights, marketing technologies to industry, facilitating the commercialization of Y technologies for the public benefit, negotiating and drafting license and inter-institutional agreements, and guiding faculty and students through the patenting and commercialization process.
2	X serves as a Technology Analyst in the Office of Technology Commercialization at Y. In this role, X works with technologies in the oil and gas space where she evaluates commercial opportunities for university inventions, oversees patent prosecution using outside counsel, market tech, negotiates intellectual property licenses.
3	X has a Ph.D. in Biochemistry with over 18 years of research experience. She has multiple research publications and is a registered USPTO patent agent. Prior to joining the Y, she was a research associate at the Department of Neuroscience at Y.
4	X serves as Technology Licensing Specialist for Physical Sciences in the Office of Technology Commercialization at the Y. In this role, X conducts market research to identify companies that may have a need for advanced technologies disclosed to Y. Her responsibilities also include the commercial assessment of the University’s inventions and the identification of market opportunities.
5	X Ph.D., serves as Senior Technology Licensing Specialist for Y. In this role, X is responsible for working with faculty members to manage their intellectual property portfolios by evaluating the commercial potential of inventions, marketing technologies to prospective licensees, negotiating IP licenses, and enabling startup formation.

I supplemented and corroborated the staff profiles described on TTO websites using LinkedIn, a professional networking online service. The LinkedIn platform served as an excellent resource for confirming educational qualifications and work experiences. To complete this exercise, I devised a three-tiered coding mechanism to summarize the TTO staff profiles.

Profile 1 code designates TTOs staffed with predominantly PhD's in STEM disciplines, or a combination of scientific qualification at the undergraduate and the graduate level, combined with degrees in law or business. Profile 1 code also includes staff with relevant work experience in industry, and the assignment of licensing portfolio is aligned with the scientific training or experience of the respective personnel. This typology of Profile 1 is based on the multiple pieces of literature which advocate for a diverse range of skill sets and division of labor in TTOs, and the alignment of those skillsets with innovations. Profile 1 represents the top of the scale along the dimension of how professionalized and experienced the TTO staff are, and effectively, the TTO staff capabilities in the patenting and licensing functions. In Profile 1, I noted a few instances wherein TTO staff were inventors and held patents. Profile 2 and Profile 3 codes represent the sliding scale of capabilities as denoted in Table 6.

Table 6*Codification of TTO Staff Profile*

Code	TTO Staff Profile	Label
Profile 1	Predominantly PhD in STEM disciplines, bachelors or masters in STEM disciplines plus law (JD) or MBA degrees.	Strong Capabilities
	Work experience with industry in technical capacity or business development.	
	TTO staff assigned licensing portfolio aligned with their scientific training or industrial background.	
Profile 2	Limited number of TTO staff with relevant scientific or industrial experience.	Moderate Capabilities
Profile 3	Staff generally lack scientific grounding or industrial experience. Often university administrators, or university counsel transitioned into tech transfer function.	Weak Capabilities

I reviewed the online organizational charts for the TTOs to determine reporting structures and IP ownership. In all but two of the universities represented, the ownership follows a traditional model wherein the TTO reports to a Vice President or Vice Provost of Research and the IP is owned directly by the university. The TTOs are formal administrative units serving the university. The two institutions that were exceptions to this are governed by the same university system and follow a model wherein a nonprofit foundation linked to the university owns all intellectual property.

In cases wherein the TTO operates in a nonprofit foundation, the reporting line remains the VP of Research or equivalent. The nonprofit status facilitates ownership of IP in a separate entity. As such, the foundation serves as a contracting entity for all sponsored research and the assignee on all intellectual property, while the TTO manages the invention portfolio in a manner typical to the traditional TTOs. I could not find any correlation between the structure of IP ownership and any faculty perceptions conveyed. Similarly, I could not find any evidence that

the institution control (public vs. private) had any bearing on how faculty perceived the TTO. Specifically, I did not observe that the three private institutions included in this study possessed a TTO mission, structure, or procedures distinct from their public counterparts.

I continued with pre-interview activities by reviewing the TTO policies, procedures, and forms published on the TTO websites. Consistent with the literature review and confirming DiMaggio and Powell's (1983) concept of organizational homogenization, I found the published policies and procedures to be similar in design, structure, and content. As DiMaggio and Powell described, the uncertainty that encourages imitation leads organizations to model themselves closely to other organizations. I found the published policies, procedures, forms, and FAQs comprehensive in scope and detail in all but one case, which appeared bare. I found faculty participants were generally informed on TTO policy and displayed an understanding of procedures.

By combining my evaluation of TTO size and TTO staff capabilities, I approached the interviews with insight into the respective TTOs. I remained alert for any faculty explanations that appeared inconsistent with my analysis. Upon completion of interviews, I added the frequency of faculty interactions with TTO to add further context. Ten of the faculty participants described interactions with their TTO that I coded as "High Frequency," which denotes a literal high frequency of faculty engagement with a depth of interactions. This includes all forms of communications with TTO staff or patent attorneys. Conversely, "Low Frequency" encapsulates periodic communications with TTO, or at least a year has elapsed since the last engagement on patent matters. While maintaining anonymity in institutional profiles, I devised a high-level codification of the organizational profile of TTOs illustrated in Table 7.

Table 7*Organizational Profile of the TTOs*

Organizational Profile of the TTOs					
No.	Participant Pseudonym	TTO Staff Count	Label	TTO Staff Profile	Participant Interaction With TTO
1	Charles Macauley	16	Large-sized staff	Strong Capabilities	High frequency
2	Andrei Mayo	3	Small-sized staff	Moderate Capabilities	Low frequency
3	Kevin Mattias	7	Full-sized staff	Strong Capabilities	High frequency
4	William Hart	1	Small-sized staff	Weak Capabilities	Low frequency
5	Mohamed Hisham	16	Large-sized staff	Strong Capabilities	High frequency
6	George Calvin	11	Large-sized staff	Strong Capabilities	High frequency
7	Pascal Thomas	12	Large-sized staff	Strong Capabilities	Low frequency
8	Randy Freeman	2	Small-sized staff	Moderate Capabilities	High frequency
9	Claire Tasapoulo	5	Full-sized staff	Strong Capabilities	Low frequency
10	Kim Noor	5	Full-sized staff	Strong Capabilities	High frequency
11	Mansoor Qureshi	3	Small-sized staff	Moderate Capabilities	High frequency
12	Larry Becht	8	Full-sized staff	Strong Capabilities	High frequency
13	Lee Zuckerman	7	Full-sized staff	Strong Capabilities	Low frequency
14	Stephen Wang	2	Small-sized staff	Moderate Capabilities	Low frequency
15	Sudipta Kaviraj	5	Full-sized staff	Strong Capabilities	High frequency
16	Charles Ling	3	Small-sized staff	Moderate Capabilities	Low frequency
17	Bakari Camara	7	Full-sized staff	Strong Capabilities	Low frequency
18	Veera Ramanathan	15	Large-sized staff	Strong Capabilities	High frequency

The codification of TTO size is almost evenly distributed with faculty participants tiered with large, full, and small TTOs with a corresponding count of five, seven, and six participants, respectively. Swamidass and Vulasa's (2009) survey of TTOs found 72% of TTOs had a total staff count of three or fewer staff members. The codification of TTO staff generated 12 faculty participants linked to Profile 1 TTO organizations, which offered the most robust combination of talent and capabilities. This predominance of Profile 1 was unsurprising as it parallels the 16 participants representing R1, research-intensive institutions.

Developing an aggregate ranking of university technology transfer outcomes is fraught with challenges, and more so for a qualitative study. Nevertheless, an examination of metrics-based benchmarking offered by AUTM's Annual Licensing Activity Survey helped me assess the relative position of the TTO among its peers. Having AUTM data detailing patenting and licensing metrics provided an opportunity to triangulate this data set with faculty perceptions of

the TTO and the devised codification of TTO organizational profiles. This triangulation helped me identify instances wherein faculty explanations diverged from the compiled analytics and offered an opportunity to follow up with probing questions.

TTOs lack the resources to patent inventions but successful ones are well resourced (Gewin, 2005). The institutions in this study ranged from an annual research budget of \$100 million to well over \$1 billion. They converted faculty inventor disclosures to patents, at a rate of 18% up to above 100%. The number of invention disclosures as a percentage of the number of patent applications filed, meaning a single invention disclosure can generate multiple patents. Therefore, the computation can exceed 100%.

To maintain institutional anonymity, I converted key metrics reported in the 2019 AUTM Survey into broad ranges that cannot be traced to a single entity. One institution did not participate in the 2019 AUTM survey, which underscored the lowest organizational profile codified (Tier 3/small-sized staff, Profile 3/weak capabilities). Data for a second institution were not readily accessible as that institution is included in a consolidated reporting for a university system.

The codification of the 2019 AUTM Survey into broad ranges was sufficient for this study because the literature review already detailed the concentration of measurable outcomes in a small group of well-funded institutions. Thus, the code “Top 50 for license income” in Table 8 represents the institutions with the highest license income totaling \$2.7 billion or 93% of all university license income reported. Overall, the codification approach used in this study provided a layer of assurance as the codes were correlated positively. That is to say, Tier 1 and Tier 2 (large and full-size TTOs) correlate with Profile 1 staff coding and also correlate with coding for

top license income earners. Going forward, I will use the term “elite” to encapsulate this cohort of high-tiered institutions and “nonelite” for lower tiered institutions.

Table 8

Codification of 2019 AUTM Survey

AUTM 2019 Survey		
	Participant Pseudonym	TTO Survey Overview
1	Charles Macauley	Research budget above \$750M; 25% to 50% of disclosures filed. Top 50 for license income.
2	Andrei Mayo	Research budget below \$250M; 25% to 50% of disclosures filed.
3	Kevin Mattias	Research budget \$250M to \$500M; 25% to 50% of disclosures filed. Top 50 for license income.
4	William Hart	Unreported - No Data
5	Mohamed Hisham	Research budget above \$750M; 25% to 50% of disclosures filed. Top 50 for license income.
6	George Calvin	Research budget above \$750M; 25% to 50% of disclosures filed. Top 50 for license income.
7	Pascal Thomas	Research budget \$500M to \$750M; 25% to 50% of disclosures filed. Top 50 for license income.
8	Randy Freeman	University System Consolidated Reporting
9	Claire Tasapoulo	Research budget \$250M to \$500M; below 25% of disclosures filed. Top 50 for license income.
10	Kim Noor	Research budget \$250M to \$500M; below 25% of disclosures filed. Top 50 for license income.
11	Mansoor Qureshi	Research budget below \$250M; 25% to 50% of disclosures filed.
12	Larry Becht	Research budget \$500M to \$750M; 25% to 50% of disclosures filed. Top 50 for license income.
13	Lee Zuckerman	Research budget \$250M to \$500M; 50% to 75% of disclosures filed.
14	Stephen Wang	Research budget below \$250M; 75% to 100% of disclosures filed.
15	Sudipta Kaviraj	Research budget \$500M to \$750M; 100% of disclosures filed.
16	Charles Ling	Research budget below \$250M; 25% to 50% of disclosures filed.
17	Bakari Camara	Research budget \$250M to \$500M; 50% to 75% of disclosures filed.
18	Veera Ramanathan	Research budget above \$750M; 25% to 50% of disclosures filed. Top 50 for license income.

Framing Emerging Themes Into Findings

Previously in the data collection section in Chapter 4, I described conducting interviews via Zoom and personally editing the raw interview transcripts. Using Zoom allowed me to immerse fully in the interviews without concern of notetaking. In the same chapter, I also described using MAXQDA, a qualitative data analysis software application, to manage and analyze the collected data. Interview transcripts were uploaded into MAXQDA, and this digital format allowed for multiple types of searches across the data set to answer significant questions. Using MAXQDA reduced manual tasks, increased flexibility, and improved validity and auditability of this qualitative research.

In MAXQDA, I proceeded to apply descriptive codes based on key terms to structure my understanding of the transcript content. Miles et al. (2020) suggested the vast majority of qualitative analysis methods work with categories. Codes in MAXQDA have a hierarchical structure, meaning I created multiple codes, followed by subcodes. For this study, I used codes and subcodes derived from my interview protocol. For example, I used TTO Staff as a code, with subcodes for Staff Skill Sets, Staff Competency, and Frequency of Interaction. Another example is TTO Policies as a code, with subcodes including Invention Disclosure Procedures and Royalty Distribution Policy. MAXQDA offered agility in data retrieval as I coalesced on themes and queried what was said about a certain topic and by whom. Another strength of this application is the multiple ways to visualize data to show data connections in a comprehensible way. For example, the MAXQDA word cloud function scanned all 18 digital transcripts to generate a visual of the most common terms used across all interviews. The data visualization tools were helpful in confirming key themes and grouping the themes into associated findings. This alignment of themes led to five major findings summarized as follows:

- Faculty Motivations to Engage With TTOs
- Leveraging TTO Capabilities
- Considerations for Faculty Tenure and Recognition
- Fiscal Considerations, Royalties, and TTO Incentives
- The Evolution of TTOs

In reiterating the sample selection method described in Chapter 4, this study focused on faculty engaged in applied scientific research projects, who were likely to produce new intellectual property and have had an engagement with their TTO concerning an invention. As described in the faculty profile, all study participants had the experience of filing at least one

patent. This allowed for faculty to critique and evaluate the TTO based on their experiences. However, it also posed an inherent limitation of the study because the findings only represent a subset of faculty's attitudes toward TTOs. That is to say, because the sample is selected based on engagement (even though this may have been a single engagement that occurred years ago), the study does not posit on faculty who have never engaged with their TTO. This constituency of faculty who have never engaged with their TTO offers an opportunity I address in Directions for Future Research.

Faculty Motivations to Engage With TTOs

Claire Tasapoulo is unenthusiastic and perhaps disillusioned with tech transfer. She described the hard work involved in patent filings and found it hardly worthwhile. Consequently, she is now resigned to focusing on basic research. She described her current situation as enjoying doing research and making scientific contributions rather than pursuing tech transfer. Claire referred to the "whole suite of things" beyond her control in the patenting process and complained even with a great idea, the patenting process took too much effort and too much time:

And the patent examiners were almost all taught to just basically reject, reject, reject . . . finding any slight similarity of something else out there to turn down your claims, right? So . . . I guess I was a little bit put off by that in our last attempt.

Professor Tasapoulo holds a single patent, and it was apparent that the difficulties she encountered were discouraging. As we discussed further, Professor Tasapoulo questioned whether filing additional patents would create a significant impact or simply be decorative to her CV. She was doubtful whether she would be able to convert patents into usefulness in her

lifetime. Lastly, she conveyed the position of academic purists as described in the literature review and offered a current justification:

I feel like all the patentable discoveries all come from basic research, right? So, like the mRNA vaccines, the CRISPRs, those are perfect examples. Without fundamental research, there wouldn't be any vaccines that you can fast track. And in a few months, here in a pandemic, we have not one but multiple vaccines. And it wouldn't be possible without the previous basic research investment. So yeah, I don't think we will have any tech transfer operation without basic research.

Sudipta Kaviraj echoed Claire Tasapoulo's points on basic research but was motivated to engage with his TTO at a "High Frequency" and had succeeded in licensing some of his technologies. He offered the following dissection of faculty temperament:

If you don't do fundamental research, then applications-oriented research will only go so far. It's the fundamental research that will create true breakthroughs. And also, in terms of scientists and engineers, there are some engineers and scientists who are...you can say, temperamentally suited for doing fundamental research, while others are more driven or temperamentally suited for applications research. So, both the university and the government have to recognize that both are important, not just one.

Veera Ramanathan offered a different take on faculty motivations and emphasized faculty persistence can improve interactions with their TTO. He suggested faculty who have positive experiences with their TTOs tend to be inventors who routinely engage with the TTO office, and consequently, they learn over time how to make their case with the TTO:

Three years back, we had a different project, and I wanted to do this. And it took a lot of time. It took hours and hours to write down the statements that they wanted, things like

that. And it didn't go very far, okay. And I was thinking, "Oh, this seems like a hassle," and so on. But then, as you develop more and more projects, you get used to it . . . it's just like writing a proposal. You just get used to it, and then it's okay. It's just a different audience as well. And I think it depends on the personality of the faculty member to make use of that. So, first of all, I should have a large incentive to push through the TTO office, right? And if not, I'm going to complain about every small thing, and I'm going to quit, right?

Although the probing questions on faculty interactions with TTO form the basis of the study's findings, a single question unrelated to TTOs provided me with invaluable insight into faculty motivations. It led me to ask the faculty the following question: What do you associate with a "successful" career as a scientist? In varied responses, faculty described a desire to make a mark on their scientific domain, develop and nurture future scientists, tackle major global problems, and invent technologies to save lives, among other responses.

Some faculty noted their good fortune to have pursued a PhD under the supervision of a faculty inventor and traced their inspiration for pursuing patents to their doctoral training. Faculty were aligned in describing the ancillary benefits of a strong tech transfer effort in teaching students how research is translated into commercial products, preparing them for industry jobs. Charles Macauley, who had the longest career of all faculty participants that spanned five decades, was principally motivated to create opportunities for students. He explained as follows:

You know, for engineering students, even PhDs, at least 80% are going into industry. The PhDs in the engineering majors are all going to industry. You're training people going there, so you bet it's good if you work with industry.

Sudipta Kaviraj noted the success of his former students was a measure of his successful career and echoed points raised by Charles Macauley:

So, I'm happy that my students that have gone out to work for industry or academia or government labs . . . they are doing very well. They are leaders in their own right in various places. When people come back and tell me, "Hey, do you have more experience like that? We want to hire them," that is a measure of success.

Mohamed Hisham offered a comprehensive response to the question and offered a different take by linking his work to global problems around plastic materials:

I'm definitely driven by the more technological and applied aspects of my work and the idea that we can help the persistent plastics problem. I recognize as an academic that if you only define your success on the ability to translate into the market, you might be very unsuccessful because in the sense that it's difficult to do. But it is important to me that the elements of what I do in my laboratory can be, ultimately, in some way, beneficial to society.

The faculty responses to this line of questioning offered me an excellent opportunity to capture their perspective on scientific research and their level of enthusiasm for tech transfer. It led me to believe TTOs would also benefit from understanding the motivations of the faculty that they serve. Consequently, this would aid TTO's design and align their operations to enhance faculty engagement. The varied responses provide an illustration that faculty approach tech transfer with various desires and missions. And yet, none of the faculty participants could recall solicitation by their TTO to understand what stimulates or discourages their engagement with the TTO. It appears that TTOs have wrongly settled the principal stimulants are the faculty's desire to earn monetary rewards and to burnish their credentials.

For Randy Freeman, seeing a technology that was his invention save the lives of friends and loved ones was his ultimate measure of success. His biomedical device, inserted to open up blocked heart arteries, was successfully licensed and developed. On top of that success, his uncle and a faculty colleague had the technology inserted essentially saving their lives. He recalled his feeling of success:

I published probably 350 publications, so it's not minuscule. But I still value more success when one of my inventions turns into practice. Once you have 300 papers . . . so I write another 10 papers, who cares? Right? But I know that there is this fellow; he could have died if they didn't put my stent in him; that's a fantastic feeling.

And I always tell younger scientists, if you have to pick a research topic, why don't you research something that has some kind of potential to benefit society? Why research things that would never amount to anything? You can write a paper. So what? Relevant research, which leads to something, is not less interesting than irrelevant research, right? You can do good research, exciting research. You can publish exciting papers on things that actually will help society at large.

Throughout the interviews, there were varying motivations to engage with TTO, but not a single interviewee prioritized income generation as a stimulus. In my interview with Pascal Thomas, he added a metric to the possibility of making money through patents: "I think the emphasis on patents is slightly misplaced because the hit rate is so low, and I don't think it works that often. 0.01% of these patents make money. I mean, they just don't make money."

Based on his invention, Larry Becht's cofounded startup has gone through a series of mergers and acquisitions and is now part of a multi-billion-dollar entity. As he eyes retirement after an illustrious 40-year career, he recounted the early days when there was no guidance, no

supervision, and no support. The current situation is no longer of his liking; he lamented the ever-increasing bureaucracy:

The bureaucracy is out of control. I can't do anything without an NDA [nondisclosure agreement] or material transfer agreement. And I think faculty ultimately retire from science not because they don't like science but because the bureaucracy is ever increasing. And when you start, it's at a level. And so, the younger colleagues coming in, this is the life they know.

Professor Becht illustrated the real-world impact of income streams. He and his entire research group donate their patent license proceeds back to the lab and the department (although he noted he retains equity in the corporation that acquired his startup). I was impressed by his approach in using patent proceeds to advance the work of his research group. Professor Becht explained he had been diagnosed with cancer as a young man and spent much of his life fighting against that, and this experience defined his approach to giving back:

So, I'm very proud that I've never made a cent from any of these licenses or royalties. But generally, this goes to an unrestricted fund that can send students to conferences, pay for a postdoc, pay for a refrigerator, or whatever. So, it's not just emergency money, and we use it towards our latest technology . . . we prime the pump by using some of this old money to do key experiments. All inventors (in the research group) have always donated their share back to the lab.

You give it back to the lab. You're a hero to the next generation of students. They're certainly inspired and then pay it forward. The idea is not to get rich off of somebody else's poor genes or bad luck . . . to try and do something about it.

The conversations with faculty participants confirmed Hermanowicz's theory on cumulative advantages wherein early success determines the arc of the career (Hermanowicz, 2009). Faculty participants who had patented several inventions observed success brought credibility and facilitated engagements with TTO. Furthermore, successful licensing deals raised the scientific profile of the faculty inventor, causing TTOs to spend a limited patenting budget on the faculty who possessed a more illustrious track record. George Calvin, who has successfully licensed some inventions, explained:

They kind of trust me if I take something over there and say, "Look, guys, I think we really got to patent this." They're like, "Okay, yeah, we trust you." I'm not sure they do that with everybody. Usually first time around, they kind of give you the benefit of the doubt, and they'll at least file a provisional. And then if you want to go to a full patent and incur tens of thousands of dollars in cost, they kind of want to have somebody interested, or some idea that somebody's going to come along at some point and do something with it.

Veera Ramanathan, who also has several patents licensed, described the prioritization of faculty who possessed a strong track record as entirely appropriate and suggested this should be the standard operating procedure for TTOs. He justified his perspective as follows:

I mean, any part, any aspect of life, if you have a track record of filing successful patents, then the university and anybody who is interested would be more willing to put in the money and resources. And I think I have no problem with that. In fact, it should be like this. In a way, you have to first . . . you have to hustle and demonstrate that the inventions that you bring to market are actually useful because there are only finite resources at the university. And they have to make a judgment. And I have colleagues who have started

multiple companies. And compared to them, if the choice is between funding my invention and theirs, the university should decide 100% of the time theirs because they've already successfully done all of these things. And this is exactly how the faculty research programs work. When you start out, the university gives you your seed money, and then you are supposed to go out, hustle, and get the money in. And once you get it, more money comes because you now have a track record.

Leveraging TTO Capabilities

With a mission to study faculty perceptions of their institutional TTO, the research questions predominantly centered on the role and function of the TTO. An exploration of the commentary offered by interviewees on this topic is therefore essential to inform this study. In this section, I hope to form a continuum for leveraging TTO capabilities based on crucial points illuminated by faculty interviewees:

TTO Capability Continuum

- TTO outreach to faculty, training programs, and relationship management
- TTO scientific skillsets to engage, query, and aid the faculty with patent filing procedures
- TTO ability to recognize the value of the invention
- Seamless handover from TTO to contracted patent attorneys
- TTO management of faculty – patent attorney interactions
- Patent attorney scientific skillsets to grasp the invention and minimize faculty burden in patent filing procedures
- TTO business pedigree to gain credibility and to network with industry

Although faculty described TTO practices at their current institutions, a few participants compared existing conditions against their experiences at previous institutions to add emphasis. For Andrei Mayo, the world of patents is rugged terrain. His experience includes engagement with the university in-house counsel and the subsequent referral to an external patent attorney. Then a series of back-and-forth on topics he described as evident to him but not to the attorneys. His TTO, coded Tier 3 (small-sized staff), and Profile 2 (moderate capabilities), offered limited support, and beyond the preliminary screening of his invention disclosure, the TTO was hardly involved in the patent filing process. Further complicating matters, the contracted patent attorneys lacked the scientific pedigree to quickly grasp his explanations which resulted in him carrying a significant burden in conducting the prior art search and the defense of his invention. Overall, he described the process as cumbersome and “a real pain” and said:

Prior to coming to ___, I was a researcher at Los Alamos national lab, and we did patents over there. It’s a big-name government research lab, and they have their own patent office and patent lawyers, and that experience was fairly straightforward for us as scientists. Because they have everything set up, they have patent lawyers who have PhDs in their respective fields, and therefore they can talk technical details.

Pascal Thomas recounted a similar experience with his prior employer, a semiconductor manufacturing company. He described the enthusiasm that the company demonstrated for patents and the accompanying support that he received:

If you came up with something cool, they would do all the paperwork and funding to do the patent because they considered it valuable, which is totally not the case here, right? It’s screwed up here, right? So, if you want to hear my story—

I was taken aback by Professor Thomas's description because I had conjured an image of his west coast institution based on the tech transfer ecosystem that the region is renowned for. Instead, he described a TTO that offered platitudes but was not results driven. I recalled Bozeman's (2000) description of how organizations participate in technology transfer reflexively, or by directive, but lack any regard for the impacts of technology transfer. It also echoed Meyer and Rowan's (1977) research on organizations incorporating prevailing rationalized concepts of organizational work with the primary aim of increasing their legitimacy and their survival prospects rather than the efficacy of the acquired practices and procedures.

William Hart noted several shortcomings with his TTO but kept his commentary lighthearted and avoided criticizing the TTO. Perhaps this was an acknowledgment of the resource inadequacies at his R2 institution. We both laughed as he described the directive from his TTO that he should not communicate with the patent attorneys directly, a limitation he described as redundant and a pointless administrative layer that only increased his workload:

But when it comes to contacting lawyers, they would say, "oh, don't contact them," because every time when you send the email, it costs the university money. They say, "you know, once you give us everything, once we feel confident, we can sell it to them."

My earlier codification of TTO staff profiles reflects the importance of a balanced skillset of personnel in the TTO. It parallels the multiple pieces of literature cited to demonstrate that the labor division in the TTO significantly shapes TTO performance. The faculty who spoke positively of their TTO officers, and described them as competent, generally displayed satisfaction with the TTO state of affairs. Charles Macauley, a polymer scientist, expressed delight at his TTO officer's abilities and emphasized her background in chemistry: "She has a PhD in chemistry; she's super sharp. She really conveys confidence and capability."

Every faculty participant who displayed satisfaction with their TTO applauded the capability of their respective TTO officer. There was tremendous consistency in these findings. Yet, staffing TTOs with a range of experts remains problematic. Mohamed Hisham summarized the challenge of staffing a wide range of capable experts and offered a broad proposal:

Yeah, they're stuck because they'd love to have a polymer expert, a magnetics expert, a biologist, all these experts. And they have a handful, but they don't have 50, you know what I mean? And then that's a budgetary constraint. But if you get the right people who have broad interest and are a little bit more generalist, who can understand basic scientific phenomena and basic, I would say, placement of technologies in the field, I think that you'll have a better experience. If it's only about claim structure and legalese, it is going to be harder. And I got to say, for me, at the University of __, it has continually improved over the time that I've been here.

My interview with Veera Ramanathan expanded my perspective as he skillfully linked TTO capability to value generation. This was a description that supplemented the emphasis on the technical ability that was predominant in other interviews: "Every single technology transfer is a little bit different. And so . . . I think it comes down to individuals who understand the value, and not just a procedure that needs to be executed."

The interviews revealed a clear pattern wherein faculty perceptions are infinitely shaped by their interactions with TTO officers and patent attorneys, and the competence of these individuals was frequently described in terms of their scientific or technical ability. As revealed in my earlier codification of TTO staff, elite institutions demonstrate a commitment to leveraging TTO capability by aligning faculty inventors with TTO officers that possess the scientific ability

to engage, query, and aid the faculty. Elite institutions take this further by contracting patent attorneys who also espouse this scientific ability.

William Hart was almost apologetic in describing the TTO, a fledgling unit at an R2 institution. He spoke of a learning process in developing TTO capacity and expressed optimism his TTO would eventually acquire the necessary skillsets:

People are basically still learning, so they're kind of practicing and seeing, you know, what to say, what not to say, and how to write those contracts. Once they write one, they will go with the second, third, fourth, and fifth, and then they will become good at it. If you're the tenth person, then you probably get a better service.

Mohamed Hisham cautioned, although a scientific background was essential for TTO interactions with faculty, business experience was also vital for TTO interactions with industry. He described the distinction between the capabilities as follows:

I've never heard anybody say, "Oh, I know too much science." I don't think it's going to be detrimental to them. Probably more critical is a basic business understanding. And so, in fact, we've had folks who have come from industry who want to change up their career, who were working at a particular division of a big company. I think that helps companies feel more comfortable that the university folks have at least a rudimentary understanding of what it looks like in the industry. Because academics, in general, don't. And so scientific background, yes, but business background and industry background is probably, from the marketing side, more critical, I would say.

Claire Tasapoulo spoke positively of her TTO officer's capability, especially the officer's outreach to faculty. This surprised me as Professor Tasapoulo had expressed discouragement at the patenting process earlier on in the interview. I did not expect layers of perceptions that

seemed conflicting. Yet, I appreciated that she articulated her negative perception of a patent filing process that she found tortuous while still holding a favorable impression of her designated TTO officer:

She's very good because we have this umbrella organization on campus. So, we have an annual function, like faculty, researchers all get together, and we choose a poster, talk, and all that. This is a really vibrant community. I'm talking about 200 people altogether having a scientific exchange. So, whenever we have retreats, she will come and give a talk, introduce herself to other people. So, she's very good.

Sudipta Kaviraj described his TTO officer as competent, knowledgeable, and open minded. I asked what he meant by being open minded and he responded it was important for the TTO to listen and adapt if the information he was providing was different from the TTO process. He surmised the good TTO officers were willing to make this evolution. George Calvin is one of the most successful licensors in the cohort of faculty participants and cofounded a startup that exited for \$75 million. Professor Calvin explained competency and specialization extended outside of the TTO to include the patent attorneys and that his TTO organization was aware of this:

They know they can't have one person that knows everything, so they will try to handpick a patent lawyer in an outside firm that can specialize in your area. And when you start talking about toxicity and molecular weight, and mechanical properties, they don't have a blank look on their face.

Similarly, Charles Ling could hardly contain his excitement as he described the scientific background of the patent attorneys that he was engaged with during this study. He stated both patent attorneys possessed PhDs in chemical engineering, which aligned with his research focus,

and he concluded this was a bonus for him. In my discussion with Mohamed Hisham, he applauded his TTO for their outreach efforts and underscored the value of effective TTO leadership. Lastly, Professor Hisham defined the concept of “lowering the bar”:

They listen to faculty; they come to our department faculty meetings and try to lower the bar for people to file invention disclosures. There are some faculty who think I just want to do basic research. But there are some folks who have this technological value in what they do, but they don't understand or are intimidated. I don't know if that's the right word, but they don't want the extra work of filing complicated applications. So, a good tech transfer office or office technology commercialization helps lower the bar and helps, I think, facilitate that process. And your leadership also matters too. Whoever is at the top of the TTO has to be somebody who can really, I think, strongly connect with the faculty and strongly connect with the outside world. And this is tough.

Professor Freeman offered perspectives on TTO outreach to faculty at a nonelite university and emphasized the training component. Having arrived at his university before forming a TTO, Professor Freeman's licensing deals were the test case for the TTO. Being a pioneer, he aids the TTO engagement efforts by mentoring other faculty, and noted:

So that was a lot of time spent teaching the faculty, especially in the physical sciences and engineering, because obviously, most of the patents and the disclosure came from physics, chemistry, engineering, etc. So, they did many of these presentations to the faculty. They came to the department. They presented in 1-hour lectures, basically, what is an intervention? And what's the process? How do you file disclosure of an invention? What's the process at the tech transfer office?

Because a lot of faculty don't know, they have an idea, they think it's an invention, and they don't understand that the idea is not. You cannot patent an idea. And they don't understand that even if it's novel, but it's not useful, there's no reason to patent that invention.

Stephen Wang does not care much for the emails periodically received from his TTO, and he finds the interactions superficial. He wishes they would do more by visiting with faculty and touring their labs to understand ongoing projects. Professor Wang described the content of the generic emails and his frequent response to the solicitations:

“Professor Wang, do you have any technology you might want to discuss or transfer?”

Then I reply to him back, “Why don't you come to my office, and then look at the lab together, and I can explain to you, so you understand what I am doing.”

Professor Wang doubts the TTO will ever take him up on his offer. For now, he is skeptical about the capabilities and motives of the TTO, and thus, he is unmotivated to engage with the TTO. Randy Freeman made a case for TTOs to manage relationships with industry while considering faculty experience and perspective. He complained his TTO engaged in siloed discussions with companies, and he, as the inventor, was left out of negotiations. Further, he detailed an experience wherein a company had offered to pay a one-time fee of \$1.4 million for his invention instead of annual royalties. The TTO rejected the offer because they wanted to extract higher revenues, and the company eventually ended negotiations.

This was an excruciating episode for Professor Freeman, mainly because the company had sponsored the research and already owned a nonexclusive license. The technology never got to market. This weighs heavily on Professor Freeman, who is adamant things would have turned out differently if TTO officers had just listened to him and prioritized getting to market over

revenue targets. I commented to Professor Freeman that the AAUP would agree with him and that this was precisely the type of conflict that the AAUP position aimed to eliminate. I shared with him excerpts of AAUP's (2014) bulletin, which states:

A fundamental problem that arises from university ownership of patent rights to faculty inventions is that it tends to create institutional conflicts of interest between the university's governance role and its financial and competitive interests in exploiting patented inventions for its own benefit.

It is all too easy for universities to conflate royalty income with their public service mission to enhance economic growth while failing to perceive or to acknowledge the conflict that arises with respect to other institutional responsibilities and the university's longstanding commitment to the broad dissemination of knowledge. (p. 2)

While also stressing the need to engage with companies, Sudipta Kaviraj explained faculty also has an important role. He further emphasized the need for a strong partnership between the TTO and faculty. I appreciated that he did not place the burden singularly on the TTO. Professor Kaviraj's statements furthered Thursby and Thursby's (2001) finding that 58% of TTO respondents indicated faculty inventor contacts helped market the technology to companies:

I've done things like gone on roadshows with a technology commercialization person. We've gone to a company and pitched both from the logistic side, what it would cost to license, how it would actually work, and the technical side. That is pre-Covid, of course, but there were some active pursuits to really market technology. And then there's the passive route. We put it on a website. We don't want to spend time marketing. But in

part, we have to, I think, to go from discovery to translation. And faculty are spread thin generally, I would say.

George Calvin echoed Sudipta Kaviraj's comments and furthered the commitment and enthusiasm required from faculty to market their inventions to industry was nonnegotiable:

And if you have faculty saying like, "I don't want to do that," you should tell them that we're not going to file your patent because we need you totally committed to seeing this through from the invention to the writing the patent, to talking with potential people too. Hey, if you really believe this stuff, you might have to go start a company. Right?

Andrei Mayo noted the significance of marketing inventions to industry but expressed the limitations of his experience and the lack of a recognizable name. With the limited scope offered by his TTO, he would have to do much of the marketing himself. Professor Mayo described himself as a regular faculty at a regular university and explained the limitation:

A person who is a big name like a Nobel Prize awardee, or you know, a big-name scientist, it's probably easier, but being a regular faculty, it's quite difficult to get in touch with people from industry. For different reasons, I mean mostly because you don't know who you have to talk to, and you have to really find the people who are interested and so on.

As I described in my profiling of the universities and TTOs in this study, I observed the standard practices deployed by TTOs, including the listing of technologies available for licensing on the TTO website. Pascal Thomas described this practice as "lazy" and expounded only a handful of elite universities would attract traffic to their TTO websites. Although he had observed some improvement in his TTOs capability, he surmised the marketing was still largely ineffective:

I think they've gotten a lot better recently. They've hired some more competent people. And, yeah, so it's a little bit better than it was. But they don't have the resources to fund a patent, to investigate it properly. I mean, basically, they put it on some website and let other people decide whether they want it.

Yet, no matter the intentions and marketing efforts of the TTO, most university inventions will not be adopted by industry. Charles Macauley offered a rational summation: "And now the challenge always is you think your ideas are great . . . then they try to market it, and nobody wants it . . . you know what I mean? You know, that's the challenge; I mean, every Professor thinks so."

Considerations for Faculty Tenure and Recognition

With mostly long-tenured faculty participating in this study, it follows that the discussion around faculty tenure was light, and only one interviewee raised a grievance on this point. This associate professor (one of only two associate professors in the study) described a grueling patenting process he surmised was significantly more complex than publishing. Furthermore, he detailed that if publishing was a measure of success, so too should be patenting. Although faculty tenure decisions are external to TTOs and out of scope for this study, tenure is often the singular goal for junior faculty and drives many motivations. Bakari Camara served as department head for the mechanical engineering program at his university and offered some insight on deliberations on faculty promotions, precisely the complexity in valuing patents listed in promotion dossiers:

Faculty are driven to get tenure, especially junior faculty, and the promotion to full professor. So, I've been on the school of engineering tenure promotion committees. So, the question is how to value patents compared to journal articles, for example. We all

know that to get the patent awarded takes a long time. So, there's always a discussion, is one patent equal to one journal article, or is one patent equal to two journal articles or--? Then some of the committee members say, "Invention disclosure should also count as a publication." Well, you can come up with an idea; I mean, some people file so many patent disclosures that they are not worth anything, right? I mean, there is no peer-review process. At least when you get a patent, it's examined by the patent examiners. So, it's my opinion that, yes, patents should count because you want to encourage faculty to be entrepreneurial, and they should put that on paper in terms of what their intentions are. But then again, the issue is you get so many people involved in a patent application; you have a one-page long list of authors. So how do you give credit to this person? What fraction of the credit goes to the faculty?

Randy Freeman also described a grueling process for patent filings but suggested recognition for faculty engaged in patenting could be exhibited in a different form. He expanded on the practice at his university and what he had hope for:

Whenever I have a patent issued, they always send me a payday chocolate bar as an acknowledgment, and they bought me these nice little plaques where the first page of the patent was engraved in some kind of copper or something. It was really nice, but they never truly associate that spending time on a patent, not the research, is much more work than a scientific paper. If you're really working hard and you have so many patents, perhaps the university could give us a teaching load reduction or something. But none of that.

On these topics, Hermanowicz's (2009) treatise on academic careers provided a thorough grounding in understanding how university types impact faculty and precisely how the

recognition sought by faculty unfolds differently based on the institution type and the career phases. This theory follows that faculty at elite intuitions carry the most worry to meet the demands of publication and other research metrics.

Fiscal Considerations, Royalties, and TTO Incentives

In discussions on the role of the TTO, faculty interviewees suggested TTOs should be self-sustaining, although the mechanism of achieving this was not articulated. Professor Mattias also observed a lack of awareness of the cost of maintaining patents and suggested TTOs should actively review their portfolios to identify patents allowed to expire:

I think the first thing is they shouldn't be losing money in the university. Maybe you shouldn't have that office if you're just pouring money in. People sometimes don't realize that having your patents worldwide for the duration of, let's say, 20 years cost a quarter-million dollars.

Royalty Policies

In the 18 separate conversations, no faculty expressed displeasure at their institutional royalty policy. My interview transcript included follow-up questioning on royalty policy to determine whether policy modification would stimulate greater faculty engagement with TTOs. However, these subquestions were unnecessary; my expectation that royalties could be a contentious topic turned out to be uneventful, as all of the faculty interviewed deemed royalty rates fair. My exploration of TTO policies discovered all of the institutions represented in the study promoted royalty rates between 30%–40% of licensing revenues shared with the inventor. This finding echoes earlier literature which suggested strong isomorphic forces and the resulting commoditization of tech transfer structures, policies, and operations. Thus, I conclude this

observation of no substantive differences in royalty rates across institutions resonates with faculty as a testament to fairness. Mohamed Hisham elaborated:

I generally think it seems fair. I've never thought to myself, "Oh, I think it should be higher for the inventor." Of course, yeah. I'd like it to be higher for the inventor. But the university, I mean, it's their lab, their infrastructure, and their students. They all had a role to play. And I think that it seems to me to be kind of pretty well-calibrated.

Although faculty expressed satisfaction with royalty rates, there was frequent mention of faculty only receiving income after the administrative expenses were refunded to the TTO. As such, the faculty only receive payment when patent filing costs, which could be substantial for nonprovisional filings, have been reimbursed. Further, the faculty explained the process might take a year to several years, from filing the application to obtaining a patent.

TTO Incentives

Randy Freeman introduced the concept of incentive pay for TTO staff. I anticipated this particular interview because of Professor Freeman's rich experience with a series of multi-million-dollar licensing deals, which was achieved at an R2, pluralist institution I coded as Tier 3 (small-sized staff), and Profile 2 (moderate capabilities) TTO. Professor Freeman was not shy to talk about money and firmly supported incentive pay to TTO staff as an incentive to close deals and (more specifically), motivating TTO personnel to engage with companies and market the invention. For most public universities, providing staff incentives in a commission of license revenues is prohibited by rules governing public servants.

The seminal work of Slaughter and Leslie (1997), however, which promulgated the theory of academic capitalism, illustrated that universities are increasingly adopting business norms in a cutthroat competition for resources. As this inclination toward business accelerates, it

would not be at all surprising for public institutions to adopt staff incentive pay via policy amendments or policy exceptions in a bid to attract and incentivize TTO staff. Slaughter and Leslie (1997) suggested the competition for relevance and prestige is a strong motivation for universities to adopt business practices.

I do not find the values of broad dissemination of scientific knowledge and motivating TTO staff incompatible; however, I struggle to reconcile higher education professionals receiving incentive pay to do the job they are hired to perform. Nevertheless, I note the tensions that can arise when a TTO pursues the most lucrative deals rather than a razor-sharp focus on getting the technology to market in the quickest time. Still, Professor Freeman embodies the brilliance and commitment required to attain multi-million-dollar revenue streams from patents at a nonelite university. He recalled: “The tech transfer office of our university was always very much reliant on the university's financial health. When that was in question, the first thing that was going was the tech transfer office people.”

Professor Freeman’s success with licensing deals renders his arguments difficult to dispute. He is adamant that TTOs can and should make money. The problem, as he described it, was the lack of marketing to companies. If done well, he argued, TTOs stand to bring in substantial revenues:

Small universities like ours still think that the tech transfer office is a money-losing enterprise. But if they run it properly, it could be a money-making enterprise.

They have to go to trade shows. They have to do conferences. They have to do a lot of things to market these technologies, and that didn’t happen. And that really pissed me off, honestly, because it shouldn't be the inventor’s job to go and find the company

who wants to license it, okay? But I did this job most of the time because, as I told you, I had 50 patents altogether, more than 10 were licensed, which is a pretty good ratio.

I mean, if I were working with MIT, we probably would have doubled the income or tripled the income because they have the people who go after . . . and they market it rightfully or how it should be.

Kim Noor echoed Randy Freeman's comments on incentivizing TTO officers to market inventions to companies. As I pressed her on this topic and asked why licensing managers couldn't simply be better at their jobs, she replied:

They won't do it! They won't do it! There's no incentive for them to do that. And they have a lot of faculty and a limited number of staff. And that is just not in their culture. So, to be honest, they will get a paycheck every month no matter what. And I've had this discussion with other people, and some universities do this. And I hate to sound like this, but if there was a way to incentivize these licensing managers, because, most people, most scientists never get their stuff patented, let alone licensed and stuff like that. But even if it's not a big blockbuster drug that's going to get the university \$100 million, if it's something that makes it better, public health or advancing public health—If there was some way to even minimally incentivize the licensing agent, other than “you're doing this for the public good,” and say “you would get 0.5% of whatever the universities take in.” I think you would get people that got up out of their chair.

Having spent over 30 years at his institution, Sudipta Kaviraj has seen the range of marketing efforts by his TTO. Although he noted the TTO has improved over the past 10 years, he concluded marketing efforts were an area of concern and that there was still plenty of room for the TTO to improve. However, Professor Kaviraj was cautious when we discussed incentive

pay for TTO officers, and he did not believe this would make much of a difference. He explained his position as follows:

Well, I feel that if you have a bad patent or a bad technology that nobody cares about and nobody wants, it doesn't matter that you can pay 50% to the licensing associate. If you have bad technology, it's not going to go anywhere. On the other hand, if you have a drug or a formulation that millions of people want to buy and cures a disease, it doesn't matter even if you don't go out to sell it. As long as the technology is proven, then people will want to buy it. So, I don't know whether providing an incentive will do that much to sell an invention. It might do a little bit.

The Evolution of TTOs

Engagement With Industry

Many TTOs continue to evolve and now offer multiple pathways to support university innovation. Thus, the role of TTOs is consistently redefined. This study provided me an opportunity to observe TTOs have evolved beyond a sole focus on patenting and licensing and instead are integrated into the efforts of technology management offices into the broader engagement activities of the institution. As Charles Macauley observed, "It used to be Tech Transfer Office, now it's called Office of Commercialization, so it makes it really clear what they're trying to do."

With the ongoing TTO evolution, and the multiple pathways now exhibited by TTOs, it is unsurprising that relations with industry were the predominant expectation of faculty participants. No matter the level of patenting activity, interviewees generally expressed a desire to engage with companies. Larry Becht shared:

I think the important thing, though, is to help us to have good relations with industry.

What I look for and think we have is a climate of welcoming industry, making industry want to invest in your research. The amount of money we get for research from the companies is way more, I believe, than they generate in their patents, you know... way, way, more.

Charles Macauley was my first interviewee, and this was to my good fortune because he described a practice with which I was unfamiliar. To circumvent hesitancy over licensing negotiations, his institution offered a waiver of IP rights to research sponsors in return for a percentage premium on research contracts. Essentially, this meant that companies gained ownership of all the IP rights, almost like prepaid royalties for an additional 10% increase in the grant funding. The faculty received additional research funds in line with the royalty policy. For example, if Professor Macauley has a research grant for \$100,000, the sponsoring company is offered all the IP rights for an additional \$10,000. Of that amount, \$3,000 goes toward Professor Macauley's research. He described the arrangement as "quite a good deal." As I queried further and asked Professor Macauley about potentially giving away a gold mine, his response was swift and adamant: "It's not true. Just look at the numbers. And you better put that in your thesis."

I was unfamiliar with this type of arrangement and had not encountered this in my literature review. Therefore, I used the opportunity to anonymously mention this practice in subsequent conversations to gauge faculty participants' reactions. I enjoyed the spirited debate and found myself agreeing to points on the opposite spectrum. Also, at the same institution, Mohamed Hisham believed the practice was a game changer and incredibly beneficial to faculty. On this topic, Mohamed Hisham expressed a pragmatic tone and provided his perspective:

So, faculty are realistic. I think they understand that even a patent is not quite a lottery ticket . . . pretty low odds of actually being the next big thing. But people like to have skin in the game on that front. It's a prepaid royalty. So . . . the university and the inventors benefit from that technology fee. They get paid, okay? And it's a small amount of money, 10%.

Mansoor Qureshi not only liked the idea of prepaid royalties, he noted, as head of the materials science department, he had advocated for similar arrangements at his institution, but his TTO was not on board with the idea. He also defended his position with a sense of pragmatism:

I've been a big proponent of something like that here at ___ because I think we need to recognize we're not the MIT and Stanford's, right? So, to give you an example, ___ brings about \$120 million a year on external research model...you want to charge 10%, we get \$12 million a year, right? That's very good revenue for us, right? How many patents do I need to file in one year to generate \$1 million?

Interestingly, none of the other faculty participants found the concept appealing and the support for the practice of prepaid royalties ended with these three personalities. Most faculty participants were vehemently opposed to the idea. For Kevin Mattias, the suggestion was a nonstarter, as he explained most top universities follow the so-called MIT model and "MIT wouldn't do that." Similarly, Randy Freeman was opposed to the idea and seemed offended by the mere suggestion: "That's stupid! That's a silly idea. I would never go for that. Never! Never!"

Facilitating Startups

Although the structures and ecosystem for expanded TTO capabilities are visible at elite institutions, and faculty at these institutions expressed an appreciation for this evolution, faculty at nonelite institutions faced a struggle, as demonstrated by Mansoor Qureshi. Professor Qureshi stressed it was important for the TTO to help faculty identify alternative paths for their inventions. His description included finding alternate sources of funding and developing business proposals.

Well, they should have a team that can help the inventor write proposals, right? I have my idea; I can write the technical aspect. Help me with a business plan, right? Help me with the market analysis. Help me with...what is the total addressable market? Help me with those aspects that I don't have time to learn now, right? What is your business model, okay? What is your exit strategy? What is your market? Yes, I kind of know, but I don't have the expertise, the tools, to do that, right? You can have a team that can help support the internal inventors; that will be great, in my opinion.

Although outside the scope of this study, there was frequent mention of the work done by TTOs in facilitating startups. Several interviewees noted the growing trend of faculty wanting to demonstrate the practical use of their inventions through startups. They discussed a noticeable pivot whereby established companies acquire startups that own a novel technology rather than licensing a patent. Larry Brecht noted:

So, one of the things that the tech transfer does is to facilitate startups. I think that might be a better function and a way to reward faculty better than you know, sitting back and hoping to get some income from patents.

The cohort of study participants included a handful who had formed startups around their patents. In general, faculty were supportive of this trend. However, Veera Ramanathan offered a caution:

I'm supportive of the trend. I licensed my technology and started a small company. So, I was the recipient of the marketing of a technology that I developed in my lab. I cofounded a company with my colleagues, and I have to say that it's not for the faint of heart. So, you have to go in with your eyes open about how to start companies.

Having identified a gap in the TTOs marketing to industry, Kim Noor decided to form a startup based on her invention. She illustrated the burden this arrangement brought to her life and saved the loudest criticism for the process of licensing her invention to the startup. Despite the lackluster support from the TTO, she felt the TTO was too eager to use her startup in their promotional materials. Professor Noor elaborated:

So, I'm doing my day job, right? And then I'm running this company on the side. And I'm promoting it to the NIH (National Institutes of Health). And I have to do a presentation next week for them. And I have people helping me communicate to venture capital people and so on. And I have to do all of the government reporting, all of the administrative stuff being paid for off the grant. Nevertheless, I have to manage that on the side. We started this spin-out company to help get these vaccines out, and we are getting to the point where now I, as part of the company, would like to license back my technology to the company -- and to be honest, Ahmed, that makes me a little cranky because that's my work and I have to license it back to myself to be able to use it. And they like to take credit; they love it that I started a company. I'm the girl that started the company. They love that. And I'm like, "You guys didn't do anything."

According to Professor Noor, the TTO stated they could not help with the start-up company because it posed a conflict of interest for the TTO, an explanation which she characterized as a poor excuse:

No, it's not a conflict of interest. You have an interest in this. You have a bigger financial stake in this than me, and I'm down here in the trenches doing the work. So, it's disappointing in that regard. I think there's sort of a failure of leadership. I go, "wow, we have one of the best business schools in the country, and you guys can't help me? I don't know how to write a business plan."

CHAPTER 6

CONCLUSION

In this final chapter, I conclude with a discussion of findings from my research. After a high-level discussion of results, I discuss alignment with the theoretical framework established for this study and the implications of the theories. Next, I continue with directions for future research and end with implications for policy and practice.

For this study, a TTO was defined as any university or university foundation unit responsible for obtaining patent protection for university inventions and licensing the patented inventions. The research question that guided this study is stated as follows: How do faculty who are engaged in high-level scientific research endeavors articulate their perceptions of their institutional TTO? Specific subquestions included:

1. How do faculty define the role of their institutional TTO?
2. How do faculty describe the overall effectiveness of their TTO and evaluate TTO success?

This study's research questions pursue an understanding of what motivations and factors lead to faculty engaging in tech transfer and the experiences encountered in the translation of scientific research. This study homed in on the patenting and licensing of inventions, including the boundary spanning activities of TTOs vis-à-vis faculty and industry. Fundamentally, this basic qualitative study sought to explain how TTOs can be better structured to facilitate faculty engagement and success.

Recognizing the perceptions faculty hold of their institutional TTOs are critical in determining faculty willingness to engage in tech transfer, this study aimed to address a gap in

the literature relating to faculty perceptions of the role, effectiveness, and success of their institutional TTO. The target population was defined as U.S. faculty employed in research universities in the United States who are actively involved in applied scientific research, commonly the engineering and life sciences domains, and have had an engagement with their TTO concerning an invention.

This basic qualitative study involved interviews with faculty participants and followed the study design, data collection, and analysis methods described in Chapter 4. The literature review noted previous studies relating to TTOs were focused on quantitative measurements of outputs. Thus, this study contributes to the literature on tech transfer by considering the subtleties and nuances of faculty perceptions through a qualitative evaluation.

A combination of theories was used to provide a grounding for scientific research, academic careers, institutional theory, and organizational effectiveness theory. The study methodology, therefore, allowed for an understanding of the findings that emerged from the study. Faculty participants in this study were deemed a constituency of TTO stakeholders, and thus, the overall effectiveness of TTOs was correlated to faculty satisfaction with the state of affairs.

Discussion of Findings

The significant findings of this study revealed a complex process for the patenting and licensing of inventions and that this process required a concerted effort and commitment from faculty inventors. Exploring the motivations behind faculty participants' willingness to engage with TTOs revealed a range of insights, especially when backed by the faculty's definition of a successful academic career. Motivations and stimuli ranged from the long-standing debate about fundamental research versus applications-oriented research and a confirmation of the literature

review, which recorded tech transfer benefits such as spillovers to basic research, job opportunities for graduates, and an underlying desire to make an impact. The findings and recommendations suggest TTOs would benefit from an understanding of faculty motivations relating to tech transfer and consequently would be better positioned to craft policies and to adapt practices to facilitate greater engagement.

The findings illustrated reliability and consistency with the three vital organizational functions performed by TTOs (Link et al., 2008). That is to say, the conclusions emerged correlated with the information processing function defined as the interaction between scientists and the TTO to understand the invention and its potential; the coordination function defined as linking the scientist to the market; and incentive alignments which refer to the institutional formula for allocating licensing revenue derived from the invention.

I feel an immense sense of appreciation for the faculty who participated in this study, principally, for their forthrightness and intelligence in response to my questions. I was unprepared for what initially seemed like conflicting responses. Still, I greatly appreciated the delineation of perceptions which aided my understanding of faculty sentiments relating to TTO staff and practices. Faculty participants were skillful in describing their angst, successes, and criticisms; the range of shared emotions greatly enhanced this study.

The most noteworthy finding in this study is easily identifiable as the segment on leveraging TTO capabilities. To this end, the TTO capability continuum was devised to abridge the predominant data collected from the interviews. I hope it surmises the faculty desires of a TTO. Within this principal finding, faculty offered detailed experiences of their interactions with TTO personnel. The emotions recalled from these interactions served as the most significant

indicator of faculty satisfaction with their respective TTO. In short, perceptions of TTOs are principally formed by faculty opinions about TTO staff.

Always mindful of budgetary constraints, the structural guidance I offer considers the wide-ranging university types, and similarly, the massive differences in research funding and TTO resources. It would be easy to state TTOs should hire all the skill sets required to satisfy faculty. Yet, the financial realities are a limitation and particularly acute for nonelite institutions. Thus, I have responded to the findings with a sense of pragmatism and a conceptualization of usefulness.

Although I struggled with the concept of incentive pay for TTO staff, I remained aware that my role as a researcher was to convey the themes that emerged from the interviews, no matter the conflicting emotions they evoked. The capabilities of TTOs to market inventions struck a chord with faculty interviewees, and some of the strongest criticisms and frustrations were rendered on this topic. Thus, I commiserate with faculty and understand the basis of incentive pay endorsements.

Despite an interview protocol designed to focus on patenting and licensing activities, there was bound to be commentary that fell on the periphery of TTO operations. Matters relating to faculty tenure and recognition for patenting activities generated stimulating conversations and are worthy of dedicated literary research. This study widened my view and brought me closer to the vivid expansion of university innovation practices. This visibility left me convinced expansion of TTO functions will grow exponentially as universities aspire to integrated innovation ecosystems ranging from sponsored research to company formation and divestitures. The same isomorphic forces so evident in this study will be unrelenting, and scholars of tech transfer like myself should expect a boom in entrepreneurial-type activities. This will present

new challenges as TTOs will need new skill sets to adapt to these expanded responsibilities. I fear the gap between elite and nonelite institutions, the haves and the have nots, will become even more glaring.

Summary of Findings

The study illustrated the complexity of tech transfer and generated five major findings aligned with the following themes:

- Faculty Motivations to Engage With TTOs – the motivations and stimuli for faculty to pursue tech transfer, including the age-old debate about fundamental research versus applications-oriented research.
- Leveraging TTO Capabilities – How TTO structures interact with faculty, the capabilities of TTO staff, and the level of support offered to faculty as illustrated in the TTO Capability Continuum.
- Fiscal Considerations, Royalty Policies, and TTO Incentives – The wherewithal of TTO finances, the policies and practices impacting the payment of royalties to faculty inventors, and incentives to spur TTO personnel to actively market inventions and deal making.
- Considerations for Faculty Tenure and Recognition – Junior faculty are driven to attain tenure; thus, the impact of patenting activities vis-à-vis faculty tenure is worthy of consideration. Also, consideration of privileges granted to faculty for their patenting activities.
- The Evolution of TTOs – The role of TTOs is expanding, and TTOs are increasingly embedded in university innovation ecosystems and offer multiple pathways to engage with industry and facilitate startups.

To these themes, I now offer structural guidance. For findings that fall out of the scope of TTO operations, specifically faculty tenure and recognition considerations, I defer to my Directions for Future Research.

Theoretical Implications

This study endeavored to reinforce a distinction between the terms “efficiency” and “effectiveness” commonly used in evaluating TTOs. I embarked on this study from an “effectiveness” perspective, with the ambition of collecting data that contained nuance and thereby illustrating the flexibility and value of a qualitative approach. The research answers call for qualitative studies in tech transfer to aid the plethora of quantitative studies that measure TTO success purely on quantitative outputs without considering stakeholder satisfaction. That there were instances wherein faculty perceptions of their TTO differed from the conclusions drawn from quantitative outcomes such as AUTM data lend credence to my theoretical selections. TTO efficiency, as reported by external data, did not always correlate to TTO effectiveness as perceived by study participants.

Criticisms of tech transfer were iterated in the literature review and included concerns over shifting academic agendas (Blumenthal et al., 1996; Murray & Stern, 2007), public access to knowledge (Huang & Murray, 2009; Toole & Czarnitzki, 2010), and the ever-prevalent financial contemplations (Gewin, 2005; Greenbaum & Scott, 2010; Mowery et al., 2001). This study adds context to these debates by vocalizing the views of faculty inventors classified as TTO stakeholders. By deploying the strategic constituency approach of organizational effectiveness theory, this study expands our knowledge of TTO impact on the main stakeholders and their interests. This is in line with similar posits by Schermerhorn et al. (2004) and Cameron

(1981) in describing the relationship between the strategic constituency and their respective organizations.

Lacking a unified perspective of effectiveness, this study was grounded in the descriptions offered by the faculty participants, and faculty satisfaction with TTO affairs was correlated to effectiveness, as Altschuld and Zheng (1995) suggested. My findings translated TTO capabilities perceived by faculty into the TTO capability continuum and formed the bedrock of this study's contribution to organizational effectiveness theory. While allowing for flexibility in the context of each stakeholder, this study contributes to the academe by expanding on faculty motivations to engage in tech transfer and supplements literature on academic careers. The study furthered our understanding of institutional theory as findings revealed many commonalities in the approach, policies, and procedures of TTOs.

Any study of tech transfer will be insufficient if it fails to appreciate the larger constituency of the general public that benefits from these novel inventions. Thus, the combination of the scientific research paradigm and academic research paradigm, plus the combination of institutional theory plus organizational theory, was intended to journey the reader from university labs into translation into usefulness for the general public. Any theory that attempts to explain tech transfer and the actors in tech transfer must consider expeditious delivery of innovation to the public domain.

Directions for Future Research

For study participants who expressed dissatisfaction with TTO, burdensome patent filing procedures were often the culprit. It would be worthy of exploring whether this burden increased dramatically after the United States switched from a "first-to-invent" to a "first-to-file" country in 2013 or whether there was any impact on patent filing procedures at all. Previously, the United

States awarded patents to the applicant who could prove that they were the first to invent. This changed with the enactment of the America Invents Act, and the United States shifted to awarding patents based on the first to file the patent. Future research in the form of taxonomy on patent legislation will help assess the degree to which patent legislation impacted provisional patent filings. Did this shift in legislation create a more upfront burden for inventors by including much more information in the provisional patent and the claim language? Were there any impacts to TTO patenting strategy and university research in general?

Future research conducted in TTO environments could aid our understanding of TTO finances by examining the upkeep of patents and the methodology to optimize value. That is to say, evaluating the TTO approach to maintaining patents. What active pursuits do TTOs deploy to scrutinize their portfolios, and what decisions are made to identify patents that should be allowed to expire and thereby reduce costs?

With policies on faculty tenure, instructional duties, and recognition entirely outside the scope of TTOs and often residing with academic programs or provost offices, the observations in this area present engaging scenarios for future studies linking academic careers to tech transfer. With tenure being the ambition for junior faculty, what is the impact of patenting decisions on assistant professors? A survey of academic program heads or deans could reveal insight into the deliberations across university types. How are universities handling this debate on the value of patenting activity in faculty promotion procedures? For universities that assign value to patents, how is this value computed in faculty promotion dossiers? Future studies may replicate the methods of this study exclusively to junior faculty at the assistant professor rank for whom tenure considerations are more prominent.

Also, further studies linking academic careers to tech transfer should examine trends in recognizing faculty for their tech transfer activities. What are the rewards (beyond the promise of royalties) and recognition offered to engaged faculty? Like the survey of academic program heads or deans, future studies should query how academic responsibilities such as instruction or committee participation are calibrated against the faculty's tech transfer efforts. Lastly, there was an inherent limitation of the findings of this study due to a sample selection method that was inclined toward faculty who had already engaged with their TTO. What about faculty in the applied research fields who have never engaged with their TTO? Future studies may home in on this constituency of faculty to investigate reasons for this lack of engagement and to offer guidance.

Implications for Policy and Practice

This study revealed the linear tech transfer process described in the literature review is anything but linear. Consequently, university policies have to accommodate the human and subjective component of recognizing value. To successfully translate scientific research into innovations in the public domain requires concerted investment and effort, which may span many years. Success is often elusive, so policymakers and practitioners must play the long game and avoid the impulse to demand short-term financial returns.

Although quantitative outputs of TTO have a place in TTO evaluation, it is vital from both a policymaking and practitioner perspective that TTO assessments also include qualitative concepts. This study revealed a gap between quantitative outputs that present an image of success and the realities the dominant coalition faces. This study supports tech transfer literature and calls for tech transfer scholarship to deviate from quantitative approaches.

TTOs are essential because they both enable and restrict the utilization of research results and impact the competitiveness of science-dependent industries. Tech transfer is central to higher education because of its economic growth implications. Based on the increasing importance of university tech transfer in the recruitment and retention of faculty, the study's objectives form a basis for evaluating university TTOs and implementing change.

The increasing intersection of sponsored research with tech transfer activities holds implications for policymakers and practitioners. What is the impact of the disappearance of distinct boundaries between sponsored research and patenting activities? How will university policies adapt to the expanded economic engagement mission? How will core academic responsibilities evolve or adapt to faculties' entrepreneurial engagements?

The insights gained from this study will allow university TTOs to initiate and manage relationships with faculty more effectively. Policymakers and university administrators also benefit and are better equipped for their oversight functions. This is particularly acute as the linkages between universities and industry will create new and unforeseen complexities. Universities that have been accustomed to operating under stable policies will need to adapt to the speed of industry and promulgate policies with dexterity.

Knowing the faculty perceptions of TTOs enables policymakers and university managers to reflect on strategies, monitor performance, and foster linkages between universities and industry. The overarching goal of this study was to provide insight that facilitates successful faculty engagement with TTOs, and consequently, more translation of university research into novel and useful innovations in the public domain. Accordingly, this study contributes to the literature on the institutional and organizational effectiveness theories of TTOs and expands our understanding of academic careers.

TTO practitioners should aspire to the professionalization of their staff as TTO resources allow. Policies should be developed to prioritize the transfer of inventions to the public domain expeditiously, and practices and procedures must align with policy. As with all tech transfer deliberations, the policy must be constructed considering the university resources and not just the duplicity of university peers. Thus, university leadership should embark on honest policymaking. When practice deviates from the TTO policy, it creates an impression that the university makes declarations on tech transfer but does not actively support it. The study revealed this discordance can result in faculty seeing the TTO as a foe.

As TTOs expand their scope and broaden economic engagement, policy formulation must adapt to this trend and endeavor to eliminate silo policies that create challenges to the university innovation ecosystem. Further, TTO practitioners should be mindful of the new skill sets that may be required to undertake these new responsibilities in startup formation and other economic development activities.

The first goal of TTOs should be the expeditious and wide dissemination of inventions for the public good. Dissemination of inventions must be held as the primary mission, and TTOs must not place revenue above everything else. Rather than strategizing on the proverbial “golden goose,” TTOs should focus on the expeditious conversion of as many inventions as possible to the marketplace. Patenting and licensing practices should not have the explicit goal of raising significant revenue for the institution because the probability of success is minuscule. Universities should pursue patenting and licensing practices that prioritize the rapid deployment of inventions rather than holding out for the highest monetary rewards to the greatest extent possible.

To this end, TTOs should maintain flexibility for the scientific judgment of faculty and should not reject licensing opportunities that the faculty find acceptable. Faculty have spent years working in their fields and can identify avenues for technological advancement and opportunity. TTOs at all levels should offer opportunities for governance, oversight, and transparency of their respective missions. An oversight committee for TTOs should include representation from the faculty and the broader community (including university administration), in addition to the relevant business and investment communities.

The committee's goal should help the TTO apply policies and procedures consistent with the university's mission. Providing faculty with a (proverbial) seat at the table ensures that faculty possess the means of conveying their concerns about TTO practices and offering an opinion as a strategic constituency. Furthermore, TTOs should undergo independent periodic reviews of their operations, with the governing board serving as judge of any findings from such assessments.

Clarifying the TTO mission would eliminate conflicts between the TTOs responsibility to disseminate knowledge and its financial and competitive interests in exploiting patented inventions. The findings regarding the leveraging of TTO capabilities included a subset of conflicts that arise when the faculty and the TTO may differ on the commercial potential of the technology. The faculty may not be skilled in assessing retail value, whereas the TTO office might be marketing the technology and inflating the value. It also follows that faculty may prefer a particular company that offers the public the broadest access to inventions, even though the invention might attract more revenues from other entities. On this finding, my recommendations are closely aligned with the AAUP position, and TTOs should heed the faculty's desire and broaden the scope of licensing deals beyond monetary values.

Faculty have the most profound knowledge of their inventions, and it is simply sound policy for faculty members to have a say in disseminating their research. The oversight committee will play a primary role in defining the policies and protocols that guide the patenting and licensing approach and issue recommendations for policy changes as needed. Having an independent complaint mechanism to reconcile these differences would be valuable. This responsibility can be added to the scope of the oversight committee in my opening recommendation, or it can be a separate mediation group. For nonelite universities, a singular oversight committee overseeing both policy and mediation is sufficient. Elite universities may see an advantage in separating policy oversight from mediation and operate an independent mediation or complaints group.

The TTO Capability Continuum, which emerged from the study's findings relating to the leveraging TTO capabilities, reinforces the concerns over the TTO division of labor prevalent in TTO literature. The consistency of these findings overwhelmingly concludes faculty satisfaction is positively correlated to the scientific alignment with their TTO interaction. That is to say, faculty realize a positive experience with patenting and licensing of their inventions when their designated TTO officer has the scientific pedigree to engage, query, and aid the faculty. The broad range of scientific research specializations creates a challenge for any university to field experts aligned with each faculty inventor. As outlined in the Chapter 5, inadequate staffing and expertise indicate budgetary constraints, and I deviate from a blanket call for increased TTO funding.

Elite institutions make up for a shortage of niche experts by appointing TTO officers with PhDs in STEM disciplines close to the faculty research. Further, elite TTOs ensure consistent staffing alignment to enable relationship building between the faculty and TTO staff. This is

backed by patent attorneys who also possess a scientific background relative to the faculty invention. It makes for enhanced engagement, less workload on faculty, and expeditious patenting cycles. To this end, it is essential that TTOs inventory the skillsets available in their respective organizations and offer the closest alignment to faculty inventors. TTOs should also apply similar vigilance in appointing patenting attorneys. That is to say, that TTOs should inventory the skillsets of patenting attorneys to facilitate the closest scientific alignment with faculty inventors. Large sized law firms are likely to include patent attorneys with a range of scientific backgrounds, thereby allowing the firm to administer patents for inventions in a variety of fields. TTOs should therefore investigate the firm or the attorney capabilities in pursuing patent applications and confirm the appropriate legal experience. Additionally, TTOs should endeavor a seamless handover to patent attorneys and remain engaged throughout the interactions of attorney–faculty, thereby reassuring faculty of their support.

In the inventory of TTO skillsets, it is also critical to consider the business experience that facilitates networking with companies. Thus, PhDs in STEM disciplines who have worked in large companies can satisfy the dual role of supporting faculty and expediting the patenting process while maintaining credibility to engage with companies and effectively speak the language of business.

Faculty at nonelite universities expressed dissatisfaction principally due to heavier burdens caused by a lack of TTO support. TTOs can aid faculty by developing a workforce already available on their campus. TTOs can offer graduate students and post-doctorates an introduction to university technology transfer and explicitly patenting procedures. Under the supervision of a TTO officer, these recruits will assist in conducting prior art searches, writing invention summaries, and initiating market research of inventions, which tend to be the most

time-consuming activities in the patenting process. This provides an affordable resource that can lift administrative drudgery from faculty and offer a layer of support. The additional benefit is that this cohort of graduate students and post-doctorates gain the experience of researching innovative technologies and understanding the patenting and commercialization processes.

Findings of this study revealed a consistency in faculty valuing TTO outreach in the form of training sessions and other informal interactions. The following recommendation to enhance TTO outreach to faculty is also derivative of the TTO Capability Continuum, which emerged from the study's findings relating to the leveraging TTO capabilities. Faculty who experienced this outreach spoke fondly of the immense benefit of facilitating faculty engagement and deciphering tech transfer to intimidated faculty or lacking basic understanding. It was striking that there was no differentiation between faculty with a string of successes in patenting and licensing and those with minimal activity. Faculty who expressed satisfaction with TTO outreach heaped praises on the TTO personnel even though other areas of TTO activity may have been unsatisfying. Therefore, this presented a case of "out of sight, out of mind." That is to say, TTOs that failed to have meaningful interactions with faculty also failed to generate much interest in tech transfer.

TTOs across all university types have a crucial responsibility in allaying faculty fears and reservations through training sessions and presentations on tech transfer and TTO procedures for patenting and licensing in general. It is therefore essential TTOs maintain flexibility in their approach and listen to faculty concerns. In this regard, TTOs should avoid interactions faculty deem superficial or disingenuous and strive for authentic engagements for the TTO officers to grasp ongoing research projects and manage relationships with faculty.

Budgetary constraints are always in the purview of TTO deliberations, yet the successful outreach described by faculty was low-cost events most TTOs can model. The events were typically informal and generally planned at a group level by catering to an academic program or department, thus reaching a wider cohort of faculty. TTOs can exploit speaking engagements during new faculty orientation, and a range of seminars offered at academic program or department level. Therefore, at a preliminary level, this will enable establishing relationships individual interactions can further as time and resources permit. Fundamentally, this study revealed that TTOs have to plan on strategic relationship-building actions.

When the TTO has concluded its evaluation of an invention and has decided not to move ahead with the patent, the faculty should always be provided with the option of filing patents independently. Often, the decision to patent is restricted by the financial resources available to the TTO. No matter the potential of ideas or inventions conveyed by faculty inventors, it is understandable that it is impossible for any TTO to patent every invention. No matter the final decision, TTOs should operate on the premise that the option to move ahead with a patent using non-TTO resources is always permissible. The procedures for assigning ownership of the invention back to the faculty should be seamless and demonstrate the TTOs support.

This recommendation to facilitate seamless transfer of patent ownership rights to faculty is linked to the findings on the evolution of TTOs, and specifically the broadening role of TTOs in facilitating startups. In instances wherein the faculty has selected to start a company to pursue further technology development, TTOs should streamline processes to enable faculty to license their inventions to their respective startups without burden. As company formation and financing ecosystems grow around universities, further developing the invention in a start-up environment is often a viable option for some faculty. TTOs should operate on the principle that faculty

understand their invention and are best positioned to know its potential application and readiness. Therefore, any attempt to further develop inventions via a startup should be encouraged.

TTOs should anticipate this growing trend and aim to simplify the conflict-of-interest stipulations that often stifle this transition. Furthermore, licensing to startups founded by faculty should be done without a financial burden to the startup. Additionally, licensing terms should be keenly focused on supporting the development of the technology, and divergence from routine TTO-industry procedures should be allowed for these cases.

Many research universities encourage the research endeavors of their faculty by offering what is often labeled “discretionary accounts” or “overhead funds.” Typically, these funds are indexed to the amount of external research funding derived by the respective faculty. Generally, the funds can be used for research-related expenses such as staff and student salaries, travel, and supplies. To the extent possible, faculty should be allowed to use their discretionary resources or overhead funds to pay for patenting expenses when the TTO has reverted ownership to the faculty.

Findings relating to royalty policies indicated faculty were generally content with their institutional royalty rates. Additionally, the study illustrated the extent to which TTO royalty policies had coalesced to a similar model. Yet, faculty explained the inconvenience of only receiving royalty income after the administrative expenses are refunded to the TTO. Faculty royalties are often delayed with filing procedures potentially spanning several years and incurring substantial legal costs.

Reducing the delay in faculty receiving their rewards would be welcomed by faculty. Both elite and nonelite universities can prioritize the payment of royalty to faculty over the reimbursement of TTO expenses. Once the license is executed, there is a manageable risk to the

TTO in collecting payments, so this shift in payment priorities will not constrain TTO operations. This is an opportunity for TTOs to build goodwill with faculty.

TTOs would benefit from understanding the motivations of the faculty they serve, and consequently, this would aid TTOs to calibrate and align their operations to enhance faculty engagement. As illustrated in the opening finding relating to faculty motivations to engage with TTOs, faculty approach tech transfer with a variety of influences and interests. A periodic survey of faculty by the TTO to gauge faculty expectations and decipher criticisms bodes well for TTO accountability to faculty. If deployed effectively, it can generate a pipeline of ideas and guidance to enhance TTO and faculty interactions.

A discussion on the strategies deployed by some universities to circumvent sponsor hesitancy over licensing negotiations, such as IP waivers and prepaid royalties, produced varying opinions from faculty participants. This discussion influenced the finding on engagement with industry as a subset of the evolution of TTOs. The faculty who participated in these nontraditional TTO practices of IP waivers and prepaid royalties spoke enthusiastically in favor; however, there was generally a negative reaction from other faculty. Although such strategies offered convenience for avoiding delays with negotiating licensing terms, a faculty constituency finds the arrangements ill-advised. The faculty know their science best; therefore, universities should provide these innovative strategies to research sponsors only when the faculty consent to such offerings.

The concept of incentive pay surfaced as a mechanism for motivating TTO personnel, albeit from a minority of study participants. Thus, this recommendation to study the concept of TTO incentive pay emerged as a finding that was grouped with other fiscal considerations. For most public universities, paying a commission of license revenues to TTO staff would be

forbidden by conflict-of-interest rules. However, such systems should be evaluated for public institutions that operate their TTOs via nonprofit foundations and private universities that possess the flexibility to implement incentive compensation. Incentive structures should be tied to the speed and volume of inventions transferred to industry rather than formulae tied to revenues. It would be worthwhile for TTOs at elite institutions to study this concept and for TTO oversight committees to determine the practicality for their respective contexts.

This study reported on faculty perceptions of TTO success, and the nuanced evaluation results illustrated various motivations that fall outside of monetary and quantitative scenarios. Thus, the study provides context to the faculty's willingness to accept, support, and participate in tech transfer. The study results will help institutions seeking information and direction in increasing the success of their patenting and licensing programs. In my exchange with a study participant, he provided commentary that encapsulates the importance of this scholarly research, and it is my privilege to end with this quote:

I think what you're doing is important. I think that the future will be defined in academia, in academic research, and there is more shared responsibility between industry and academia to translate technologies. And OTC (Office of Technology Commercialization) plays a key role. I think federal funding will continue to play a role, but it can be shaky depending on what administration is in charge. And so, I think that this is really an important endeavor in general. So, good luck to you.

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APPENDIX A

INTERVIEW PROTOCOL

- Elaborate on your interactions with the TTO and the type of TTO personnel you frequently interface with.
- How would you rate your knowledge of the tech transfer policies of your institution?
- What are the incentives for faculty to develop new inventions at your institution?
- What influence do TTO policies have on your relationship with the TTO and your desire to engage in tech transfer?
- Based on your interactions, how would you rate TTO staff competence?
- What is your opinion of the royalty distribution policies?
- How would you define the role of the TTO?
- In your mind, what are the criteria for a successful TTO? How do you assess the performance of the TTO? If you could design a TTO, what would you do differently, and why?
- Describe the level of importance assigned to university licensing income in your assessment of the TTO? What level of university licensing income would change your evaluation of the TTO?
- What do you associate with a “successful” career as a scientist?

APPENDIX B

IRB APPROVAL VIA LETTER OF EXEMPT DETERMINATION



Tucker Hall, Room 212
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Human Research Protection Program

NOT HUMAN RESEARCH DETERMINATION

April 15, 2021

Dear [James Hearn](#):

On 4/15/2021, the Human Subjects Office reviewed the following submission:

Title of Study:	Structuring Technology Transfer Offices for Faculty Engagement and Success
Investigator:	James Hearn
IRB ID:	PROJECT00003919

We have determined that the proposed activity is not research involving human subjects as defined by DHHS and FDA regulations. Information of interest is about Technology Transfer Offices rather than private information about individual respondents.

University of Georgia (UGA) IRB review and approval is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities are research involving human subjects, please submit a new request to the IRB for a determination.

Sincerely,

Katherine Bright, Sr. Compliance Officer
 Human Subjects Office, University of Georgia

APPENDIX C

INTRODUCTORY LETTER FOR STUDY PARTICIPANTS

Dear Professor,

I hope you are doing well. I greatly appreciate X's introduction and your willingness to hold a discussion.

For a brief introduction about my background, I am Director of Operations for the Physical Sciences and Engineering Division here at KAUST. I support faculty on a range of administrative matters from budget management to human resources (excerpt of my CV included). I am also a student pursuing a doctorate in education (emphasis in higher education management) at the Institute of Higher Education at the University of Georgia.

My dissertation is titled *Structuring Technology Transfer Offices for Faculty Engagement and Success*. I attach the study consent letter which describes the objectives of the study, the methodology for collecting data, and other relevant points. If you could please review this letter and let me know if you have any questions. Once you're satisfied with the consent letter and willing to proceed, it would be my privilege to schedule the interview based on your availability.

Thank you. I look forward to your response.

Regards,

Ahmed Banya

APPENDIX D

STUDY CONSENT LETTER

**UNIVERSITY OF GEORGIA
CONSENT LETTER
STRUCTURING TECHNOLOGY TRANSFER OFFICES FOR FACULTY
ENGAGEMENT AND SUCCESS**

Dear Participant,

My name is Ahmed Banya, and I am a student at the Institute of Higher Education at the University of Georgia under the supervision of Dr. Jim Hearn (jhearn@uga.edu). I am inviting you to take part in a research study.

With the awareness that faculty cooperation is necessary for technology transfer, this basic qualitative study will explore faculty perceptions of the role, effectiveness, and success of their institutional Technology Transfer Office (TTO).

The overarching research question guiding this study is: How do faculty who are engaged in high-level scientific research endeavors articulate their perceptions of their institutional TTO? Specific subquestions include:

1. How do faculty define the role of their institutional TTO?
2. How do faculty describe the overall effectiveness of their TTO and evaluate TTO success?

Fundamentally, this study focuses on faculty engaged in applied scientific research projects, who are likely to produce new intellectual property transferred to the marketplace. Thus, all participants in this study will have an existing relationship with their university TTO. Although the study will collect primary participant data such as faculty rank, date PhD was awarded, etc., the study itself is not designed to stratify faculty by tenure or tenured faculty, race, or gender. My research questions are motivated by my own experience as Director of Operations for an academic division within a research university. A role that allows me to observe faculty interactions with the university TTO.

This research will employ in-depth, individual interviews with selected participants using a semi-structured, open-ended protocol. If you consent to this study, you will be asked to participate in a single discussion. Interviews will be planned for a maximum of 45 minutes and will be digitally recorded and transcribed via Zoom. The interview protocol was purposefully drafted to allow participants to broadly describe their relationship with the TTO, elaborate on interactions with TTO personnel, elicit an assessment of TTO policies, and the impact of those policies on the participant's desire to engage in tech transfer.

Strong precautions will be taken to protect your identity. Your name will be excluded from transcripts, and all study records will be stored in a data management system on a secured computer. In the dissertation, quotations from or references to your interview will be attributed to

a generic title. Your institution will be broadly described and anonymized, and your information will not be used or distributed for future research.

Participation is voluntary, and you can refuse to take part or stop at any time. There are no known risks or discomforts associated with participating in the research. If you have any questions, you may contact me at xxxxx@uga.edu.

Your responses and insights gained from this study may help us understand how TTOs can initiate and manage relationships with faculty more effectively. Second, this study is relevant to policymakers and university administrators and equips these parties to foster links between universities and industry.

If you have any complaints or questions about your rights as a research volunteer, contact the IRB at XXX-XXX-XXXX or by email at xxxxx@uga.edu

Please keep this letter for your records.

Sincerely,

Ahmed Banya