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Innovation Processes in University Technology Transfer: Case Studies from the UK and the US

A thesis submitted to the University of Manchester for the degree of Doctor of Business Administration in the Faculty of Humanities

October 2013

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Manchester Business School
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List of Abbreviations

AIM Alternative Investment Market of the London Stock Exchange
AUTM Association of University Technology Managers
CEO Chief executive officer
CIT Critical incident technique
IP Intellectual property
MIT Massachusetts Institute of Technology
R&D Research and development
TTO Technology transfer office
UK United Kingdom of Great Britain and Northern Ireland
US United States of America
VC Venture capitalist

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Abstract

Innovation Processes in University Technology Transfer: Case Studies from the UK and the US

This study focuses on university technology transfer organizations and innovation processes. Universities in the UK and the US have established organizations to facilitate the transfer of technologies from the university to industry, with public use and benefit as an ultimate objective.

This research asks what process or processes describe and explicate innovation in the technology transfer organization in universities. Responses to the question derive from organization theory and case studies of four universities, two in the UK and two in the US. With qualitative data analysis, a resultant framework explains an innovation process.

Justification for this research includes benefits for technology transfer officers in improving their innovation process and for university administrators, industry executives, venture capitalists, and government policy makes in better understanding technology transfer organizations.

This study makes a contribution to the literature and practice of innovation and university technology transfer. Analysis of the research leads to a framework more robust than earlier frameworks by expanding antecedent conditions and actions and adding the influence of resources and organizational environments. Case studies, subsuming 48 critical incidents, permit a more rigorous analysis than hitherto available, in particular identifying actions in tripartite clusters (i.e., actions unique to successful incidents, actions unique to unsuccessful incidents, and actions present in both successful and unsuccessful incidents). This study also identifies more similarities than differences between UK and US technology transfer offices, both small and large.

Jonathan Giuliano
For the degree of Doctor of Business Administration
University of Manchester
January 2013
Declaration

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Author

The author has worked with universities in the transfer of their technology for more than 15 years. He has sourced, negotiated, and executed more than 70 licenses with more than 30 universities on four continents. He has been, at different times, an entrepreneur with firms licensing university technologies, an investor in university technologies that he helped bring to market, and an advisor to academic technology transfer offices (TTOs). He has also advised global firms (including 12 of the 100 largest global firms) on matters that included working with TTOs, developing university intellectual property, and launching products and services involving academic technologies.

Under the auspices of the Association of University Technology Managers (AUTM), he was one of 10 committee members who conducted a survey and issued a report in 2011 on non-licensing activities of TTOs. The survey, ‘The AUTM Transaction Survey for Fiscal Year 2009,” marked the first time that AUTM, the world’s largest TTO association, studied TTOs’ numerous non-licensing activities including local economic development, promotion of research capabilities to industry and to government, grant applications, agreements (e.g., material transfer, nondisclosure, inter-institutional, and consultancy agreements), and development of networks with present and prospective sponsors of research.

The author holds the degree of artium baccalaureus from Colgate University, in Hamilton, New York, and the degree of master of business administration from the Darden School of Business at the University of Virginia, in Charlottesville, Virginia.
1. Introduction

This introduction comprises five parts. The first provides background for this study. The next three discuss the objectives, the justification, and the methodology of the study. The fifth and final part outlines the structure of this thesis.

Background

This study focuses on university technology transfer organizations and innovation processes. Hundreds of universities in the UK and the US have established an organization to facilitate the transfer of technologies from the university to industry, with public use and benefit as the ultimate objective, or at least the ostensible objective; the university organization is typically called or identified as a technology transfer office. Graff, Heiman, and Zilberman (2001, p. 112) describe TTOs as “a recent institutional innovation created by universities to provide a new marketing channel and to improve this flow of trade between university research and industry.”

The technologies that a university transfers may include one or more patents, patent applications, trademarks, or copyrights and may include know-how for practicing an invention. The transfer of technology typically occurs through a legal contract, often a license agreement, in which the university grants the right or rights of one or more technologies to a commercial entity for present or future economic consideration, or both. The commercial entity can range from a firm newly formed for bringing the technology to market to a firm, for example, with global operations and hundreds of thousands of employees.
Consideration can include a payment at the time of executing the license, a grant of shareholders’ equity, and royalty payments.

The term “technology transfer,” defined in a strict sense of simply licensing a patent from a university to a commercial firm, is superseded by the term “knowledge transfer,” which entails the broad and deep transmission of academic knowledge to industry (subsumes the license of academic patents to industry and). “Knowledge exchange” denotes a free (or freer) flow of knowledge among a “triple helix” of universities, commercial firms, and governments (Leydesdorff and Meyer, 2006). Knowledge exchange as a term has been used for decades in connection with technology transfer (e.g., Gruber and Marquis, 1969) and more recently has been applied to university technology transfer (e.g., Collins and Smith, 2006, Acworth, 2008, Martinelli et al., 2008, Yusuf, 2008, Ponds et al., 2009, Hughes and Kitson, 2012). Knowledge exchange, in the context of organization theory and practice, has been an important concept (e.g., March and Olsen, 1976, March, 1988, Nonaka, 1994, Becker et al., 2006, Ward et al., 2012). Indeed, the concept of knowledge exchange has a connection to the three themes of innovation and organization theory – viz., adaptability, cognition, and structure – and to the concept of open innovation (Chesbrough, 2003b). Knowledge exchange as a concept provides a bridge between organizational and economic concepts of university technology transfer.

The connection between university technology transfer and commonweal remains a topic of debate. The ostensible motivation and purpose of university technology transfer is ultimately the public welfare; at least this is the view of politicians and others who vocally support statutes and regulations in effect at the present time. The distinction between public benefit and private benefit is sometimes difficult to discern. The notion of ultimately benefitting the public may entangle
private benefit and may even exclude public benefit for a period of time; academic studies (e.g., Jensen and Thursby, 2001, Thursby et al., 2001, Jensen et al., 2003, Moore et al., 2005, Sweeney, 2011) highlight apparent changes in pecuniary motivations, purposes, and behaviors at US universities since Bayh-Dole became law. The debate over university technology transfer and commonweal may depend on how one defines the public welfare.

Powell, Owen-Smith, and Colyvas (2007) examine technology transfer at US universities and warn, “University–industry partnerships will never generate the returns that politicians and administrators covet. Nor will curiosity-sparked research ever find wide industrial support. But it is precisely this research that produces breakthroughs and spawns new industries. Few corporations appreciate this fact, much less support it financially. But universities that become obsessed with intellectual property threaten the culture of inquiry that is the soul of the academy. The current tendency to favor exclusive licenses, and to regard science as property, may, if unchecked, have negative consequences for economic growth. Those who wish to emulate the US [technology transfer] experience would be well to recognize this possibility, and to avoid its uncritical acceptance.”

Consistent with this warning is a call for greater transparency, responsibility, and accountability in government science policy and for a more inclusive definition of the public interest in science and technology transfer. In a study of the British biomedical industry, de Chadarevian (2011) concludes, “As the story told here suggests – and as critical voices indicate – what is at stake is not just economic competitiveness and biomedical innovation, but the redefinition of the notion of the public good of science and its broad ramifications.” Gibbons (1999) asks, “If the boundaries between science, technology and society are becoming more
permeable, why should not a similar approach in science likewise produce more socially robust solutions?"

Nelles and Vorley (2010, 2011) expand and explicate this policy theme in their discussion of the third mission of universities and their architecture for entrepreneurial universities. The first two missions of a university are teaching and research; over the past 20 years, a third mission of socio-economic engagement has developed. Nelles and Vorley note that that the third mission is defined broadly by Jongbloed et al. (2008) as all institutional activities beyond teaching and research and is defined narrowly by Hackett and Dilts (2004) as technology transfer. Nelles and Vorley employ and develop a concept of entrepreneurial architecture as a perspective for understanding the third mission and its origins in public policy, government funding, and political decision making, which has intentionally extended the function and reach of universities. The concept of an entrepreneurial university may trace origins to Romer (1986) and Lucas (1988), who quantify a new variable – knowledge – in their economic models. They present knowledge as a key driver of economic growth. The models represent not only an advance in economics but also an advent for recognition of universities not only as vast reservoirs of knowledge but also as entrepreneurial organizations creating, disseminating, and exchanging knowledge. Slaughter and Leslie (1997) note that universities endogenously encourage entrepreneurial behavior (e.g., provide incentives for academic researchers to develop commercially their inventions) and exogenously serve as a locus of entrepreneurial activities (e.g., license technologies to startups, collaborate in research and development with venture capital firms and industrial firms, offer science parks and other facilities for startups connected with or even unrelated to the university, and host entrepreneurial events). Etzkowitz (2003) observes that the entrepreneurial university is a manifestation of an intrinsic logic “of
academic development that previously expanded the academic enterprise from a focus on teaching to research. The internal organization of the research university consists of a series of research groups that have firm-like qualities, especially under conditions in which research funding is awarded on a competitive basis. Thus, the research university shares homologous qualities with a start-up firm even before it directly engages in entrepreneurial activities.” Bureaucratic structure notwithstanding (Styhre and Lind, 2010), universities, including their technology transfer offices, are increasingly adopting and adapting entrepreneurial perspectives and behaviors, as noted in numerous academic studies (e.g., Etzkowitz, 1998, Etzkowitz et al., 2000, Etzkowitz, 2003, Etzkowitz, 2004, O'Shea et al., 2005, O'Shea et al., 2007, Siegel et al., 2007, Clarysse et al., 2011, de Chadarevian, 2011).

The literature of academic technology transfer reflects increasing interest in the topic since the 1980s. Quantitative methods tend to prevail, especially regression analysis. Rothaermel, Agung, and Jiang (2007) note that, because of the embryonic stage of technology transfer literature, most of the research has appeared outside of general management journals. They observe that the high percentage of quantitative studies is unusual for an emerging field and offer the explanation that methods and frameworks from neighboring fields, such as economics, and the availability of quantitative data (from AUTM, the United States Patent and Trademark Office, and the European Patent Office) have encouraged the preponderance of quantitative research.

Schumpeter (1934, 1942, 1947, 1949) identified organizational change, new products and processes, and new markets as factors of creative destruction. The significance of the organization – i.e., organizational influence on innovation processes and in the emergence of innovation in the market – is evident. In the decades since Schumpeter’s
work, contributions to the organization-theory literature on innovation tend to highlight one (or more) of three themes: adaptation, cognition, and structure (Lam, 2005). Although the three intersect frequently and necessarily, they often pursue predominant objectives and distinct theories. Adaptation literature tends to address questions of how organizations adapt to environmental change (Hannan and Freeman, 1984); innovation is an organizational tool to shape the market and industry environment (Burgelman, 1991, Child, 1997). Cognition literature tends to focus on learning, problem solving, and creating organizational knowledge (Argyris and Schon, 1978, Nonaka and Takeuchi, 1995, Tsoukas and Knudsen, 2003); this approach considers organizational knowledge as a tool to spark, incubate, or exploit innovation. Structure literature tends to explicate the link between organizational structure and innovation proclivity (Lawrence and Lorsch, 1967, Mintzberg, 1979, Teece, 1999); the research objective often is to identify the structural properties of an innovative organization or to establish the structural factors driving innovative products or processes, with structure as a tool to observe or to effect innovation.

Within the context of the three themes of innovation – adaptability, cognition, and structure – the themes of the literature on university technology transfer tend to connect most with structure and least with cognition. This begins to suggest a research opportunity in exploring theory and practice in the organization theory of cognition and adaptation.

Link and Siegel (2007) observe, “The extant literature on TTOs suggests that the key impediments to university technology transfer tend to be organizational in nature.” They note that organizational researchers are beginning to connect the economic models in the literature with organizational drivers. TTO literature is comparatively nascent, and it
has tended to describe and inventory phenomena. Theory is emerging, however, and the Link and Siegel cite organizational theories as the key and conclude that organizational theory could provide a basis for deeper insights, hence the focus of this study.

Link and Siegel (2007) refer to the connection between economic and organizational models, and this is an important theme. With the growth of the information technology industry (both hardware and software), new models of innovation have become apparent: viz., user, cumulative, and open innovation. These models rely on the themes of adaptation (how do we shape change in the market and industry environment?), cognition (how are we learning and creating knowledge to develop innovation?), and structure (what structural properties and factors allow us to drive innovation?). The models also identify the nexus among suppliers, customers (or users), rivals, and intermediaries.

Researchers identifying, exploring, or explicating these models include Von Hippel (1988, 2005, 2007, Baldwin and von Hippel, 2009) on user innovation, Scotchmer (1991, 2004) on cumulative innovation, and Chesbrough (2003b, 2006, 2011) on open innovation. Hargadon and Sutton (1997) develop a model of technology brokerage, and Hargadon (2003, 2005) builds this model on a foundation of organization theory. Murray and O’Mahony (2007) employ the nomenclature of cumulative innovation and devise a framework that strongly links economic models, such as Chesbrough’s, with organization models, such as Hargadon’s. Murray and O’Mahony argue that three conditions – access, disclosure, and rewards – most strongly influence cumulative innovation; their framework emphasizes the accumulation of knowledge (i.e., cumulative innovation). Murray and O’Mahony expand Hargadon’s model of technology brokerage and discuss accumulating, combining, and reusing knowledge in innovation.
This study applies and develops frameworks of innovation processes developed by Hargadon and Murray and O’Mahony in the context of the technology transfer organization of universities.

Objectives

For more than 15 years, the author has worked with technology transfer offices and wondered whether an innovation process operates within TTOs and, if so, how it operates and why. From that experience the question thus emerges: what processes describe and explicate innovation in the transfer of technology at universities? Mohr (1982) defines processes as a set or series of perceptible conditions and actions that together influence or result in a distinct outcome. Schumpeter (1934) defines innovation as new combinations of knowledge or other resources. Schumpeter (1942, 1947, 1949) emphasizes that innovation is distinct from invention: unlike invention, innovation is necessarily a social activity executed within an economic context and with a commercial objective. Technology transfer, in this study, refers to translating and transmitting knowledge (e.g., intellectual property) toward potential commercial utility.

Definitions of innovation and innovation processes require context. For example, a study in political economy may look at innovation processes in one or more national or regional economies (e.g., Mowery, 1992, Breznitz, 2007a, Breznitz and Murphree, 2011); a study in macroeconomics may look at innovation in or across industries or markets (e.g., Malerba and Orsenigo, 2002, Christensen et al., 2004), and business research may look at innovation in products or processes between firms and within firms (e.g., Chesbrough and Teece, 1996, Teece, 1999). Informed by organization theory, this study examines innovation
processes within organizations, specifically technology transfer organizations. Lines can blur, however, and processes can intersect with and fit within one another. Officers in Stanford University’s Office of Technology Licensing could provide much evidence that innovation processes within their TTO interconnect with innovation processes across the entire university, in proximate communities (e.g., technology, business, and venture capital firms in and around Palo Alto, California), and across industries and markets in Silicon Valley, in the US, and throughout the world.

The question emerges not only from practice but also from theory in the literature. In contrast to the vast majority of academic studies of TTOs, the question motivating this research focuses on the innovation processes of university TTOs. Nearly all studies of TTOs analyze input (e.g., invention disclosures made by university researchers) and output (e.g., patents, licenses, and startups). Though building firmly on earlier research of TTOs (e.g., Jensen et al. (2003)), this study focuses on processes occurring after input and before output.

Justification

The justification for conducting this research on university TTOs includes these six reasons.

First, universities worldwide receive the equivalent of billions of pounds sterling in government research funds with the expectation that the discoveries and inventions resulting from academic research lead ultimately to innovation that can benefit society. Whether such funding is appropriately productive is a question asked by policy makers throughout
the world, especially when national governments move to curtail the growth of such funding or to cut it outright.

Second, university administrators and researchers also look to evaluate the efficacy of research expenditures and innovation initiatives yet often conclude that data and studies thus far, with a strong emphasis on subsets of inputs and outputs and a singular focus on efficiency metrics, fail to capture and explain the process of university technology transfer.

Third, technology transfer officers and other university administrators work to improve their processes and find little or no insight in quantitative studies. TTO staff frequently discuss processes yet lack an explanatory framework.

Fourth, business executives and venture capitalists often believe that only invention – and not innovation – occurs at universities. Technology transfer officers often believe that invention does occur and that innovation frequently occurs in the university environment. At least one of those beliefs is incorrect.

Fifth, large companies, venture capital firms, and others dealing with universities may arrive at a deeper understanding of university technology transfer and consequently may establish more productive relationships with universities. Greater understanding may lead to more financially rewarding work between industry and academia; though the financial benefits could augment university budgets, the intellectual benefits for academic researchers, including student researchers, could add appreciably to knowledge and experience.
Sixth, most global corporations, like many universities, are more bureaucratic than entrepreneurial, so lessons learned in this research may have implications for innovation processes in the commercial sector. Styhre (2007, 2010) notes similarities between the bureaucracies of large firms and universities as well as correspondence in desires, objectives, and attempts to become more entrepreneurial.

**Methodology**

Technology transfer officers often criticize academic studies of TTOs saying that quantitative studies, focusing on relatively few variables, fail to capture what happens in a TTO and even qualitative studies fail to fully reflect the perspective and the process of TTO staff.

The objective of this research fits more closely with a qualitative strategy, with ontology slightly more constructivist than objectivist, and epistemology slightly more interpretivist than positivist, according to definitions and constructs provided mainly by Bryman and Bell (2007).

With objectives, epistemology, and ontology in mind, a case study methodology seemed most appropriate. Unlike other studies of TTOs that focus on one or two of the most elite universities, this research encompassed four universities, two in the UK and two in the US, all four widely recognized and well known among TTO directors and researchers for overcoming obstacles familiar to most TTOs. The four universities in this study are the University of Manchester (a larger TTO in the UK), the University of Southampton (a smaller TTO in the UK), the Georgia Institute of Technology (a larger TTO in the US), and the University of Utah (a smaller TTO in the US). An equally proportional and representative group of respondents at each TTO participated in the
study. The case studies, relying on multiple data sources and extensive triangulation, employed semi-structured in-depth interviews. Each respondent discussed two critical incidents of his or her own selection, with one incident representing a successful outcome and the other an unsuccessful outcome (with “successful” and “unsuccessful” defined by each participant). A total of 48 incidents were collected, confirmed with other sources of data, and analyzed. Qualitative data analysis techniques were used.


Ethical considerations were a principal concern. Precautions and additional safeguards were necessary to encourage participation and protect the privacy of participants.
Contributions

This study makes contributions to the literature and practice of innovation and university technology transfer. Among the contributions made by this study (and covered in detail in the final chapter) are these:

- This study explicates the organizational perspective of technology transfer officers engaged in innovation processes. From the collection of perspectives from each organization emerged explanatory details of what the organization did, why, and to what effect. Unlike other studies, this study followed the tradition of Mintzberg’s research into what business managers actually do (Mintzberg, 1973, 1975).

- The identification and addition of risk as a counterpoise to reward as an antecedent condition helps explain cognitive and behavioral processes within technology transfer organizations specifically and universities generally. Prior studies identify antecedent conditions as disclosure, access, and reward. Empirical data in this study reveals that risk, as a counterpoise to reward, has an important effect.

- The comparison of successful and unsuccessful incidents – within and across four universities in two nations – contributed particularly to a deeper comprehension of which actions tend to emerge (a) in both successful and unsuccessful incidents, (b) only in successful incidents, and (c) only in unsuccessful incidents. The tripartite clusters lent insight to mapping and navigating the innovation process in university TTOs. Moreover, the extensive expansion of actions lends critical insights into how technology transfer organizations operate and why.
The Identification of a resource-based ethos (which is different from a resource-based view) assists in explaining a perspective of technology transfer officers. A resource-based ethos helps explicate an organizational culture (i.e., the values and norms) of a technology transfer organization and a series of actions taken by technology transfer officers.

Empirical data in this study provide insights into environmental factors affecting technology transfer organizations. Environmental factors contribute to an understanding of causes and effects beyond the control of TTOs (such as an economic recession) and sometimes within the influence of TTOs (such as a university policy). Earlier studies tend to exclude the nuance and effects of environment, with no explicit recognition of what TTOs may and may not influence or control. This study shows how environmental changes, sometimes abrupt and sometimes slow, influence a technology transfer organization’s conditions, actions, and resources. Environmental factors contribute to the innovation process and help explain it.

Structure

This introduction is the first section of this thesis. The second section covers the literature review, the third addresses the methodology, and the fourth contains the case studies and the analysis. The fifth section presents the conclusion.
2. Literature review

A review of the literature provides context for this research. Here the literature is reviewed in four sections.

- The first section addresses the themes of innovation literature; these broad themes provide a background to the literature and, later, a foreground that (1) exposes a gap in both literature and practice and (2) provides contextual groundwork for this study.

- The second section discusses frameworks – viz., traditional, user, cumulative, and open innovation – that (1) connect with the themes of the first section (2) begin to add detail to the gap addressed by this study, and (3) contribute to the construction of a framework for this study.

- The third section begins to situate the first two sections by reviewing university technology transfer and offering historical context with a summary of major events, trends, and debates; this section provides context to explore the gap.

- The fourth section explains the gap by (1) reviewing the literature on university technology transfer, (2) connecting that literature to the themes of innovation in the first section, (3) employing the perspective offered by the frameworks of innovation in the second section, and (4) identifying the gap in the literature that this study addresses.

The first section leads logically to the second, and both sections interconnect with the third and fourth. The first section is expansive; the
second section is less expansive, and the third and fourth sections narrow the focus further.

The conclusion to this section notes that, within the iterative of innovation, the evolution of recent models (user, cumulative, and open innovation) has received little attention in the literature of university (as distinct from commercial) technology transfer. In particular, the model of cumulative innovation and technology brokerage in the context of university technology transfer in the UK and the US has received no apparent attention yet offers potential for important scholarly and practical contributions to advance the understanding of university technology transfer organizations.

2.1 Themes of innovation literature

Schumpeter (1934, 1942, 1947, 1949) identified organizational change, new products and processes, and new markets as factors of creative destruction. The significance of the organization – i.e., organizational influence on innovation processes and in the emergence of innovation in the market – is evident. In the decades since Schumpeter’s work, contributions to the literature tend to highlight one (or more) of three themes: adaptation, cognition, and structure (Lam, 2005). Although the three intersect frequently and necessarily, they often pursue predominant objectives and distinct theories.

Adaptation literature tends to address questions of how organizations adapt to environmental change (Hannan and Freeman, 1984); innovation is an organizational tool to shape the market and industry environment (Burgelman, 1991, Child, 1997)). Cognition literature tends to focus on learning, problem solving, and creating
organizational knowledge (Argyris and Schon, 1978, Nonaka and Takeuchi, 1995, Tsoukas and Knudsen, 2003); this approach considers organizational knowledge as a tool to spark, incubate, or exploit innovation. Structure literature tends to explicate the link between organizational structure and innovation proclivity (Lawrence and Lorsch, 1967, Mintzberg, 1979, Teece, 1999); the research objective often is to identify the structural properties of an innovative organization or to establish the structural factors driving innovative products or processes, with structure as a tool to observe or to effect innovation.


The literature of cognition is deep and expansive. In this literature, the innovative organization is creative and intelligent and, by discovering, learning, and inventing, provides the corpus for innovators to think of new ideas and to solve problems (Argyris and Schon, 1978, Kanter, 1983,
Amabile, 1988, Cohen and Levinthal, 1990, Mezias and Glynn, 1993, Nonaka, 1994, Glyn, 1996, Amabile et al., 1996). This literature has firm roots in cognitive psychology; organizational cognition, however, adds a social context. Simon (1991) and Grant (1996) see learning as an individual activity, but other theorists emphasize organizational learning and collective knowledge (Walsh and Ungson, 1991), communities of practice (Lave and Wenger, 1991, Wenger, 1998, Brown and Duguid, 1998), and knowledge-creating companies (Nonaka and Takeuchi, 1995). Prahalad and Hamel (1990) elucidate the core competence of the organization, a concept which focuses on cumulative and directional knowledge in organizations. March (1991) calls attention to the dynamic of exploiting old certainties while exploring new possibilities. Research by Lundvall (1992) indicates that innovation often resides beyond the organization's boundaries. Teece and Pisano (1994) argue that a company should build its competitive, company-specific core while reconfiguring its competences in view of the creative destruction occurring in the environment. Other models explaining how organizations solve problems and innovate include the adhocracy (Mintzberg, 1979), the J-form (Aoki, 1988), N-form corporations (Hedlund, 1994), hypertext organizations (Nonaka and Takeuchi, 1995), cellular forms (Miles et al., 1997), and modular forms (Galunic and Eisenhardt, 2001). Kaplan and Tripsis (2008) apply a cognitive lens to understanding technology by developing a co-evolutionary model through which they view each stage of the technology life cycle. Carlsson, Acs, Audretsch, and Braunerhjelm (2009) conduct an historical review of knowledge creation in the context of entrepreneurship and economic growth and conclude “(i) that in order to explain economic growth it is necessary to distinguish between general knowledge and economically useful knowledge; (ii) that the effectiveness with which such knowledge is converted into economic activity varies over time and depends on institutional arrangements and on the nature of the knowledge created;
and (iii) that the mechanism converting economically useful knowledge into economic growth also varies over time. Until the late 1970s, incumbent firms were the main vehicles. Subsequently, new ventures have been the main mechanism, at least in the United States.”

The literature of organization structure subsumes Weber (1947) and Chandler (1969), generally concentrates on the connections between organizational structure and organizational performance (Teece, 1999), and includes interest in organizational networks, processes, and boundaries (Pettigrew and Fenton, 2000). The central thesis of contingency theory is that structure should fit a specific operating contingency, e.g., technology (Woodward, 1965), operational scale (Blau, 1970), or environment (Lawrence and Lorsch, 1967). The ambidextrous organization accommodates both evolutionary and revolutionary change (Tushman and O’Reilly, 1996). Mintzberg (1979) proposes archetypes, each with its own potential for innovation. A different approach is taken by economists who focus on strategy and see structure and strategy as the two key variables. Lazonick and West (1998) develop a theory of the innovative enterprise, which postulates that companies should achieve greater organizational integration to sustain competitive advantage. Teece (1999) explores connections among strategy, structure, and innovation, and he suggests that boundaries, formal (governance), informal (culture and values), and external networks influence the rate and direction of innovation. Teece also distinguishes between two types of innovation – autonomous and systematic – and matches them with different organizational structure; for example, systematic innovation, involving a system rather than an autonomous unit, requires a more integrated organization structure. Roper, Du, and Love (2008) model a value chain of innovation that highlights the structure and complexity of transforming knowledge into commercial value.
2.2 Traditional, user, cumulative, and open innovation

With the growth of the information technology industry (both hardware and software), new models of innovation have become apparent: viz., user, cumulative, and open innovation. These models rely on the themes of adaptation (how do we shape change in the market and industry environment?), cognition (how are we learning and creating knowledge to develop innovation?), and structure (what structural properties and factors allow us to drive innovation?). The models also identify the nexus among suppliers, customers (or users), rivals, and intermediaries. Though these models originated with information technology, they apply to other technologies.

Table 1: A comparison of innovation frameworks

<table>
<thead>
<tr>
<th>Model</th>
<th>Supplier</th>
<th>User/customer</th>
<th>Rival</th>
<th>Intermediary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chandler: Traditional</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Von Hippel: User</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scotchmer: Cumulative</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Murray &amp; O’Mahony: Cumulative</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Chesbrough: Open</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Adapted from West (2009)

Chandler and Hikino (1990) document processes by which companies innovated and organizationally developed in the nineteenth and twentieth centuries. In this traditional model of innovation, the centripetal force for innovation was within the company itself (i.e., supplier innovation). Mowery (2009), however, detects the adumbration in the nineteenth century and early twentieth century of elements of new innovation models, such as user and open innovation.
Von Hippel (1988, 2005, 2007, Baldwin and von Hippel, 2009) develops the model of user innovation, which notes that some suppliers can use the knowledge and objectives of their customers (or “users” in the software industry). Ideally, user innovation leads to the sellers getting a better product and the customers getting a better solution. Unlike supplier innovation, von Hippel describes supplier-customer (that is, supplier-user) innovation. This is innovation in the context of the market.

Scotchmer (1991, 2004) discusses the model of cumulative innovation, especially in the context of patents, innovation, and public policy. The innovation model here is between the supplier and its rivals. This is innovation in the context of the industry. In contrast to von Hippel, whose emphasis is on the market (i.e., demand), Scotchmer’s focus is the industry (i.e., supply) – an important distinction. Further, Scotchmer’s construct of a cumulative innovation model speaks more to public policy than business policy (i.e., strategy).

Chesbrough (2003b) explicates the model of open innovation as distinct from traditional, or closed, innovation. Open innovation presents a network of suppliers, customers, and rivals – all benefiting one another with innovations. Suppliers may collaborate with customers, as in von Hippel’s model. Suppliers compete with rivals but may also collaborate on research and development projects. This is innovation in the context of both the market and the industry, both demand and supply, and befits an economic model. Chesbrough (2006) also discusses the role of intermediaries that facilitate the exchange and the effect of intellectual property in combination with business models. With other researchers, he identifies opportunities for further academic research on open innovation (Chesbrough et al., 2006, Chesbrough, 2011) to develop a more comprehensive model.
Extending the concept of continuous innovation (Nonaka and Takeuchi, 1995), Hargadon and Sutton (1997) develop a model of technology brokerage. Hargadon (1998) builds this model to include the firm as knowledge broker. Though this model involves the literature of adaptability and structure, the model mainly adds to the literature of cognition (Elsbach et al., 2005, Hargadon, 2002, Hargadon and Fanelli, 2002). Hargadon focuses on the processes of invention to innovation as they occur within one or more firms (Sutton and Hargadon, 1996, 2001, Hargadon, 2003, 2005) in a framework built on a foundation of organization theory.

Hargadon, Murray, and O’Mahony focus on innovation within the organization of the firm. Using concepts from organization studies, Murray and O’Mahony (2007) expand Hargadon’s model of technology brokerage and discuss accumulating, combining, and reusing knowledge in innovation; referring to economic models, Murray and O’Mahony subsume the breadth of Chesbrough’s open innovation model and address the factors of supplier, user (or customer), rival, and intermediary. In this contextual process, innovation can start in academe, where inventing (making a technological discovery) can lead to innovating (developing the invention into a commercial product or service). The model that Murray and O’Mahony present is (1) the intersection of Hargadon’s organizational model and Chesbrough’s economic model and (2) the combination of theory from adaptation literature (how do we shape change in the environment?), cognition literature (how are we learning and creating knowledge to develop innovation?), and structure (what structural factors allow us to drive innovation?).

2.3 University technology transfer: Context

This section comprises, first, a brief historical account of technology transfer and, second, a review of important issues emerging during past decades.

2.3.1 Context: History in brief

University or academic technology transfer generally refers to a university or another institution conveying its intellectual property (e.g., one or more patents, trademarks, copyrights, or practices, including know-how) for purposes that can include the institution allowing the
commercial practice of the technology and, in turn, receiving a royalty or other proceeds of value.

The history of academic technology transfer organizations in the US spans more than 100 years. Arthur D. Little, a chemist educated at the Massachusetts Institute of Technology in the 1880s, retained close ties with the university, formed the eponymous consulting firm in 1909, and located the firm’s first office next to the university campus; by the early 1950s, the Massachusetts Institute of Technology owned more than 50 percent of the firm, which had by then established an outstanding record of commercial success with many inventions (Kahn, 1986). Hamermesh, Lerner, and Andrews (2011) document that, in 1912, three years after Little formed his firm, faculty at the University of California at Berkeley, established Research Corporation, an independent nonprofit organization to patent and license intellectual property on behalf of faculty and universities. The University of Wisconsin at Madison, raised money from alumni to establish the Wisconsin Alumni Research Foundation in 1925 to commercialize discoveries made by researchers at the university. Other universities formed offices to assist faculty with patenting and licensing, but efforts overall yielded relatively little commercial success.

By the 1930s an economic depression and then the second world war constrained interest in the commercial pursuit of university inventions. In 1944, at the request of President Franklin Roosevelt, Vannevar Bush, who led the US Office of Scientific Research and Development, wrote a report titled “Science: The Endless Frontier” to answer the question of what the federal government could do to aid research activities in private and public organizations. Bush’s report led to the formation of the National Science Foundation.
A precedent for Bush’s report was set 60 years earlier, in 1884, when the US Congress established the Allison Commission to examine federal expenditures on research, such as charting and mapping (geography), mining (geology), and meteorology. With a remit of investigating and eliminating overlapping jurisdictions among federal departments and offices, the commission expanded its hearings to take testimony from scientists and bureaucrats on the quality and productivity of federally-funded scientific research. Thus, the federal government established a rudimentary interest in science policy (Guston, 2000).

Throughout the 1950s and 1960s, federal grants to universities increased. In 1957, 84 percent of all federal research funds went toward military purposes, but by the early 1960s the National Institutes of Health funded more university research than the Department of Defense sponsored. Rarely did universities attempt to commercialize research during this period of increasing funding in the 1950s and 1960s.

US federal funding to universities decreased in the 1970s, and to offset the decline universities and federal agencies became more interested in commercializing research to pursue royalties and other streams of income. The federal government created the University-Industry Cooperative Research Program, administered by the National Science Foundation, to provide grants to faculty who also received funding from industry. Thursby and Thursby (2003) note that by 1980 legislation sponsored by Senator Birch Bayh of Indiana and Senator Robert Dole of Kansas became law; the major provisions of the Bayh-Dole Act allow universities to retain title to inventions developed under federally-funded research programs, encourage universities to collaborate with firms to promote commercial use of inventions arising from federal funding, expect universities to file patents on inventions that the universities elect to own, and require universities to give licensing
preference to small businesses. Under the act, the federal government retains a non-exclusive license to practice a patent throughout the world and maintains the right to assume all rights under a patent.

The Bayh-Dole Act focused US universities on commercializing research. In 1980, only 25 US universities had technology transfer offices, and by 2000 more than 200 US universities had TTOs (Hamermesh et al., 2011). University administrators whose responsibilities included licensing and patenting had formed the Society of University Patent Administrators in 1974, and this organization later became the Association of University Technology Managers. Since 1996, AUTM has conducted an annual survey called the AUTM Licensing Activity Survey, which compiles research and technology-transfer statistics by university. Since inception, the Licensing Activity Survey contains only quantitative data of inputs (e.g., invention disclosures) and outputs (e.g., patents). In 2011, AUTM published the Transaction Survey, which presented non-licensing data from university TTOs; this study acknowledged technology transfer offices’ numerous non-licensing activities including local economic development, promotion of research capabilities to industry and government, grant applications, agreements (e.g., material transfer, nondisclosure, inter-institutional, and consultancy agreements), and development of networks with present and potential sponsors of research. Though still a quantitative study, the AUTM Transaction Survey identifies non-licensing processes essential to the operation of academic technology transfer offices.

AUTM published a survey (Hofmann et al., 2002) that looked at differences between UK and US TTOs and found that UK research expenditures, per capita, are lower than those in the US; UK TTOs tend to have higher staff levels, fewer invention disclosures and patents, and greater emphasis on startups. Decter, Bennett, and Leseure (2007)
similarly identify differences between UK and US TTOs. UK universities have tended to emphasize publication of papers over pursuit of patents, and such emphasis on information (in UK universities) over invention (in US universities) affects UK TTO activity. The authors find differences between UK and US universities, for example, in how they view the role of the university, the purpose of research, and the role of technology transfer. UK industry tends to have less interest in university invention. Two significant findings are these: (1) the range of technology transfer practices is much more diverse in the UK than in the US and (2) UK TTOs tend to lack resources — from staff experience to government funds — in comparison to US TTOs. This study, however, fails to account for the broad diversity of resources, policies, and practices within US universities and within UK universities; for example, the Massachusetts Institute of Technology’s TTO has much more in common across every factor with the University of Cambridge than with Northeastern University; however, only two miles separate the two US universities, which are in Boston, traditionally the second most active venture capital market in the US.

As AUTM collects technology-transfer data in the US, government agencies and professional associations perform similar functions in the UK. The Higher Education Funding Council for England and the Higher Education Statistics Agency collect and publish annual data sets, including surveys of university intellectual property and interaction with industry. Prominent TTO associations in the UK, similar to AUTM, are the Association for University Research and Industry Links, which represents knowledge-transfer practitioners in academia and industry, and PraxisUnico, which supports research and commercialization activities at universities and charities. Many UK and US university technology transfer officers belong to other, similar organizations, such as the Association of European Science and Technology Transfer Professionals,
ProTon (a European knowledge transfer association), and the Licensing Executives Society International.

The history of university technology transfer in the UK helps explain many of the differences from US technology transfer. Flanagan and Keenan (1998) note that the government, surprised by national dependence on German industrial products at the onset of the first world war, responded by forming in 1915 an advisory council on scientific and industrial research and in 1916 the Department of Scientific and Industry Research. Established in 1919, the University Grants Committee began funding for faculty to work solely on research. In 1920, the medical council and, in 1931, the agriculture council began their support of research. With the start of the second world war, major programs funded research in electronics, aviation, atomic energy, and other scientific initiatives. After the war, government funds for science and technology continued mostly on military, health, and energy programs, with emphasis on science rather than technology.

Flanagan and Keegan (1998) observe that, by the 1960s, a question of priorities arose, as programs in nuclear physics and space research received relatively high levels of funding, and a discussion of economic development began. These discussions led to an “increasing focus on the potential role of science and technology in economic development, and of the possibility of directing research in certain directions in order to best achieve positive economic returns. Internationally, the newly-created [Organization for Economic Cooperation and Development] had published the Piganiol Report [in 1963] which had sought to mark a distinction between ‘policy for science’ and ‘science for policy’. This document claimed that expenditures on both education and research represented long-term investments in economic growth” (Flanagan and Keenan, 1998). Interest in the potential of science
and technology funding to spur and accelerate economic growth continued, although priorities, government organizations, and levels of funding changed with governments and the effects of global economic conditions during the ensuing decades.

Technology transfer organizations in the UK can trace a beginning to the National Research Development Corporation, established by the government in 1949 and merged with the National Enterprise Board in 1981 to complement scientific with financial activities. Thus emerged the British Technology Group in 1985 to commercialize academic intellectual property. Several years earlier the Higher Education Funding Councils began to fund basic research, and specific research programs were sponsored by the Research Councils (Adams and Bekhradnia, 2004).

In 2002 the UK government requested an independent review led by Richard Lambert with the objective of increasing cooperation between industry and academia to encourage and increase economic activities. The Lambert review (2003) concluded that government should more actively assist collaboration between universities and industries. The report also noted that government expectations of significant income from commercializing university inventions were often unrealistic. Another observation was that, despite the excellence of UK universities in research and development for international firms, UK firms seem to place relatively little value on the benefits of academic collaboration. The report favored regional technology transfer offices for universities and encouraged licensing inventions to industry rather than starting up or spinning out ventures.

In 2007, with the government’s commission, Lord Sainsbury of Turville conducted a review and issued a report, “The Race to the Top: A Review of Government’s Science and Innovation Policies,” that generally
underscored the importance of industry-university collaboration and university technology transfer in a global business environment (Sainsbury, 2007). The Sainsbury report listed approximately 70 recommendations, mostly for coordination of government operational support. Lord Sainsbury issued a subsequent report with an emphasis on implementation of the 2007 report’s recommendations (Sainsbury, 2008).

In general, government-funded research occurred earlier in the UK than in the US, industry-sponsored research and collaboration began earlier in the US, and university-organized technology transfer started earlier in the US.

2.3.2 Context: Issues, historical and current

This recitation of chronological events, however, misses important debates and issues that lend insight to the historical and the present context of technology transfer, especially from the perspective of government science policy, which has a vast effect on universities and their transfer of technology. Seven issues are particularly noteworthy: (1) the linear model, (2) the definition of basic research, (3) knowledge exchange, (4) technology transfer and commonweal, (5) university-industry partnerships, (6) the social contract of science policy, and (7) the entrepreneurial university, and.

1. The linear model of innovation is a framework claiming to explain the connection between scientific research and economic growth. The linear model asserts that innovation begins with basic research, which leads to applied research (or research and development), which in turn leas to production and ultimately to
diffusion in the market. Godin (2006) explains, “The precise source of the model remains nebulous, having never been documented. Several authors who have used, improved, or criticized the model in the past fifty years rarely acknowledged or cited any original source. The model usually was taken for granted. According to others, however, it comes directly from [Vannevar] Bush’s ‘Science: The Endless Frontier’.” Edgerton (2004) argues that the linear model is “simplistic”, “inaccurate”, and a distraction from how innovation occurs. Stokes (1997) challenges the one-dimensional linear model and proposes a two-by-two matrix. Of the four quadrants, the upper left quadrant represents basic research without regard for application (e.g., Bohr’s research on the atom). The lower left quadrant represents taxonomic studies. The lower right quadrant represents applied research without regard for fundamental understanding (e.g., Edison’s work). The upper right quadrant represents Pasteur’s work: “basic research that seeks to extend the frontiers of understanding but is also inspired by considerations of use” (p. 74). Stokes recommends that scientists and policy makers give greater attention to Pasteur’s quadrant.

2. The definition of basic research, like the linear model, has been questioned and debated. Calvert (2006), for example, maintains that basic research is “a flexible and ambiguous concept that is drawn on by scientists to acquire prestige and resources.” Similarly, Clarke (2010) shows that the term “fundamental research” was first intended as a synonym for “pure science” and was eventually used for applied research by the Department of Scientific and Industrial Research to gain political support for science polices.
3. The term “technology transfer,” defined in a strict sense of simply licensing a patent from a university to a commercial firm, is superseded by the term “knowledge transfer,” which entails the broad and deep transmission of academic knowledge to industry (subsumes the license of academic patents to industry and). “Knowledge exchange” denotes a free (or freer) flow of knowledge among a “triple helix” of universities, commercial firms, and governments (Leydesdorff and Meyer, 2006). Knowledge exchange as a term has been used for decades in connection with technology transfer (e.g., Gruber and Marquis, 1969) and more recently has been applied to university technology transfer (e.g., Collins and Smith, 2006, Acworth, 2008, Martinelli et al., 2008, Yusuf, 2008, Ponds et al., 2009, Hughes and Kitson, 2012). Knowledge exchange, in the context of organization theory and practice, has been an important concept (e.g., March and Olsen, 1976, March, 1988, Nonaka, 1994, Becker et al., 2006, Ward et al., 2012). Indeed, the concept of knowledge exchange has a connection to the three themes of innovation and organization theory – viz., adaptability, cognition, and structure – and to the concept of open innovation (Chesbrough, 2003b). Knowledge exchange as a concept provides a bridge between organizational and economic concepts of university technology transfer.

4. The connection between university technology transfer and commonweal remains a topic of debate. The ostensible motivation and purpose of university technology transfer is ultimately the public welfare; at least this is the view of politicians and others who vocally support statutes and regulations in effect at the present time. The distinction between public benefit and private benefit is sometimes difficult to discern. The notion of ultimately benefitting the public may entangle private benefit and may even
exclude public benefit for a period of time. For example, in the US, under the Bayh-Dole Act, a university may use government funds (i.e., public money), make a discovery, and then license that discovery – say, a molecule with potential therapeutic benefit for millions of people throughout the world – to a pharmaceutical firm, which develops a therapy slowly to avoid competition with another, highly-profitable proprietary therapy sold by the same firm; only after fully exploiting such sales, the firm releases the therapy based on the university license and then, to keep prices as high as possible, engages in a series of maneuvers to extend the effective life of the patent. This hypothetical illustration shows how universities and firms could hinder public welfare through typical practices of university technology transfer. Though this illustration is hypothetical, the historical connection between the use of public funds for university and commercial interest is clear in the US. Stevens (2004) notes that immediately after the Bayh-Dole bill was passed by the US Senate on 23 April 1980, Senator Birch Bayh said, “What sense does it make to spend billions of dollars each year on government-supported research and then prevent new developments from benefiting the American people because of dumb bureaucratic red tape?” Indeed, the title of the bill was “The University and Small Business Patent Procedures Act”. The impetus for the bill was a complaint from administrators at Purdue University, a large public research university in Indiana, the state which Senator Bayh represented. Purdue administrators said the university had benefited from federal grants of patent rights to the university, and the administration of President Jimmy Carter was attempting to rescind those rights and stop grants of further rights. The rights to the patents made money for Purdue, and support for the Bayh-Dole bill gathered momentum as universities throughout the US lobbied senators to vote for the bill.
The bill passed the US Senate with 91 votes in favor and 4 in opposition. Under the Bayh-Dole Act, universities have profited from licensing to firms in the private sector, from the smallest venture capital firms to the largest global enterprises, and those firms have often profited too. If universities perceived that the total costs of licensing exceeded the sum of all the benefits to the university, then academic licensing may have ended long ago. Academic studies (e.g., Jensen and Thursby, 2001, Thursby et al., 2001, Jensen et al., 2003, Moore et al., 2005, Sweeney, 2011) highlight apparent changes in pecuniary motivations, purposes, and behaviors at US universities since Bayh-Dole became law. The debate over university technology transfer and commonweal may depend on how one defines the public welfare.

5. Powell, Owen-Smith, and Colyvas (2007) examine technology transfer at US universities and warn, “University–industry partnerships will never generate the returns that politicians and administrators covet. Nor will curiosity-sparked research ever find wide industrial support. But it is precisely this research that produces breakthroughs and spawns new industries. Few corporations appreciate this fact, much less support it financially. But universities that become obsessed with intellectual property threaten the culture of inquiry that is the soul of the academy. The current tendency to favor exclusive licenses, and to regard science as property, may, if unchecked, have negative consequences for economic growth. Those who wish to emulate the US [technology transfer] experience would be well to recognize this possibility, and to avoid its uncritical acceptance.”

6. Consistent with this warning is a call for greater transparency, responsibility, and accountability in government science policy
and for a more inclusive definition of the public interest in science and technology transfer. In a study of the British biomedical industry, de Chadarevian (2011) concludes, “As the story told here suggests – and as critical voices indicate – what is at stake is not just economic competitiveness and biomedical innovation, but the redefinition of the notion of the public good of science and its broad ramifications.” Gibbons (1999) asks, “If the boundaries between science, technology and society are becoming more permeable, why should not a similar approach in science likewise produce more socially robust solutions?”

7. Nelles and Vorley (2010, 2011) expand and explicate this policy theme in their discussion of the third mission of universities and their architecture for entrepreneurial universities. The first two missions of a university are teaching and research; over the past 20 years, a third mission of socio-economic engagement has developed. Nelles and Vorley note that that the third mission is defined broadly by Jongbloed et al. (2008) as all institutional activities beyond teaching and research and is defined narrowly by Hackett and Dilts (2004) as technology transfer. Nelles and Vorley employ and develop a concept of entrepreneurial architecture as a perspective for understanding the third mission and its origins in public policy, government funding, and political decision making, which has intentionally extended the function and reach of universities. The concept of an entrepreneurial university may trace origins to Romer (1986) and Lucas (1988), who quantify a new variable – knowledge – in their economic models. They present knowledge as a key driver of economic growth. The models represent not only an advance in economics but also an advent for recognition of universities not only as vast reservoirs of knowledge but also as entrepreneurial organizations creating,
disseminating, and exchanging knowledge. Slaughter and Leslie (1997) note that universities endogenously encourage entrepreneurial behavior (e.g., provide incentives for academic researchers to develop commercially their inventions) and exogenously serve as a locus of entrepreneurial activities (e.g., license technologies to startups, collaborate in research and development with venture capital firms and industrial firms, offer science parks and other facilities for startups connected with or even unrelated to the university, and host entrepreneurial events). Etzkowitz (2003) observes that the entrepreneurial university is a manifestation of an intrinsic logic “of academic development that previously expanded the academic enterprise from a focus on teaching to research. The internal organization of the research university consists of a series of research groups that have firm-like qualities, especially under conditions in which research funding is awarded on a competitive basis. Thus, the research university shares homologous qualities with a start-up firm even before it directly engages in entrepreneurial activities.”

Bureaucratic structure notwithstanding (Styhre and Lind, 2010), universities, including their technology transfer offices, are increasingly adopting and adapting entrepreneurial perspectives and behaviors, as noted in numerous academic studies (e.g., Etzkowitz, 1998, Etzkowitz et al., 2000, Etzkowitz, 2003, Etzkowitz, 2004, O’Shea et al., 2005, O’Shea et al., 2007, Siegel et al., 2007, Clarysse et al., 2011, de Chadarevian, 2011).

Kerr (1963) warns of changes at universities, first in the Godkin Lectures on the Essentials of Free Government and the Duties of the Citizen (a lecture series at Harvard University) and then in a book containing his lectures. Here and elsewhere, Kerr candidly notes transformative changes at US universities and the emergence of a
university-government-industry complex, an observation and a theme reminiscent of President Eisenhower’s caution during his farewell address two years earlier of a military-industrial complex. Kerr (1963, p. 45) writes, “The multiversity in America is perhaps best seen at work, adapting and growing, as it responded to the massive impact of federal programs beginning with World War II. A vast transformation has taken place without a revolution, for a time almost without notice being taken. The university has demonstrated how adaptive it can be to new opportunities; how responsive to money; how eagerly it can play a new and useful role; how fast it can change while pretending that nothing has happened at all; how fast it can neglect some of its ancient virtue.” It is noteworthy that Kerr was chancellor of the University of California at Berkeley and then president of the University of California system while this transformation occurred, two of the most powerful positions in US academia. (It is ironic that for the next 38 years, without explicit recognition of personal amenability, he inveighed against transformations that were, directly or indirectly, results of policies and practices that he either encouraged or failed to discourage.) In later editions of the book, he affirms his criticism and expands its scope. For example, in the fifth edition, Kerr (2001) writes that the concern of faculty “with the general welfare of the university is eroded and they become tenants, rather than owners, taking their grants with them as they change their institutional lodgings. The university, as Allen Wallis, president of the University of Rochester, has remarked, becomes to an extent a ‘hotel.’ The [government] agency becomes the new alma mater. The research entrepreneur becomes a euphoric schizophrenic” (p. 45) and that the “university and segments of industry are becoming more alike. As the university becomes tied into the world of work, the professor – at least in the natural and some of the social sciences – takes on the characteristics of an entrepreneur... The two worlds are merging physically and psychologically” (p. 68).
Though the discussion here of these debates and issues is necessarily brief, it acknowledges the contextual intricacies of the environment in which university technology transfer operates. Weaving through several of the debates (viz., the linear model, knowledge exchange, university-industry partnerships, and the entrepreneurial university) are threads of the literature of organization theory and innovation (i.e., adaptation, cognition, and structure) and of models such as open innovation by Chesbrough, technology brokerage by Hargadon, and cumulative innovation by Murray and O’Mahony.

2.4 University technology transfer: Literature

Phan and Siegel (2006) examine the effectiveness of US and UK TTOs and reach conclusions that, they argue, apply equally to UK and US TTOs; to wit, universities must address skill deficiencies in TTOs, TTOs must educate faculty in starting new ventures and in working with entrepreneurs, and business schools are well positioned within the university environment to address these skill and knowledge deficiencies through special programs for technology transfer officers and academic researchers.

With many UK and US academic institutions systematically engaged in technology transfer only after 1990, the literature of academic technology transfer is comparatively recent. One or two articles were published annually in peer-reviewed journals in the 1980s, and less often before then (Rothaermel et al., 2007).

Four themes encompass most of the literature: facilities, transactions, startups, and intermediaries. Although most literature addresses multiple themes, one theme generally predominates in each
journal article or book chapter (Siegel and Phan, 2005). Within the context of the three themes of innovation – adaptability, cognition, and structure – the four themes of academic technology transfer literature tend to connect most with structure and least with cognition.

Facilities – science parks, incubators, and other entities providing offices, laboratories, and other means of support for startup firms – constitute one theme in the study of technology transfer. Link and Scott (2003) employ survey data and regression analysis to conclude that science parks increase the quantity of university patents and publications. The parks also facilitate the hiring of university faculty and graduates, especially when the parks are near the university. Link and Link (2003) use survey data to determine that the number of science parks was rapidly increasing. Link and Scott (2005) find that startups are a higher percentage of the firms in science parks that are older, closer to richer university research environments, and focused on biotechnology. In both the Link and Scott 2003 study and the Link and Link 2003 study the data came from the Association of University Related Research Parks. Rothaermel and Thursby, analyzing data on one university incubator, study linkages to licenses and researchers and the knowledge flow from universities to incubator startups (2005a) and the absorptive capacity of those startups (2005b).

The theme of transactions is evident in the literature analyzing patenting and licensing activities. In general, the methodology is quantitative, and at least some data in the study derive from surveys of the Association of University Technology Managers, a professional organization for technology-transfer administrators at universities mostly in the United States. Associations in the United Kingdom providing data for studies have been the University Companies Association, PraxisUnico, and the Association for University Research and Industry Links. Thursby,
Jensen, and Thursby (2001) use regression analysis to analyze invention disclosures, licenses, and royalties. Jensen and Thursby (2001) find that university patent licensing increases commercial use of federally-funded research in the United States. Thursby and Thursby (2002) analyze trends in patenting and licensing at universities with trends in outsourcing by firms. Colyvas, Crow, Gelijns, Mazzoleni, Nelson, Rosenberg, and Sampat (2002) examine the patenting and licensing and the efficacy of technology transfer. Shane (2001) finds that the probability of a university invention leading to a license with a startup is influenced by how important and radical the invention is and how broad and deep the scope of the patent is; Shane’s method in this study is regression analysis. Carlsson and Fridh (2002) employ linear regression to explore the research expenditures, invention disclosure, technology office tenure, university patenting, and university licensing. Owen-Smith and Powell (2003) build several quantitative models and determine that, in patenting and licensing, technology transfer offices can learn from networks of corporate partners and consequently can more effectively evaluate the potential of invention disclosures. Network ties allow technology transfer offices to develop better patent and license portfolios; however, academic-corporate ties that become too close effectively limit the impact of portfolios. Shane (2002) also concludes as a result of regression analyses that effective university patents increase the probability of (1) licensing, (2) licensing to non-inventors, and (3) greater success and higher royalties from licensing to non-inventors instead of inventors. Sine, Shane, and Di Gregorio (2003) examine the halo effect (i.e., the effect of university prestige) on licensing; after using regression analysis on data from more than 100 universities from 1991 through 1997, they conclude that the halo effect increases the quantity of licenses and the rate of future inventions. In a study relying on quantitative and qualitative data, Agrawal and Henderson (2002) explore the magnitude, direction, and impact of knowledge transfer resulting from patents from
the Massachusetts Institute of Technology. Zucker, Darby, and Armstrong (2002) find that collaborative research articles between firm scientists and top research university scientists can lead to effective knowledge transfer and firm success. Siegel, Waldman, and Link (2003) use stochastic frontier analysis and field interviews to analyze the scaling of licensing and to conclude that technology licensing officers add significant value to the process of commercialization. Link and Siegel (2005) use the same quantitative method to investigate efficiencies, royalty sharing, and licensing income. Chapple, Lockett, Siegel, and Wright (2005) also rely on stochastic frontier analysis to explicate scale, efficiency, and environmental factors at university technology transfer offices in the United Kingdom. Debackere and Veugelers (2005) study the balance between centralization and decentralization, incentives, structures, monitoring, and decision making in the connections between research groups and technology transfer offices. Mowery, Nelson, Sampat, and Ziedonis (2001) rely on data provided by three universities (Stanford University, the University of California system, and Columbia University) and conclude that the Bayh-Dole Act of 1980 is one factor, and not the only factor, driving the growth of patenting and licensing at universities in the United States. Mowery and Ziedonis (2002) further examine Bayh-Dole’s effect on the quantity and quality of patents at US universities. Mowery, Sampat, and Ziedonis, (2002) examine the experience of universities during the first decade of the Bayh-Dole Act. Mowery (2011) also examines the cross-border emulation effects of the Bayh-Dole Act as governments and universities enact laws, adopt policies, and implement practices to increase the quantity of university technology transfer. In a quantitative study, George (2005) examines the history of the Wisconsin Alumni Research Foundation, which is the technology transfer office of the University of Wisconsin, between the years of 1925 and 2002; using data on patenting and licensing from that period, he explores experiential learning and the cost of capability development. Fabrizio (2007)
conducts a quantitative analysis and finds that university patenting may hinder or slow industrial innovation. Chang, Yang, and Chen (2009) use a quantitative methodology with the numbers of patents, licenses, and startups as dependent variables to report that, in the commercial performance of academic research in Taiwan, two types of organizational ambidexterity are evident: structural and contextual. Czarnitzki, Hussinger, and Schneidery (2011) examine academic patenting using a sample of German scientists and find implications for scholarly publication and professor privilege (which is a German counterpart to the United States’ Bayh-Dole Act).

Startup firms emerging from universities present another theme. Louis, Blumenthal, Gluck, and Stoto (1989) conducted one of the earliest studies. Using regression analysis of data from life-sciences faculty, the study shows that the main determinant of professors starting businesses is that their peers are starting or have started businesses; the group norm is more important than academic policies or structures. In more recent studies, Shane and Stuart (2002) conduct quantitative analyses and conclude that in university startups the founders’ social capital provides and important organizational endowment (i.e., an embodiment of resources) contributing to the startup’s success. Di Gregorio and Shane (2003), using regression analysis on AUTM data, find that the two key factors driving startup formation are the quality of faculty and the ability of inventors and their university to receive equity in the startup. Nerkar and Shane (2003) use data from startups at the Massachusetts Institute of Technology and conclude that the most important dimension in startup strategy is industry concentration. Nicolaou and Birley (2003) conduct a quantitative study to examine the influence of social networks of academics in university startups, academic stasis and exodus, and the extent of academics’ participation in the startup. Feldman, Feller, Bercovitz, and Burton (Feldman et al., 2002) conclude that universities
increasingly welcome equity in startups because the equity stake offers potentially more cash and aligns objectives more effectively between universities and other equity holders in the startup. Markman, Phan, Balkin, and Gianiodis (2005b) reach the opposite conclusion: universities, averse to risk while intent on maximizing short-term income, tend to avoid early-stage technology startup formation, which carries greater costs and potentially greater rewards. Markman, Gianiodis, Phan, and Balkin (2005a) further the theory of innovation speed and conclude that the faster that technology transfer offices can license technology patents, the higher their licensing income and the greater the number of startups they create. Ensley and Hmieleski (2005) find that university startups significantly underperform non-university startups in both cash flow and revenue generation. Vohora, Wright, and Lockett (2004) conduct a case study analysis of university startups and find distinct, sequential, iterative, and non-linear activity phases in the development of the new firms and identify, between phases, important junctures requiring critical resources and capabilities necessary to proceed to the next phase. The four critical junctures are: opportunity recognition, entrepreneurial commitment, credibility, and sustainability. Lockett and Wright (2005) find that the number of startups created, both with and without equity investment, are significantly and positively correlated with expenditure for protection of intellectual property, the business development capabilities of technology transfer offices, and the university’s royalty policies and practices.

Link and Siegel (2007) conclude that “the extant literature on TTOs suggests that the key impediments to university technology transfer tend to be organizational in nature.” They note that organizational researchers are beginning to connect the economic models in the literature with organizational drivers. TTO literature is nascent, and it has tended to describe and inventory phenomena. Theory is emerging,
however, and the authors cite organizational theories as the key: path
dependency, evolutionary economics, institutional theory, structural
contingency theory, and social network theory. Link and Siegel believe
that organizational theory could provide a basis for better insights.

The literature of intermediaries connects technology transfer with
open innovation and cumulative innovation. Intermediaries in this
context are firms that acquire, develop, sell, or broker intellectual
property. Such firms are external to, but cooperative with, one or more
universities. Some firms have exclusive relationships with one or more
universities; examples include Imperial Innovations Group plc and IP
Group plc. Many intermediaries operate between universities and
companies (including startups formed by intermediaries as well as global
corporations) to add value in the process of turning inventions from the
laboratory into products in the marketplace. Mowery and Sampat (2001)
review the history of Research Corporation, founded in 1912, which
administered inventions and patents for educational and research
institutions and provided grants for scientific researchers. Howells
(2006) investigates intermediation and the role of intermediaries in the
innovation process. Chesbrough (2006) and Nambisan and Sawhney
(2007) analyze diverse business models of intermediaries, including firms
focusing on transferring technology (typically patents) from academic
institutions. Hansen and Birkinshaw (2007) examine the innovation
value chain as a process, rather than as a business model. The innovation
value chain is a tool used by intermediaries and other firms. Further,
intermediaries themselves can function as a tool within the value chain;
Hansen and Birkinshaw refer to open innovation (Chesbrough, 2003b)
and user innovation (von Hippel, 2005) as tools for external sourcing of
innovation.
Separate and different from these comparatively recent models of innovation are historical models of innovation and technology transfer. Schumpeter (1934, 1949) argues for a combinatory model that implies transfer of knowledge or, in the instance of a technological invention, the transfer process by which an invention becomes an innovation. Other scholars began to conduct research on technology transfer, and they developed models (or, frameworks, approaches, or processes, among other terms) of innovation and technology transfer.

With research conducted by the Rand Corporation, Bar-Zakay (1971) presents a program evaluation and review technique (PERT) diagram listing sequences and time frames for activities performed by technology “donors” and technology “recipients”. Bar-Zakay's diagram could apply to technology transfer within and between firms and within and across national borders.

Langrish (1971) and Langrish et al. (1972) add an important dimension to models of technology transfer. Asking whether technology is pushed to or pulled by the market, they observe that technology transfer can arise from “need pull” rather than from "discovery push" alone; indeed, they argue, “need pull” is a prevalent model. Langrish (1979) develops the argument and maintains that both push and pull are necessary for a technology to achieve commercial success.

Research conducted at the Science Policy Research Unit at the University of Sussex and published by Rothwell and Robertson (1973) describes a more comprehensive model, or process. They describe the process as “a logically sequential, though not necessarily continuous, process, which can be sub-divided into a series of functionally separate, but interacting and interdependent stages, and the overall pattern of the innovation process can be thought of as a complex net of communication
paths linking the various stages of the process” (p. 204). Rothwell and Robertson discuss “technology-push” and “need-pull” as essential to their process.

Morphet (1974) continues a discussion of push and pull with research from the R&D Research Unit at Manchester Business School. Morphet identifies “source systems” and “user systems” and offers a framework that proceeds sequentially from idea generation to selection and then to approach. At the approach stage, the source approaches the user, and the user either accepts or rejects the technology from the source. Technology transfer occurs when the user accepts the technology from the source. Morphet also recognizes what he terms “discovery-push” and “need-pull” and their function in actuating his model.

Jung (1980) applies Lewin’s field theory in social science to focus on identifying and removing barriers to technology transfer. Jung addresses a dynamic environment entailed by Lewin’s theory and discusses cognitive and behavioral issues in technology transfer. Jung acknowledges the importance of social context within and between organizations and the effect of “supplier push” and “user pull” in the transfer of technology.

Voss (1984) focuses on the role of suppliers and users in innovations and finds that “technology push” is more prevalent than “need pull” in a study of technology transfer in the application software industry.

Rothwell (1992, 1994) presents what he terms a fifth generation of innovation and technology transfer models. He calls the first generation, in practice from the 1950s to the mid 1960s, the “technology push” model. The second generation, from the mid 1960s to the early 1970s, is the
“market pull” model. The third, from the early 1970s to the mid 1980s, is the “coupling” model; this is essentially the model presented earlier by Rothwell and Robertson (1973). The fourth generation, from the mid 1980s to the early 1990s, is the “integrated” model, which, unlike earlier models, emphasizes integration and parallel development of innovations. The fifth generation is essentially the fourth generation model; the difference is that, in the fifth generation, the technology itself is evolving as the technology transfer process is occurring.

It is noteworthy that all of these models – Bar-Zakay’s. Langrish’s, Rothwell’s and Robertson’s, Morphet’s, Jung’s, and Voss’ – show only unidirectional flow, except for Rothwell’s fourth and fifth generation models, which finally contain feedback loops (1992, 1994). Kline and Rosenberg (1986) offer their chain-linked model, which includes numerous feedback loops among research, knowledge, potential markets, analytic designs, product testing, and product marketing. The chain-lined model has little relevance at present – much has changed during the past 25 years in innovation processes – but the model does suggest both iteration and discontinuity, two concepts which are important to this study.

Unlike these historical models of innovation and technology transfer, other models focus exclusively on university technology transfer. Smilor et al. (1990) study 23 startups from one university, the University of Texas at Austin. The major finding of the study is that “pull factors proved to be far more important than push factors in influencing the start-up of a spin-out company” (p 74). Siegel et al. (2004) develop a model after conducting 55 structured interviews at five universities (Duke University, the University of North Carolina at Chapel Hiss, North Carolina State University, Arizona State University, and the University of Arizona). Although the study makes no mention of either push or pull
factors, the study presents a technology push model by specifically citing as a requisite activity “marketing of technologies to firm.” This model may apply to the five universities participating in the study but fails to represent the process of technology transfer at many universities (especially those with significant intellectual property in life sciences) that rely more on market pull. More important, none of these models captures what happens at present in innovation processes in university technology transfer.

In sum, the literature of university technology transfer (1) heavily emphasizes quantitative studies measuring inputs and outputs of facilities, transactions, startups, and intermediaries, (2) includes comparatively few studies examining processes, and they typically employ quantitative analyses, (3) largely ignore any application of organization theory to innovation (i.e., adaptation, cognition, and structure), and (4) study technology transfer organizations from perspectives other than technology transfer officers’.

2.5 Conclusion

The literature of innovation – comprising the literature of adaptation, cognition, and structure – is broad and deep. During the past several decades, important debates have emerged from research and theory, and they have been featured in books and leading business journals, such as Administrative Science Quarterly and the Academy of Management Journal. Research methodologies are diverse, and the analyses are generally sound.

Organization theory proceeds from this literature and informs the practice of innovation; this is evident in the literature of user, cumulative,
and open innovation, which presents contextual perspectives of innovation and organizations. These models of innovation are insightful, provocative, and reflective of the current business environment in industry. Research has focused on inter-organization, dyad, and firm analysis. Comparatively little research has focused on the intra-organizational context of open innovation (Vanhaverbeke, 2006), and three scholars are notable for their work within this theme. Hargadon’s model of technology brokerage lends significant insight to how innovation happens. His research, however, focuses on firms, not academic institutions. Murray and O’Mahony make an important contribution in explicating access, disclosure, and rewards and their connection to the economic models of user, cumulative, and open innovation.

The literature of academic technology transfer reflects increasing interest in the topic since the 1980s. Methodologies and analyses are generally sound, especially in the highly ranked journals. Quantitative methods tend to prevail, particularly regression analysis. Rothaermel, Agung, and Jiang (2007) note that, because of the embryonic stage of technology transfer literature, most of the research has appeared outside of general management journals. They observe that the high percentage of quantitative studies is unusual for an emerging field and offer the explanation that methods and frameworks from neighboring fields, such as economics, and the availability of quantitative data (from AUTM, the United States Patent and Trademark Office, and the European Patent Office) have encouraged the preponderance of quantitative research. As the field of academic technology transfer matures, more qualitative research may emerge, and the best journals may become more open to publishing articles in this field.
Comparing university TTOs in the United Kingdom and the United States reveals certain similarities. TTOs in both nations share an objective of transferring knowledge from university research to industry and an interest in protecting and then licensing intellectual property to commercial enterprises including spinout firms. Organizational structures of technology transfer operations are roughly similar in many TTOs in the UK and the US, as are many administrative practices within the TTOs. The same comparison, however, also exposes differences in the effects of history, public policy, university policy, and TTO policy, but these differences are evident among universities within the same nation.

An opportunity is evident (1) to extend organization theory – particularly the literature of adaptation and cognition – into a study of innovation processes in university technology transfer organizations, (2) to reflect the perspective of university technology transfer officers, (3) to explore and explain university TTOs with a qualitative approach (rather than the usual quantitative approaches), and (4) to develop and improve relevant frameworks (e.g., those presented by Hargadon and by Murray and O’Mahony) that begin to explain thoughts and actions (i.e., activities grounded in the cognition and the adaptation literature of innovation) of technology transfer officers as they engage in innovation processes at universities in the UK and the US.

Thus, emerging from the intersection of these themes in the literature is a framework that unifies contributions of earlier research and focuses this study.

Employing Mohr's definition of a process – i.e., a set or series of perceptible conditions and actions that together influence or result in a distinct outcome (Mohr, 1982) – and building on research by Hargadon
(1998) and by Murray and O'Mahony (2007), Figure 1 presents a conceptual framework for this research.

This conceptual framework offers a representation and summary that highlights the most important concepts from the literature and frames them to show their logical progression. In this study, the progression begins with the broad themes of adaptation, cognition, and structure in the literature of innovation. Entailed by, deriving from, and nesting within these themes are models of innovation developed by von Hippel (1998), Chesbrough (2003), and Murray and O'Mahony (2007). Nesting within these models resides the focus of this study: the context of university technology transfer, the organization of a university technology transfer office, Mohr’s (1982) definition of process (a set or series of perceptible conditions and actions that together influence or result in a distinct outcome), and insights on conditions and actions from Hargadon (1998) and Murray and O’Mahony (2007).

Murray and O’Mahony (2007) identify three conditions: disclosure, access, and rewards. Disclosure pertains to academics revealing their discoveries or inventions to their TTO. Access corresponds to a TTO making disclosures (or patents ensuing from disclosures) available for perusing by and licensing to entrepreneurs, venture capitalists, corporate executives, and their firms. Reward encompasses incentive or incentives (e.g., pecuniary and reputational incentives) for academics to participate in this process.

Hargadon (1998) and Murray and O’Mahony (2007) ground these conditions and actions in organization theory, explain the operation within the context of innovation, and meet Mohr’s (1982) definition of process: a set or series of perceptible conditions and actions that together influence or result in a distinct outcome. Thus, the framework depicted in Figure 1 proceeds from analyzing and synthesizing the literature. This study applies that framework in a context of UK and US technology transfer offices, which presents a novel context for this framework.

Figure 1: A conceptual framework for context, conditions, and actions in an innovation process of university technology transfer

![Figure 1: A conceptual framework for context, conditions, and actions in an innovation process of university technology transfer](image-url)
3. Methodology

This section begins by providing a contextual overview of university technology transfer offices. The overview is followed by a general description of the research, the research question, and justification for this research question. A conceptual framework accompanies a discussion of the research strategy and methodology. A description of the conduct of this research follows, and then an explanation of ethical considerations precedes a conclusion.

3.1 Research context: University technology transfer offices

This study focuses on university technology transfer offices. Hundreds of universities in the UK and US have established an organization to facilitate the transfer of technologies from the university to industry, with public use and benefit as the ultimate objective; the university organization is typically called or identified as a technology transfer office. Graff, Heiman, and Zilberman (2001, p. 112) describe TTOs as “a recent institutional innovation created by universities to provide a new marketing channel and to improve this flow of trade between university research and industry.” The technologies that a university transfers may include one or more patents, patent applications, trademarks, or copyrights and may include know-how for practicing an invention. The transfer of technology typically occurs through a legal contract, often a license agreement, in which the university grants the right or rights of one or more technologies to a commercial entity for present or future consideration, or both. The commercial entity can range from a firm newly formed to bring the technology to market or a firm with global operations and hundreds of thousands of employees.
Consideration can include a payment at the time of executing the license, a grant of shareholders’ equity, and royalty payments.

As the technology transfer organization collects payments from licensees, those payments generally are applied to expenses (e.g., fees already paid for patent prosecution) and then allocated and distributed if exceeding expenses. Distribution schemes vary, and in the UK they are typically much more generous to the inventor or inventors. For example, a typical allocation at a UK university may give an inventor (or inventors) between 50 percent and 95 percent of all proceeds in excess of expenses; the larger the university’s investment in commercializing the technology, the lower the inventor’s percentage. The remaining percentage goes to the university. In the event of a windfall – say, a startup with a highly successful initial public offering – the university may allocate a tiny percentage of the proceeds to the inventor’s department or school or college within the university. In the US, after a university recovers all of its expenses associated with the intellectual property under license, the allocation typically ranges from 25 percent to 40 percent for the inventor (or inventors), 25 percent to 30 percent for the inventor’s department, and 30 percent to 50 percent for the university. US universities typically have an allocation policy applying to all inventions irrespective of the investment made or expenses incurred for that technology by the university.

University technology transfer offices vary more in number of staff than in function of staff. The most current AUTM surveys, which poll more than 100 TTOs, indicate that approximately 40 percent of TTOs have 1 to 10 staff; 30 percent, 11 to 20 staff; 20 percent, 21 to 30; and 10 percent, 31 or more staff. In the last group, nearly all have staff between 31 and 40; three TTOs have between 55 and 80 staff (viz., the University of Washington, the University of Wisconsin, and the University of
Minnesota) (AUTM, 2006-2010). Offices with more than 10 staff are typically organized into teams or groups focused on specific technologies (e.g., life sciences or information technology) or activities, such as pre-licensing, licensing, and post-licensing activities.

Pre-licensing activities include seeking and receiving invention disclosures from academic scientists at the university as they make discoveries. Invention disclosures are generally a report describing and explaining an invention. If a discovery is made while using proceeds from a firm-sponsored grant, then the TTO should inform the firm of the invention. If a grant is government-sponsored, generally the terms of the grant require the inventor and the TTO to notify the government of the invention. The TTO decides on whether to elect title for a discovery made with external funding, if that option is available. The TTO must also decide on whether to file one or more patent applications. Pre-licensing activities also include negotiation and execution of material transfer agreements, which govern the transfer of tangible research material, such as biologic materials, from a university to a firm or other entity for evaluation; for example, a pharmaceutical firm may request a material transfer agreement to assess a molecule before reaching a decision on whether to license it from a university. Another pre-licensing activity is identifying potential licensees; most often they are industry executives, entrepreneurs, and venture capitalists. This is often one of the two most time-consuming activities; the other is the licensing process itself.

The licensing process focuses on negotiating an agreement on the terms of the license agreement between a university and a firm. The time period for finding one or more potential licensees and signing a license agreement can span years.
Post-licensing activities typically involve collection and compliance; collecting payments due under the terms of the license and ensuring that both the firm and the university are complying with other terms of the agreement and that the university is complying with its reporting requirements to government.

3.2 Research description and research question

This research project derives from the research’s direct observations throughout a period of more than 15 consecutive years while working with academic researchers, technology transfer officers, industry executives, venture capitalists, entrepreneurs, and public policy researchers. They generally have diverse experiences, divergent perspectives, and little or no comprehension of what the others do, how they do it, and why. For example, many industry executives, including chief innovation officers, believe that innovation begins only after intellectual property is licensed from a university to a firm for commercialization. This belief is fundamentally different from the view of most technology transfer officers; they believe that innovation begins in the university and that their process demonstrates an innovation process.

Further, industry executives often confront organizational issues in their companies’ innovation processes. The questions involve, for example, how to increase the quantity and quality of invention disclosures, how to respond to inventors’ needs, how to identify potential licensees, how to develop patent policies, how to add value to intellectual property, and whether to effect processes of open innovation. Many industry executives fail to understand that university TTOs deal with similar or identical issues daily. Some universities already have found some solutions.
The question motivating this research is this: what processes describe and explicate innovation in the transfer of technology at universities? Mohr (1982) defines processes as a set or series of perceptible conditions and actions that together influence or result in a distinct outcome. Schumpeter (1934) defines innovation as new combinations of knowledge or other resources. Schumpeter (1942, 1947, 1949) emphasizes that innovation is distinct from invention: unlike invention, innovation is necessarily a social activity executed within an economic context and with a commercial objective. Technology transfer, in this study, refers to translating and transmitting knowledge (e.g., intellectual property) toward potential commercial utility. Technology transfer, in this study, refers to translating and transmitting knowledge (e.g., intellectual property) toward potential commercial utility.

Definitions of innovation and innovation processes require context. For example, a study in political economy may look at innovation processes in one or more national or regional economies (e.g., Mowery, 1992, Breznitz, 2007a, Breznitz and Murphree, 2011); a study in macroeconomics may look at innovation in or across industries or markets (e.g., Malerba and Orsenigo, 2002, Christensen et al., 2004), and business research may look at innovation in products or processes between firms and within firms (e.g., Chesbrough and Teece, 1996, Teece, 1999). Informed by organization theory, this study examines innovation processes within organizations, specifically technology transfer organizations. Lines can blur, however, and processes can intersect with and fit within one another. Officers in Stanford University's Office of Technology Licensing could provide much evidence that innovation processes within their TTO interconnect with innovation processes across the entire university, in proximate communities (e.g., technology, business, and venture capital firms in and around Palo Alto, California),
and across industries and markets in Silicon Valley, in the US, and throughout the world.

The objective of this research is to understand how innovation processes operate in TTOs, what factors influence such processes, and why. The research question in this context subsumes such issues as knowledge flows, maps of processes (e.g., boundaries, connections, frontiers for further exploration), and potential relevance in other contexts. The question and these issues emerge from practice (e.g., the researcher’s direct experience with technology transfer officers and industry executives) and from theory detailed, discussed, and developed in the literature. In contrast to the vast majority of academic studies of TTOs, the fundamental question of this research focuses on the innovation processes of university TTOs. Nearly all studies of TTOs analyze input (e.g., invention disclosures made by university researchers) and output (e.g., patents, licenses, and startups). Though building firmly on earlier research (e.g., Jensen et al., 2003), this study focuses on processes occurring after input and before output.

### 3.3 Justification

Conducting this research on university TTOs is useful for seven reasons:

First, with the preponderance of quantitative data available, and the desire of econometricians to conduct quantitative studies of university TTOs (Rothaermel et al., 2007), a qualitative study could lend insight to innovation processes. Further, in view of the process changes in universities TTOs in recent years in response to lower TTO budgets, a qualitative study is timely.
Second, universities worldwide receive the equivalent of billions of pounds sterling in government research funds with the expectation that the discoveries and inventions resulting from academic research lead ultimately to innovation that can benefit society. Whether such funding is appropriately productive is a question asked by policy makers throughout the world, especially when national governments move to curtail the growth of such funding or to cut it outright.

Third, university administrators and researchers also look to evaluate the efficacy of research expenditures and innovation initiatives yet often conclude that data and studies thus far, with a strong emphasis on subsets of inputs and outputs and a singular focus on efficiency metrics, fail to capture and explain the process of university technology transfer.

Fourth, technology transfer officers and other university administrators work to improve their processes and find little or no insight in quantitative studies based on AUTM or patent data. They frequently discuss processes yet lack an explanatory framework.

Fifth, business executives and venture capitalists often believe that only invention – and not innovation – occurs at universities. Technology transfer officers often believe that invention does occur and that innovation frequently occurs in the university environment. At least one of those beliefs is incorrect.

Sixth, large companies, venture capital firms, and others dealing with universities may arrive at a deeper understanding of academic technology transfer and consequently may establish more productive relationships with universities. Greater understanding may lead to more financially rewarding work between industry and academia; though the
financial benefits could augment university budgets, the intellectual benefits for academic researchers, including student researchers, could add appreciably to knowledge and experience.

Seventh, most global corporations, like many universities, are more bureaucratic than entrepreneurial, so lessons learned in this research may have broad implications for innovation processes in the commercial sector. Styhre (2012, 2010) notes similarities between the bureaucracies of large firms and universities as well as correspondence in desires, objectives, and attempts to become more entrepreneurial.

3.4 Research strategy and methodology

Bryman and Bell (2007, p. 28) define research strategy as “a general orientation to the conduct of business research” and refer to “two distinctive clusters of research strategy”: quantitative and qualitative. The nature of my research aligns more closely with a qualitative strategy in epistemology, ontology, and the role of theory in relation to research.

The epistemological taxonomy of Bryman and Bell (2007) comprises positivism and interpretivism, and this study accepts that taxonomy. Positivism holds that knowledge is acquired only through the senses (e.g., direct observation), experimentation (i.e., the scientific method), and collection of objective data, which are intrinsically free of values. Comte (1830, 1975) develops early concepts of positivism; his work, however, receives influential criticism from Polanyi (1958), Popper (1959, 1962) and Kuhn (1970), among others. Popper’s work offers an example of the frequent absence of clear and distinct lines within a taxonomy of epistemology. Though Popper agrees with the idea of the possibility and desirability of an objective truth, he disagrees with the positivist formulation of the scientific method and proposes falsifiability
as the alternative. (Popper refused to consider himself a positivist, although many others did, despite his refutation; Pooper himself referred to their classification as “the Popper legend.”) Polanyi (1946, 1950, 1952, 1958) argues that positivism provides a false account, and absolute objectivity is a false ideal; all knowledge claims depend on personal judgment. Rejecting the claim that experience can distill to sense data, Polanyi maintains that experience relies on interpretation, and interpretation relies on practices. Polanyi’s influence extends to Kuhn (1970), who provides examples showing that objective evidence fails to resolve conflict in scientific theories (or paradigms) and that social factors affect scientific beliefs. Merton (1973) disagrees with Kuhn’s position and argues that natural science is a society unto itself, separate and distinct from the rest of society, and is thus independent of existential (i.e., social) factors affecting (nonscientific) society. Rorty (1979) extends Kuhn’s argument and, in effect, Rorty (1989, 1991) counters Merton’s move that natural science constitutes its own society. Rorty holds that natural science has no special exemption, though it may have a different context.

In response to criticisms of positivism, realism emerges as another approach, though Bryman and Bell place realism, notably critical realism, within positivism (2007, p. 17). Bhaskar used the terms “transcendental realism” (1975) and “critical naturalism” (1979) before accepting the term “critical realism.” (Miles and Huberman (1984, p. 4) also use the term “transcendental realism” in their discussion of epistemologies behind qualitative data analysis.) Bhaskar attempts to articulate an interface between natural science and social science with the socially situated approach of a realist as against the socially determined approach of an interpretivist. Bhaskar (1975) acknowledges the limits of observation; for example, even in the most rigorous experiment in natural science, the problem of observer bias may appear; moreover, his claim
that social structures are identified and understood only through the practical and theoretical work of social science is a claim with which positivists would disagree and interpretivists would agree (Bryman and Bell, 2007, p. 18). Positivism, then, has strong forms (e.g., Comte’s arguments) and weak forms (e.g., Bhaskar’s).

Other influential critics of positivism, with an eye toward epistemology in social science, include Goldman and Kitcher. Goldman (1976, 1986) splits epistemology into individual epistemology and social epistemology. Individual epistemology refers to the cognitive processes within the individual; social epistemology, to social processes and interactions. Gold man cites the objective of both individual and social epistemology as justified, true belief. Goldman (1999, 2002) observes that generally a higher value is placed on true beliefs rather than false beliefs, and he terms this “veritistic value”, which is a concept he develops in examining social practices. Kitcher extends the concept of justified, true belief in a social context with a concept of consensus practice, which is a social practice comprising individuals’ practices based on the beliefs of individuals. Kitcher creates a taxonomy, including core and virtual practices, that shows how individual and community practices develop directly and indirectly, with reference to external individuals (such as experts) and societies. Goldman’s and Kitcher’s arguments can apply to both normative and descriptive approaches.

Interpretivism maintains that (1) knowledge is acquired not only by quantifying social phenomena but also by providing interpretation of perceptions and (2) in the social sciences, the research of people is fundamentally different from the research of objects in the natural sciences, hence the need for different epistemological considerations. This concept largely derives from "Verstehen", a concept focused on understanding and developed by Max Weber, Georg Simmel, and others.
as an alternative to positivism. Interpretivists believe that social
constructions indicate reality (Husserl, 1965) and maintain that the key
to understanding people is to understand their social context and their
perceptions of their own activities (Collis and Hussey, 2003).

Interpretivism, like positivism, has strong forms and weak forms.
Within the strong form, researchers find illegitimate the concept of
justified, true belief. Their argument, however, focuses mainly on
rationality, not on truth or justification. Their reason is that rationality is
a function only of context and cultural norms (Barnes and Bloor, 1982).
Even proponents of the strong form, however, clearly focus on practices
of forming and justifying beliefs; they are conducting an investigation into
knowledge, or perceptions of knowledge, with a particular emphasis on
social influences. The strong form of interpretivism appears more as a
barrage against inadequacies in positivism and less as a productive
enterprise. The weak form of interpretivism places emphasis on
acquiring knowledge by analyzing and interpreting social phenomena and
perceptions, while using methods with people that are different than
methods with objects, with the objective of deriving an understanding.

Bryman and Bell (2007) note that the lines between positivism
and interpretivism can frequently blur, and their observation is evident in
weaker forms of interpretivism and positivism (such as critical realism).
The research objective and research question of this study align slightly
more closely with interpretivism than positivism.

The ontology of my research, which focuses on social entities, rests
more on social constructions resulting from perceptions and actions of
social actors (i.e., constructionism) than on objective entities with a
reality external to social actors (i.e., objectivism). Bryman and Bell (2007,
p 23-24) define constructionism (or, constructivism) as a position that
“asserts that social phenomena and their meanings are continually being
accomplished by social actors. It implies that social phenomena and categories are not only produced through social interaction but that they are in a constant state of revision.” They define objectivism as a position that “asserts that social phenomena and their meanings have an existence that is independent of social actors. It implies that social phenomena and the categories that we use in everyday discourse have an existence that is independent of separate from actors.”

The perspective and perceptions of technology transfer officers and offices are essential to this study, thus the closer alignment with constructionism. With an allusion to constructionism, Kuhn (1970, p. 113) observes, “What a man sees depends both upon what he looks at and also upon what his previous visual-conceptual experience has taught him to see.” This is fundamentally identical to the observation of technology transfer officers that essentially no studies have focused on their perceptions and experience, and this perspective is at the core of this study.

The approach is more inductive, with a goal of building theory through research, than deductive, with a goal of testing theory through research. Noting that induction could lead to omitting benefits of extant theory and that deduction could prevent developing new and useful theory, Carson, Gilmore, Perry, and Gronhaug (2001) propose combining the two approaches to overcome the potential limitations of each. With the emphasis of this research on new insights, a more inductive approach, though not an exclusively inductive approach, is logical. “Just as deduction entails an element of induction, the inductive process is likely to entail a modicum of deduction” (Bryman and Bell, 2007, p. 14). With a more inductive study, note Bryman and Bell (2007), theory emerging as an outcome may conform to middle-range theory as defined by Merton (1968). Bryman and Bell (2007, p. 15) further caution that it is important
to remember that inductive and deductive approaches are “tendencies” rather than “hard-and-fast distinctions.”

The advantages of the research strategy are that it allows the opportunity to flexibly yet systematically explore and understand rich contexts, comprehensive detail, affect, cognition, conation, experience, and variables with connections in specific and real social contexts (Bryman and Bell, 2007). Further, the qualitative research strategy emphasizes theory building, which seems more appropriate in this project; theory testing with a quantitative strategy could prove more appropriate in a follow-on study. Another advantage here is that qualitative research strategy can avoid the criticisms of quantitative research, which can (1) present an “artificial and spurious sense of precision and accuracy,” (2) fail to connect everyday life with the research because of heavy reliance on instruments and control processes, and (3) offers a “static view of social life” (Bryman and Bell, 2007, p. 174).

Typical criticisms of any qualitative research strategy are that it could entail (1) too much subjectivity, which leads to questions of reliability and validity; (2) too much difficulty to replicate, because the situation is sui generis; and (3) issues with generalization, for the scope of the research can focus on the collection of narrow and deep information (Bryman and Bell, 2007, pp. 423-424). These criticisms largely derive from the perception of insufficient objectivity in qualitative research and seem to misunderstand quantitative and qualitative research. The objectivity, reliability, validity, replicability, transparency, and generalization of quantitative research is often problematic as quantitative studies in peer-reviewed journals of medical science, physical science, and social science have failed to meet those criteria (Clarke and Primo, 2012). Giere (1992, 1997, 1999, 2006) identifies these issues in the process of scientific inquiry, noting the problems they pose,
and prefers the analogy of maps (Giere, 2004). Referring to Giere’s analogy, Clarke and Primo (2012) observe that a subway map, which is useful for navigating a subway, may prove useless for driving along surface streets; questioning the objectivity or generalizability of the map seems inappropriate. The utility of the map – is this map useful in getting from where I am to where I want to go? – is what is important. Sound qualitative research can present a useful map to understand for instance, boundaries, paths, connections, and terrain.

Bansal and Corley (2011) observe that, in qualitative studies, the academic contribution of the research can provide not only a description or an explanation of a phenomenon but also a framework lending immediate insight and anticipating or discerning how dialogue among scholars can and should change in view of the phenomenon. The authors argue that qualitative data – because of sources (e.g., interviews, observations, narratives, and archival sources) and methods (e.g., coding) – can draw deeper insights than quantitative data that have informed the qualitative study.

Table 2 shows important differences between quantitative and qualitative strategies and highlight reasons for following a qualitative strategy in this research.

Bryman and Bell (2007) list five prominent research designs: experimental, longitudinal, case study, cross-sectional, and comparative. In view of the research question, an experimental design, requiring a quantitative experiment, is inappropriate. Longitudinal design, with a focus on change (or its absence) observed and mapped during protracted periods of time, fails to provide a framework for the research question. The case study design does fit the research question. Bryman and Bell note that case studies may focus on a person, an organization, a single
location, or a single event and may include cross-sectional and comparative design elements.

Table 2: Contrasts between quantitative and qualitative research strategies

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<tr>
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<th>Qualitative</th>
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<tr>
<td>Numbers</td>
<td>Words</td>
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<tr>
<td>Researcher’s point of view</td>
<td>Participant’s point of view</td>
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<tr>
<td>Researcher is distant</td>
<td>Researcher is close</td>
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<tr>
<td>Static</td>
<td>Process</td>
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<tr>
<td>Structured</td>
<td>Unstructured</td>
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<tr>
<td>Generalization</td>
<td>Contextual understanding</td>
</tr>
<tr>
<td>Hard, reliable data</td>
<td>Rich, deep data</td>
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<tr>
<td>Macro</td>
<td>Micro</td>
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Adapted from Bryman and Bell (2007, p. 426)

In view of the scope of this research, a design involving multiple cases is appropriate; opportunities emerge for comparisons, which could prove helpful in exploring and explaining data. This design is also conducive to developing theory, including midrange theory (Eisenhardt and Bourgeois III, 1988, Eisenhardt, 1989, Eisenhardt and Graebner, 2007). A focus on specific persons and their organizations is also reasonable, given the question my research addresses. Bryman and Bell (2007, p.64) observe that the multiple case study design “encourages researchers to consider what is unique and what is common across cases, and frequently promotes theoretical reflection on the findings.” Thus, this case study design in this research includes elements of comparative designs.

Further, multiple cases, persons, and organizations can assist in meeting three prominent evaluation criteria for research: reliability (“the consistency of results obtained in research” (Gill and Johnson, 2002, p. 228)), replicability (the capability to reproduce the results obtained in the
research), and validity ("the integrity of conclusions" generated from research (Bryman and Bell, 2007, p. 41)).

Although a criticism of case studies is that they lack scientific rigor and sufficient sample size, Eisenhardt (1989) and Eisenhardt and Graebner (2007) argue that the highly-iterative case study process – tightly linked to data and especially well suited to new topic areas – results in theory that is often novel, testable, and empirically valid.


1. The first factor is construct validity, and it refers to the conceptual apparatus of a study. Construct validity should answer this question: does a study indeed investigate what it claims to investigate? A study achieves construct validity by allowing the
reader to understand how the researcher progressed from the research question to the ultimate conclusion (Yin, 2009) by triangulating through multiple data sources (Denzin and Lincoln, 2005). Construct validity is prominent in the data collection phase. Sources of data include archival data (internal reports, annual reports, news media or other secondary articles), data from original interviews, participatory observation, and direct observation (Gibbert et al., 2008).

2. The second factor is internal validity (or, logical validity), which refers to logical reasons within a plausible argument in defending the conclusions of the research. Internal validity should answer this question: is the reasoning sufficiently compelling? Evaluation of internal validity typically comprises three elements: a clear research framework derived from the literature (Yin, 2009), a match of patterns from observations or previous studies (Denzin and Lincoln, 2005, Eisenhardt, 1989), and triangulation through different perspectives informed by or based on the literature (Yin, 2009). Internal validity is prominent in the data analysis phase of a study (Yin, 2009).

3. The third factor is external validity, which refers to generalizability. External validity should answer this question: does the study account for phenomena not only in the present setting but also in other settings? Statistical generalization (i.e., statistical generalization to a population) is beyond the scope of case studies, yet analytical generalization to and across theory is appropriate (Yin, 2009). Cross-case analysis (Eisenhardt, 1989, 1991) and multiple case studies within one organization (Yin, 2009) provide the basis for analytical generalization.
4. The fourth factor is reliability, which refers to the absence of random error (Denzin and Lincoln, 2005). The important elements of reliability are transparency and replication. Transparency is established through meticulous documentation and explanation of research procedures; replication is achieved through organization of research databases, documents, and notes to allow retrieval and reproduction of the study.

Gibbert, Ruigrok, and Wicki (2008, p. 1473) reach this conclusion: “We failed to identify in our sample a single case study that used, and explicitly reported, rigor criteria other than the [four] validity and reliability notions discussed here. We are therefore confident that the present review gives an accurate and comprehensive reflection of what exactly passes as a rigorous case study.”

Stake (1995, 2010) provides a descriptive dichotomy and a process for case study research. He observes that issues in case studies are neither simple nor clean, “but intricately wired to political, social, historical, and especially personal contexts. All of these meanings are important in studying cases” (Stake, 1995 p.17). He defines case studies as intrinsic or instrumental. The goal of an intrinsic study is to understand a case (i.e., a situation or an issue) that the researcher finds intrinsically interesting. There is no need for the study to provide a representative example, to illustrate a specific problem, to frame an abstract construct, or to generate or build theory – but the study may eventually do all of these. The goal of an instrumental study is to understand a case that the researcher finds instrumental in adding insight to a situation or an issue. There is a need to offer context, to provide insight, or to contribute to a theory.
Stake's procedure begins with determining whether a case study method is appropriate. If so, deciding upon the case (or cases) is next; cases, for example, may focus on persons, programs, events, activities, or more than one of these. The case study may involve a single case or multiple cases. Collecting data from multiple sources (e.g., documents, interviews, observations) is important, and next is conducting analysis of the data. Analysis may involve categorical aggregation from multiple instances or direct interpretation of a single instance. Stake also looks for patterns and correspondence: "The search for meaning often is a search for patterns, for consistency, for consistency within certain conditions, which we call 'correspondence'” (1995, p. 78). He adds, "Sometimes, we will find significant meaning in a single instance, but usually the important meanings will come from reappearance over and over” (1995, p. 78). The final step is reporting the meaning of the case through descriptions and analysis of themes.

Within a case-study methodology, numerous methods and techniques are available, and one seems particularly relevant to this research study: the critical incident technique. The reason is that technology transfer officers have observed that universities and their TTOs allow their perception of critical incidents to drive their processes.

The influence of critical incidents is evident in how the TTOs deal with inventors, what they patent, how they seek licensees, what terms and conditions they put in license agreements, how they negotiate licenses, why they withdraw licenses, and how they structure spinouts – i.e., what they do and how they learn. “Our disclosure forms, our license [agreement] templates – everything – reflects mistakes we made and don’t want to repeat. Every time there’s a problem, we change a template or a process so that we don’t make that mistake again. And if we come up with an idea that really works – a new definition in a license, a new
approach to market a technology – we try to learn from those big events. They get attention,” explained a technology transfer officer at Stanford University.

Moreover, incidents can drive and reflect process (e.g., Kanter, 1983, Kanter et al., 1992, Dawson, 1994, 1997, Pettigrew and Fenton, 2000, Dawson, 2003a, 2003b, Pettigrew, 2004). This is especially evident when organizations focus on incidents, explicitly and implicitly, as an important driver, or as the single most important driver, in a process. Throughout this study (including the pilot study), participants readily acknowledged that their processes are driven by incidents, both successes and failures. As technology transfer officers, they work to emulate what they perceive as past successes (occurring in their TTO or in other universities’ TTOs), and they endeavor to avoid repeating what they perceive as failures.

The critical incident technique, or CIT, can sufficiently address, elucidate, and prosecute the research question. In the period since Flanagan (1954) introduced the CIT, the method has been widely used and developed. Chell (2004) notes that in early studies the positivist approach was assumed and in later studies the interpretivist approach was developed. Flanagan (1954, p. 327) defines the CIT as a process for collecting observations of human behavior with the objective of solving problems or developing principles based on experiences that are sufficiently (1) clear in intent, (2) definite in consequences and effects, and (3) complete in permitting inferences and predictions within the proper context. Chell (2004, p. 48) modifies Flanagan’s definition and explains that “the critical interview technique is a qualitative interview procedure, which facilitates the investigation of significant occurrences...identified by the respondent, the way they are managed, and the outcomes in terms of perceived effects. The objective is to gain an
understanding of the incident from the perspective of the individual, taking into account cognitive, affective, and behavioural elements.”

Chell (2004, pp. 45-60) discusses the CIT’s advantages, including that the CIT is a proven method over fifty years, a robust method in social and natural sciences, a method with reliability and validity well established and acknowledged, a method with replicability, a context-rich method, a method focused on the participant’s perspective rather than the researcher’s, and a method offering opportunity for factual corroboration (e.g., documentary evidence and additional independent interviews). Chell also mentions that, by using the CIT, researchers can relate context and outcomes, and then look for replication of patterns. If pattern replication emerges, researchers can link context and outcomes.

Two additional advantages noted by Chell are relevant to this research. First, the CIT entails a classification system, which can prove useful in exploring, mapping, and understanding the information in research projects like mine. Second, the CIT accommodates a multi-site orientation and thus offers the opportunity to compare incidents and increase generalizability. The CIT allows for flexibility within a rigorous process; e.g., studies conducted by Druskat and Wheeler (2003) and Falbe and Yukl (1992) provide evidence of such flexibility and rigor.

A further advantage is that a case study can comprise multiple incidents, and incidents can illustrate and reveal processes. In this study, the definition of process is Mohr’s (1982): a set or series of perceptible conditions and actions that together influence or result in a distinct outcome. Thus, a case study of a university technology transfer office can subsume critical incidents that may illustrate and reveal processes, such as innovation processes.
A criticism of the CIT is that there is a possibility of faulty recollection or even exaggeration; however, corroboration of incidents addresses such concern. Further, corroborating and testing information is always important in research, irrespective of the method.

Bryman and Bell (2007) and Cassell and Symon (2004) present many other options for case-study methods, including focus groups, qualitative-research diaries, life histories, pictorial representation, co-research, and language methods; however, those methods in the context of this study either fail to address the research question or impose impractical demands on participants.

Semi-structured interviews appropriately address the research question, but structured and unstructured interviews do not. Bryman and Bell (2007) offer an explanation of the three types of interviews. With semi-structured interviews, questions are determined and structured. The order of the questions, and even specific words in the questions, may depend on the flow of the interview and the direction of responses. Depending on responses, questions may be omitted or clarifying questions may be added. A structured interview entails specific questions asked in a specific order, and an unstructured interview presents one or more topics rather than questions. Chell (2004) observes that the CIT allows for in-depth semi-structured interviews. Robson (2002) recommends open-ended questions in semi-structured interviews because such questions provide flexibility to clarify issues (thus obtaining more depth, context, and accuracy) and an opportunity to develop a rapport, putting the respondent at ease.

With technology transfer offices as the unit of analysis, an issue is how many offices to include in study, and, further, how many in the UK and how many in the US. Many quantitative studies of academic
technology transfer collect data from scores of universities to provide a sufficient base of data to demonstrate statistical significance in analyses; however, some highly influential studies, both quantitative and qualitative, focus on one or two universities. These are seven examples:

1. Roberts (1991) conducts a study of entrepreneurship and focuses on the Massachusetts Institute of Technology and the transfer of technology to spinout firms.

2. Feldman and Desrochers (2003) look at one institution, Johns Hopkins University, in a study of technology transfer and local economic development.

3. Nerkar and Shane (2003), using data only from the TTO of the Massachusetts Institute of Technology, investigate interactions among radical technologies, patent scope, industry concentration, and their effect on the success or failure of university spinouts.

4. Rothaermel and Thursby (2005a, 2005b) study one university, the Georgia Institute of Technology, to examine knowledge flows from universities to spinout firms residing in university incubators.

5. Breznitz (2007b) explores the biotechnology cluster around Yale University.

6. Jain and George (2007) conduct a narrative study at one TTO, the Wisconsin Alumni Research Foundation, to examine the role of TTOs as institutional entrepreneurs protecting, propagating, and influencing the emergence of human embryonic stem cell technology.
7. Breznitz, O'Shea, and Allen (2008) examine two universities, the Massachusetts Institute of Technology and Yale University, in an investigation of university commercialization strategies and regional clusters of firms.

To effectively answer the research question, to make useful comparisons, to identify patterns or their absence, and to acknowledge practical constraints, the decision was to study a total of four universities, two from the UK and two from the US.

Then next question is this: which universities? Studies typically focus on the most elite universities; however, many technology transfer officers criticize such studies as generalizable only to several elite universities in the UK and the US because those elite TTOs enjoy benefits beyond the control of the vast majority; such benefits include a disproportionate share of top scientists, government research funds, alumni at venture capital firms, and often proximity to major centers of venture capital. A notable exception is the Rothenberg and Thursby (2005a, 2005b) study of the Georgia Institute of Technology's incubator, a study cited by a diversity of technology transfer officers as useful because they consider their TTOs more like the TTO at the Georgia Institute of Technology. An informal telephone survey of 22 people (16 officers currently leading a technology transfer organization and six university professors researching TTOs, with all 22 evenly split between the UK and the US) describing the objectives of this research (including generalizability) led to four universities: the University of Manchester, the University of Southampton, the Georgia Institute of Technology, and the University of Utah. Survey respondents mentioned that all of the universities seemed to do well without the advantages of the most elite universities. Further investigation revealed that (1) these four
universities are sufficiently similar to most major research universities in the scope and approach of their TTOs and thus are sufficiently representative of the mainstream of major research universities, (2) they have sufficient depth and breadth to offer rich data for analysis in this study, (3) the sufficient dimensions of similarity and difference among them can lead to more generalizable conclusions, and (4) cultural issues, such as the bias toward inventors in UK TTOs and the bias toward the institution in US TTOs, can lend insight into the innovation process. Table 3 presents a comparison of the four universities.

The University of Manchester, located in Manchester, UK, was formed in 2004 with the merger of the University of Manchester Institute of Science and Technology and the Victoria University of Manchester. University of Manchester Intellectual Property Limited is the technology transfer office for the university. At the time of this study, the TTO employed approximately 35 people.

The University of Southampton, located in Southampton, UK, refers to its TTO as Research and Innovation Services, which at the time of this study employed approximately 15 people.

The Georgia Institute of Technology, located in Atlanta, Georgia, US, at this time of this study referred to its TTO as the Office of Technology Licensing and Venture Lab and collectively employed approximately 30 people.

The University of Utah, located in Salt Lake City, Utah, US, refers to its TTO as the Technology Commercialization Office, which employed approximately 15 people at the time of this study.
3.5 Conduct of the research

The researcher approached the directors of the four TTOs and explained the research topic and question. The four TTO directors agreed to participate in the study on the condition of anonymity for each respondent in the write up of the study.

Attention turned to the selection of the people in each TTO who would participate in the study. The researcher requested that in each office the director identify people who would represent diversity in these dimensions: (1) length of experience in TTO work at that university, (2) length of experience in TTO work at another university, (3) length of work experience outside of TTO work, (4) function, such as evaluating technologies for patenting, or licensing patents to major corporations, or assisting university researchers in starting a venture, (5) manager of others in the office, (6) technology expertise, such as life sciences, or physical sciences, or software, (7) highest level of degree, such as bachelor’s, master’s, or doctorate, and (8) educational concentration of the degree or degrees, such as business, engineering, or science. With these dimensions in mind, each director and the researcher began the process of selecting the people whom the researcher would interview. Though impossible to achieve complete diversity across all dimensions, each director, with the researcher’s guidance, chose people who collectively met as many dimensions as possible.

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<td>Larger TTOs</td>
<td>University of Manchester</td>
<td>Georgia Institute of Technology</td>
</tr>
<tr>
<td>Smaller TTOs</td>
<td>University of Southampton</td>
<td>University of Utah</td>
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The interview group at each university included the TTO director. The group at the University of Manchester constituted nine people; at the University of Southampton, four people; at the Georgia Institute of Technology, seven people; and at the University of Utah, four people. Thus, each group represented one in four people at that TTO.

The in-depth semi-structured interview centered on the research question and followed the framework of the critical incident technique. Each interview focused on two incidents from each respondent, one incident the respondent considered successful and one incident the respondent considered unsuccessful. Each respondent selected the incident from his or her TTO experience, and both the successful and the unsuccessful incidents centered on his or her experience in moving intellectual property toward commercialization. The definitions of “successful” and “unsuccessful” were left to each respondent to determine and explain. The length of each interview was approximately one hour, with some extending to 90 minutes and others ending after 45 minutes. To capture accurately the substance and nuance of interviews, each interview was electronically recorded with the permission of the respondent, who was assured of anonymity and notified that the researcher would seek corroboration (i.e., triangulation) whenever necessary. The researcher also explained that the interview recording would be transcribed verbatim into a manuscript for data analysis.

The researcher conducted the interviews face to face whenever possible. To accommodate scheduling preferences of respondents, the researcher conducted some interviews by Skype, an audio-video communications service. In every case, the respondent was in his or her office with privacy behind a closed door.
To test the interview protocol, the researcher conducted a pilot study of four interviews with technology transfer officers. Two were at Stanford University, and two were at the University of Virginia. Stanford University, as an elite institution, was inappropriate as a university TTO to study in this research project, yet the technology transfer officers were helpful in testing the protocol. After those interviews, the researcher interviewed the two officers at the University of Virginia, which fits the same criteria as the four universities in this study.

The purpose of the pilot study was (1) to assess general feasibility of the research strategy and methodology, (2) to test the method of the CIT, the structure of the interview (which was semi-structured), and the interview questions, and (3) to determine if, and, if so, to what extent, analysis of the interviews fit the conceptual framework. The pilot study closely followed the pilot-study guidelines outlined by Yin (2010).

The pilot study led to two modifications in protocol.

1. The first modification addressed these questions: How open are participants in revealing information that they may consider embarrassing? What practical problems could emerge? For example, would participants react negatively toward recording of interviews? How easy or difficult would it be to establish trust with participants? The interviewer found that assurances, in both written and oral communication, were important in emphasizing confidentiality and anonymity. Such assurances became key to allowing participants to trust the interviewer, to talk about incidents they viewed as embarrassing, and to explicitly say and affirm that they had no concerns about electronic recording of interviews. During the pilot, the interviewer initially offered different levels of assurance, such as no assurance, only spoken
assurance, and both oral and written assurance. When participants felt they had been offered insufficient assurance, they asked questions, and the interviewer answered them, until the participants felt they could trust the interviewer. The interviewer thereafter made sure to offer explicit and unequivocal assurance, both spoken and written, to establish trust with participants.

2. The second modification addressed this question: What documents and other evidence could participants easily obtain to corroborate their recollection of facts? The interviewer learned that by simply mentioning that he would have to corroborate their recollections, and by mentioning this at the start of an interview, participants during the course of the interview would volunteer how to corroborate their incidents. For example, participants would provide details of an incident and immediately refer to emails, contracts, diary entries, public records, and other sources that would provide corroboration and to colleagues who could substantiate the information. With corroboration in mind, participants seemed to think more deeply about their recitation of incidents and to talk more confidently of their experience as they provided corroboration.

The pilot study confirmed the general feasibility by providing substantive interviews that lent themselves to rigorous analysis and proved the value of the CIT. The pilot study also offered substantive data, some fitting within the conceptual framework and some showing limitations of the framework. Such limitations began to suggest an empirical basis for the perception of a gap in the literature.

In the pilot study and the subsequent study, data analysis followed established and accepted protocols. Creswell (2003, 2012) proposes
three steps of data analysis: (1) preparation and organization of data; (2) reduction of data through a process of coding; and (3) presentation of data in discussion, tables, or graphs. Creswell believes that data analysis is an iterative process between data collection and data analysis. Miles and Huberman (1994) concur, and they offer these steps: (1) collect the data, (2) give codes to the data, (3) add comments (i.e., memo) as appropriate to aid analysis, (4) begin analyzing the interview data to identify similarities and dissimilarities among respondents, (5) allow the preliminary analysis to inform further data collection, (6) look for generalizations that emerge from the data, and (7) link the generalizations to the literature to extend knowledge on the topic. Though the list of steps is sequential within one interview, the process is simultaneous across multiple interviews, with each interview at a different step. Clearly, this process requires iteration with careful attention to nuance.

With this in mind, the researcher followed the following process after each interview: (1) listen to the recording and make notes, (2) transcribe the recording verbatim, (3) read the transcription, from the beginning to the end, and code, (4) read the transcription, by paragraph from end to beginning, and code to see if anything had been omitted thus far, (5) listen again to the recording and make further notes, reflecting again on what was said and what was not said, (6) organize transcripts, codes, memos, and notes to identify themes, and (7) look for connections with the literature and potential contributions to a body of knowledge. Later, the process would add two steps: (8) look for similarities and dissimilarities across respondents at the same institution and (9) identify and analyze similarities and dissimilarities among institutions. Within this systematic analysis, the research scrutinized what the respondent said and what the researcher was inferring.
Coding processes can follow emic or etic approaches, or both (Creswell, 2012). An emic approach refers to how people inside a community perceive their world, make sense of information, make rules for behavior, explain phenomena, and decide what has meaning; an etic approach refers to how one or more people outside of a community attempt to interpret what they observe within the community (Harris, 1976, Goodenough, 1980, Kottak, 2008). Consistent with this study's focus on the perspective of technology officers (i.e., people within a community), coding followed an emic approach. Nodes emerged from the data. A different approach to coding, inconsistent with this study, is an etic approach, such as template analysis, in which a researcher imposes a template of nodes on the data. To maintain coherence in this study, coding the data followed an emic approach; however, analyzing the codes takes both an emic approach (the perspective of the TTO participant) and an etic approach (the perspective of the researcher, who performs collective, cross-sectional, and other comparative analysis of all the data).

With analysis of nodes in the critical incidents, processes can emerge, as the incidents reveal conditions and actions, or their absence. This is important because in this study the definition of process is Mohr's (1982): i.e., a set or series of perceptible conditions and actions that together influence or result in a distinct outcome. The coding of critical incidents exposes the presence or the absence of conditions and actions, and analyzing the coding identifies processes.

NVivo software was the principal repository of data and analysis. NVivo, an application published by QSR International, is computer assisted qualitative data analysis software first developed in the 1990s and used widely in the social sciences. NVivo can function as a research tool to assist in organizing, classifying, and analyzing qualitative data and can adapt to many qualitative methodologies. NVivo, however, is no more
than a potentially useful tool. Advantages of the software include functions for data organization, data interrogation, and data retrieval with relative ease. Such functionality can make analysis more rigorous. Disadvantages of the software refer to the potential for misunderstanding NVivo’s limitations as a tool, misusing functions, and expecting the application to do more than it (or any tool) can.

3.6 Ethical considerations

With research involving interviews, especially in-depth interviews, ethical considerations arise. In this study, respondents wanted assurance that their anonymity was protected and their privacy was assured so that they could talk comfortably, honestly, and insightfully with no fear of embarrassment or repercussion. Anonymity is a special concern in this research, as identification of the institution is necessary, yet TTOs represent a relatively small organization of people whose names, and sometimes backgrounds, are easily available and identifiable on the Internet. In response to this concern, the selection of respondents represented only one in four people in a TTO; for example, a TTO with 16 people would provide four respondents. Moreover, full disclosure of the purpose and use of the interviews was clear to each respondent, and participation in this research was fully voluntary. Thus, with full and appropriate information, participants made their own decisions to participate in this study. To protect confidentiality, after recording and transcribing interviews, while performing data analysis, and while writing this thesis, the researcher kept voice, data, and other potentially sensitive files in encrypted electronic folders or locked cabinets. Further, the change of personal names of respondents to pseudonyms in this thesis helps safeguard privacy. Details of gender and title have been disguised or masked. Miles and Huberman (1994) note that ethical
considerations must apply throughout a research study, not only to the collection, analysis, and presentation of research, but also in explicit identification and documentation of sources of ideas and contributions. This thesis complies with all such considerations.

### 3.7 Conclusion

The objective of this research was to learn about TTO innovation processes, and the fundamental strategy was to listen to people who effect, actuate, and observe those processes.

The research question motivating this research is this: what processes describe and explicate innovation in the transfer of technology at universities? Mohr (1982) defines processes as a set or series of perceptible conditions and actions that together influence or result in a distinct outcome. The objective of this research is to understand how innovation processes operate in TTOs, what factors influence such processes, and why.

With objectives, epistemology, and ontology in mind, a case study methodology seemed most appropriate. Unlike other studies of TTOs that focused on one or two of the most elite universities, this research encompassed four universities, two in the UK and two in the US, widely recognized and well known among TTO directors and researchers for overcoming obstacles familiar to most TTOs, and even excelling at doing so. An equally proportional and representative group of respondents at each TTO participated in the study. Each respondent discussed two critical incidents of his or her own selection, with one incident representing a successful outcome and the other an unsuccessful outcome (with “successful” and “unsuccessful” defined by each participant). Thus,
a total of 48 incidents were collected, triangulated (with other sources of data), and analyzed. Qualitative data analysis techniques were employed, and NVivo software was used for organization and interrogation of data.

This research project met or exceeded the four factors of a rigorous case study detailed in the meta-analysis conducted by Gibbert, Ruigrok, and Wicki (2008) for sound case-study research:

1. **Construct validity**: The research clearly and directly addressed the research question, identified the sequential process from research question to research conclusions, and was triangulated through multiple data sources. The data sources in this research included original interviews, archival data internal to the TTO (e.g., internal reports, licenses, calendars, memoranda, agreements, electronic mail, and other documents), archival data external to the TTO (e.g., news media articles, management reports of startup firms, and other secondary articles), and direct observation.

2. **Internal validity (or, logical validity)**: The research clearly derived from the literature and offered both consistency with prior observation and triangulation with perspectives informed by and based on the literature.

3. **External validity**: The research allowed for the study to account for phenomena in both the present setting and in other settings by providing multiple studies within multiple organizations. This responded to criteria set by Eisenhardt (1989, 1991). This also responded to the criteria set by Yin (2009), providing the basis in this study for Yin’s concept of analytical generalization.
4. Reliability: Transparency and replication are the key elements of reliability, according to the authors. In this study, transparency was established through careful documentation and explication of research procedures, and the opportunity for replication was achieved through organization of research databases, documents, and notes to allow retrieval and reproduction of the study.

Ethical considerations were a principal concern. Precautions and additional safeguards were necessary to encourage participation and protect the privacy of participants.
4. Case analysis and discussion

This section provides analysis and discussion of four case studies (one from each of the four universities). Analysis of the case studies includes a review of the qualitative data analysis, a discussion of recurrent and emergent themes from multi-case and cross-case analysis, a comparison of similarities and dissimilarities, and a discussion of the resultant framework (i.e., the framework derived from this research and analysis of this study), which highlights and situates key findings.

Consistent with the study methodology, the case study of each university comprises the totality of the incidents of that university’s technology transfer office. Incidents, both successful and unsuccessful, illustrate and reveal processes. The definition of process is Mohr’s (1982): a set or series of perceptible conditions and actions that together influence or result in a distinct outcome (such as a successful or an unsuccessful outcome). Thus, case analysis and discussion necessarily focuses on conditions and actions, which together depict innovation processes in university technology transfer offices.

The appendix presents more fully the four cases and the 48 critical incidents. Each incident is expounded, and comments on incidents are provided by the participants and the researcher.

4.1 Qualitative data analysis

Initial coding generated more than 210 nodes. Further coding and analyzing of data identified duplication of themes, concepts, and referents; further analysis led to consolidation with approximately 100 nodes. Nodes clustered within four categories: actions, conditions,
resources, and environment. Successful incidents had one set of nodes and categories, and unsuccessful incidents had another set. A final classification identified similarities and differences between UK and US technology transfer offices.

4.2 Recurrent and emergent themes

This section provides a multi-case analysis and a cross-case analysis, including (1) an overview of recurrent and emergent themes, (2) a multi-case analysis comparing the four universities with an emphasis on different and similar themes of successful and unsuccessful incidents, and (3) a cross-case analysis that shows broad and deep similarities in themes across the universities.

The four case studies (one from each of the universities) comprise a series of critical incidents that participants described in interviews. Each participant discussed two critical incidents, one a successful incident and the other an unsuccessful incident.

The appendix presents more fully the four cases and the 48 critical incidents. Each incident is shown in detail, and commentary on incidents is provided by the participants and the researcher.

It is important to recall (from the methodology section of this thesis) that incidents can drive and reflect process (e.g., Kanter, 1983, Kanter et al., 1992, Dawson, 1994, 1997, Pettigrew and Fenton, 2000, Dawson, 2003a, 2003b, Pettigrew, 2004). Incidents can offer insight to processes by showing actions in the context of conditions (Mohr, 1982). Actions, and even inactions, in critical incidents can reveal, frame, and
exhibit process (Chell, 2004). This is the function of conditions and actions in this study.

To maintain the ethical conduct of this research, this study refers to participants by pseudonym. Participants from the University of Manchester have pseudonyms beginning with letters A through I (viz., Alex, Blair, Cameron, Drew, Ellis, Franklin, Gale, Hayden, and Inga). Participants from the University of Southampton have pseudonyms beginning with letters J through M (viz., Jordan, Kelly, Lindsey, and Morgan). Participants from the Georgia Institute of Technology have pseudonyms beginning with letters N through T (viz., Nicol, Owen, Payne, Quinn, Riley, Sloan, and Taylor). Participants from the University of Utah have pseudonyms beginning with letters U through X (viz., Ursula, Varney, Whitney, and Xian).

Overview

Conditions and actions were recurrent themes that the conceptual framework denotes. Emergent themes included perceptions of resources and environmental factors. Another emergent theme was a perception of risk as a counterpoise to reward. All of the emergent themes recurred throughout the four university cases. The addition of emergent themes and a taxonomy of actions led to the resultant framework, which is more robust than the conceptual framework.

(Weick, 1989, 2005), what they thought, how they behaved, and how they acted through process iterations. Themes of structure (Lawrence and Lorsch, 1967, Mintzberg, 1979, Teece, 1999, Pettigrew and Fenton, 2000) are most evident in environmental factors, such as university policy, affecting process.

Analyzing the critical incidents as a collective data set for each university revealed consistency in categories and nodes in comparing one university with another. Interviews at each university produced the same four categories – conditions, actions, resources, and environment. More than 95 percent of the nodes were consistent across all universities.

**Multi-case analysis**

The first case presented is the University of Manchester, the second is the University of Southampton, the third is the Georgia Institute of Technology, and the fourth and final case is the University of Utah.

**University of Manchester**

The University of Manchester, located in Manchester, UK, was formed in 2004 with the merger of the University of Manchester Institute of Science and Technology and the Victoria University of Manchester. The student population at the university was approximately 40,000 at the time of this study, comprising approximately 29,000 undergraduate students and approximately 11,000 graduate students. University of Manchester Intellectual Property Limited is the technology transfer office for the university.
At the time of this study, the TTO employed approximately 35 people. Nine participated in interviews: Alex, Blair, Cameron, Drew, Ellis, Franklin, Gale, Hayden, and Inga. The table below presents the main themes of the interviews.

Table 4: University of Manchester participants and interview themes

<table>
<thead>
<tr>
<th>Participant</th>
<th>Successful</th>
<th>Unsuccessful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alex</td>
<td>Sharing knowledge from experiences</td>
<td>Failing to align goals and to manage a process</td>
</tr>
<tr>
<td>Blair</td>
<td>Sharing, combining, and reusing knowledge</td>
<td>Failing to amass capital and networks</td>
</tr>
<tr>
<td>Cameron</td>
<td>Managing actions and resources</td>
<td>Failing to manage people, capital, and processes</td>
</tr>
<tr>
<td>Drew</td>
<td>Combining knowledge, communicating, and collaborating</td>
<td>Managing limitations</td>
</tr>
<tr>
<td>Ellis</td>
<td>Managing goals, networks, and people</td>
<td>Making false assumptions</td>
</tr>
<tr>
<td>Franklin</td>
<td>Managing people and opportunities</td>
<td>Failing to manage people and opportunities</td>
</tr>
<tr>
<td>Gale</td>
<td>Establishing trust to enable success</td>
<td>Failing to manage people</td>
</tr>
<tr>
<td>Hayden</td>
<td>Collaborating and building teams</td>
<td>Failing to manage people and capital</td>
</tr>
<tr>
<td>Inga</td>
<td>Leading and persisting</td>
<td>Failing to give access and to collaborate</td>
</tr>
</tbody>
</table>

Each incident typically involved one technology, and the technologies discussed in incidents at this TTO applied to biosensors, chemical sensors, computational chemistry, materials science, medical devices, medical imaging, physical chemistry, quantum dots, software, and therapeutic compounds. One incident involved a social enterprise. (Full descriptions and discussions of these incidents are provided in the appendix.)
Emerging from these 18 incidents is a case study of a TTO engaging in an innovation process with conditions and actions evident. Conditions of disclosure, access, and reward are present. Actions are conspicuous in their specificity: accumulating and analyzing knowledge, anticipating problems, assessing opportunities, brokering knowledge, building networks, coaching, collaborating with faculty, collaborating with colleagues in the TTO, collaborating with industry executives and venture capitalists outside the TTO, combining knowledge, leading and managing projects, learning, managing expectations, negotiating, planning and monitoring and adjusting as necessary, researching (markets, industries, etc.), and reusing and sharing information. These actions are similar to concepts discussed by Argyris and Schon (1978) and Nonaka and Takeuchi (1995) in the literature of organization theory and innovation.

Connecting with both conditions and actions is risk (Kahneman and Tversky, 1979). The connection with conditions is that reward is a condition, and reward and risk figure in the minds of academic inventors, venture capitalists, industry executives, and certainly technology transfer officers. Risk appears as a counterpoint to reward. Identifying risk, understanding risk, mitigating risk, and managing risk can become important to the process as technology transfer officers, and TTOs as organizations, take such actions and develop policies requiring such actions (Novemsky and Kahneman, 2005).

Participants frequently mentioned resources. Human resources included academic inventors, entrepreneurs, startup executives, and industry executives. Typical contexts included faculty members who understood or misunderstood the commercialization process, or startup executives who were an effective fit or an ineffective fit for a startup. Just as human resources played a critical role in success or failure, so did
capital resources (e.g., startups had sufficient or insufficient capital), technology resources (e.g., the technology was effective or ineffective in the market, or the technology held potential for efficacy). Decisions involved the strategy to get eventual products to market (a function of human resources), the requisite cost (a function of capital resources), and time (which itself is a resource): in summary, the strategy to market, the cost to market, and the time to market. The role that resources played in the incidents was prominent.

Context can identify factors beyond the control of the TTO, such as geography in the case of the University of Manchester. Technology transfer officers perceived that venture capital was more available in London than in Manchester, and surely more available in the US than in the UK. Other contextual factors mentioned in this case were national economies, which can affect to what level governments fund research, industry economies, which can determine whether companies within an industry sponsor university research, and public equity markets, which can directly and indirectly can make more or less capital available for technology development and for startups.

Themes occurring most frequently in successful incidents were (1) leading and managing people (including establishing trust, collaborating, building teams, and persisting), (2) knowledge (e.g., sharing, combining, and reusing knowledge), and (3) resources (managing opportunities) and capabilities (building and managing networks).

Themes occurring most frequently in unsuccessful incidents were failure to manage people, both inside and outside the TTO, and failure to manage resources. The failure to manage people included failure to collaborate, failure to align goals, and failure to build networks. The
failure to manage resources and capabilities included the failure to manage opportunities and capital limitations.

Unsuccessful incidents can resemble successful incidents; for example, Franklin’s unsuccessful incident included successful moments. More often, actions included momentous failures: a failure to align goals and expectations among inventors, investors, and the TTO; a failure to negotiate a sound license; a failure to hire an effective entrepreneur as chief executive officer of a startup; a failure to raise sufficient capital. Inaction was also an important factor in unsuccessful incidents: an academic inventor or a chief executive officer, for example, failing to take appropriate action.

The University of Manchester TTO offers a case of a technology transfer office initiating and supporting an innovation process, which emphasized conditions, actions, and resources. Conditions and actions were consistent with Murray and O’Mahony (2007). Discussions of resources evoked a resource-based view (e.g., Penrose, 1959, Wernerfelt, 1984, 1995, Rumelt, 1997, Barney et al., 2001), but this TTO’s approach has no suggestion of strategy for competitive advantage. Instead, the technology transfer officers viewed resources from a perspective of a fundamental sentiment that informs the beliefs, assumptions, and practices of the TTO; this is a resource-based ethos rather than a resource-based view.

**University of Southampton**

The University of Southampton, located in Southampton, UK, traces its origins to 1862 and became a full university in 1952. The student population at the university was approximately 23,000 at the
time of this study, comprising approximately 16,000 undergraduate students and approximately 7,000 graduate students. University of Southampton Research and Innovation Services is the technology transfer office for the university.

At the time of this study, the TTO employed approximately 15 people. Four participated in interviews: Jordan, Kelly, Lindsey, and Morgan. The table below presents the main themes of the interviews.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Successful</th>
<th>Unsuccessful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jordan</td>
<td>Engaging people, experimenting, learning</td>
<td>Failing to adapt in a changing environment</td>
</tr>
<tr>
<td>Kelly</td>
<td>Reusing knowledge and collaborating</td>
<td>Learning what is within or beyond one's control</td>
</tr>
<tr>
<td>Lindsey</td>
<td>Persisting, networking, and sharing knowledge</td>
<td>Attempting to manage without process</td>
</tr>
<tr>
<td>Morgan</td>
<td>Establishing trust and aligning goals</td>
<td>Managing expectations and conflicts</td>
</tr>
</tbody>
</table>

Each incident typically involved one technology, and the technologies discussed in incidents at this TTO ranged from environmental science to alternative energy. (Full descriptions and discussions of these incidents are provided in the appendix.)

These eight incidents constitute a TTO case study of an innovation process with conditions, actions, and resources, with noteworthy insights. Conditions of disclosure, access, and reward are evident. Actions are also evident: adapting to rapid change, accumulating knowledge, anticipating problems, assessing opportunities, brokering knowledge, building
networks, coaching, collaborating with faculty, collaborating with colleagues in the TTO, collaborating with industry executives and venture capitalists outside the TTO, combining knowledge, leading and managing projects, learning, managing expectations, negotiating (exemplified in Morgan’s incident of turning an unsuccessful episode into a success), planning and monitoring and adjusting as necessary, researching (markets, industries, etc.), and reusing and sharing information. “Engaging” and “engagement” with faculty members and industry partners were mentioned as key actions in the process, as were “persisting” and “persistence.” The importance of trust as a foundation to collaboration was mentioned several times. Emphasis in this TTO was on the organization as innovation intermediary (Chesbrough, 2003b) and, as the actions suggest, as an organizational connection with innovation proclivity (Lawrence and Lorsch, 1967, Mintzberg, 1979, Teece, 1999).

The role of collaboration managers is unusual because they have responsibility for assisting faculty at the beginning process of obtaining grants for research and at the ending process of commercializing inventions. This position extends, and underscores, the role of an intermediary that a TTO performs. As an intermediary, technology transfer officers navigate among university policies and objectives, TTO policies, practices, and goals, and faculty wants and needs. The expectations of investors and industry partners could add to the directions in which a technology transfer office may feel pulled and pushed.

Time appeared as a resource in this case, but sometimes as a resource in the background rather than at the forefront. Jordan denied that there are successful or unsuccessful incidents; “...things just are,” he said. Yet he referred to a TTO process as an experiment and a journey. When asked what experiment he would like to repeat or which journey he
would retake, he conceded the point one should learn from one’s experiences, successful or unsuccessful. His approach indicated a paradox of time reminiscent of the Stockdale paradox (Collins, 2001). James Bond Stockdale was the highest-ranking naval officer held as a prisoner of war during the US war in Vietnam. Stockdale said that during his incarceration of approximately seven years he learned to simultaneously hold two thoughts: one was that his personal efforts would eventually prevail, and he would eventually succeed, even if many years passed in the process; the other thought was to focus on the immediate disciplines and actions necessary, amid the brutal facts, no matter how hopeless they seem. Though Stockdale survived a life-or-death situation, a technology transfer officer may face a paradox. Jordan seemed to understand that technology transfer often requires a period of many years before achieving a success, during which time the focus is on daily processes, present facts, and a series of incidents that may appear to be successes or failures and may even switch between the two from month to month.

Jordan also mentioned that he had no interest in metrics for technology transfer offices. He seemed to understand that metrics are useful in measuring inputs and outputs during weeks or months. Over a period of years, and sometimes many years, such economic metrics lend little or no insight to what a TTO has done, is doing, should do, or will do.

Themes occurring most often in successful incidents included people (engaging with faculty, establishing trust, collaborating, networking, and persisting) and knowledge (experimenting, learning, sharing knowledge, combining knowledge, and reusing knowledge).
Themes occurring most often in unsuccessful incidents included failures to adapt in a changing environment and to manage effectively both people and process.

The participants discussed resources in the course of their incidents. Human resources included academic inventors, investors, and industry partners. A typical context was whether a faculty member was coachable or uncoachable. Technology resources and time resources – i.e., the technology was too early – were also mentioned. Resources were often mentioned in the context of successful incidents (e.g., “the right CEO” or “the right academic inventor”) and unsuccessful incidents (e.g., “the wrong CEO”), and the perspective was consistent with a resource-based ethos.

Evident in the incidents were actions or inactions that led to failures (such as a failure to align goals and expectations among inventors, investors, and the TTO, or a failure to hire an effective entrepreneur as chief executive officer of a startup) and an absence of process that led to failure.

The University of Southampton TTO presents a case of a small technology transfer office initiating and supporting an innovation process as an intermediary (Chesbrough, 2003b) that highlights conditions, actions, resources, and boundaries (Lundvall, 1992).

**Georgia Institute of Technology**

The Georgia Institute of Technology, located in Atlanta, Georgia, US, opened in 1865. The student population at the university at the time of this study was approximately 21,000, comprising approximately
14,000 undergraduate students and approximately 7,000 graduate students. At this time of this study, the TTO comprised the Office of Technology Licensing and Venture Lab.

The TTO employed approximately 30 people at the time of this study. Seven participated in interviews: Nicol, Owen, Payne, Quinn, Riley, Sloan, and Taylor. The table below presents the main themes of the interviews.

Table 6: Georgia Institute of Technology participants and interview themes

<table>
<thead>
<tr>
<th>Participant</th>
<th>Themes of incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicol</td>
<td>Brokering, networking, and aligning goals</td>
</tr>
<tr>
<td>Owen</td>
<td>Brokering, adapting, and managing resources</td>
</tr>
<tr>
<td>Payne</td>
<td>Collaborating, coaching, and combining knowledge</td>
</tr>
<tr>
<td>Quinn</td>
<td>Collaborating and combining knowledge</td>
</tr>
<tr>
<td>Riley</td>
<td>Sharing knowledge, learning, and managing expectations</td>
</tr>
<tr>
<td>Sloan</td>
<td>Brokering knowledge and collaborating</td>
</tr>
<tr>
<td>Taylor</td>
<td>Building trust, collaborating, and learning</td>
</tr>
</tbody>
</table>

Each incident typically involved one technology, and the technologies discussed in incidents at this TTO applied to aerospace, computing, electronics, materials design, medical devices, mobile communications, neurobiology simulations, photovoltaics, weather
forecasting, and wireless data routing. (Full descriptions and discussions of these incidents are provided in the appendix.)

These 14 incidents revealed a case study of a TTO engaging in an innovation process with conditions and actions evident. Conditions of disclosure, access, and reward are also evident. Actions included accumulating and analyzing knowledge, adapting to opportunities and the environment, anticipating problems, assessing opportunities, brokering knowledge, building networks, coaching, collaborating with faculty, collaborating with colleagues in the TTO, collaborating with industry executives and venture capitalists outside the TTO, combining knowledge, developing relationships, leading and managing projects, learning, managing expectations, negotiating, persisting despite big challenges, planning and monitoring and adjusting as necessary, researching (markets, industries, etc.), and reusing and sharing information (Tsoukas and Knudsen, 2003).

The theme of trust undergirded the actions. Relationships built on trust led to successes (e.g., Payne’s incident), and unsuccessful incidents (e.g., Payne’s and Sloan’s) indicated a breakdown of trust or an absence of trust.

Participants often discussed resources. Human resources included academic inventors, entrepreneurs, venture capitalists, and industry executives. Typical contexts included faculty members understood or misunderstood the commercialization process, or faculty members who retained or lost interest in startups. Just as human resources played a critical role in success or failure, so did capital resources, technology resources, and intellectual property (e.g., a patent). A distinction between a technology and a patent was clear, as industry executives could sponsor the transfer of a technology’s know-how rather than obtain the license of
a patent, and venture capitalists would look for at least one patent to secure their license with the university and, in turn, their investment.

Participants also mentioned the strategy to get eventual products to market (a function of human resources), the requisite cost (a function of capital resources), and time (which itself is a resource): in summary, the strategy to market, the cost to market, and the time to market. The role that resources played in the incidents is prominent in participants’ evaluating strategy, cost, and time to market. For example, Owen observed that in his unsuccessful incident he should have taken actions sooner (such as forming a startup); had he done so, he believed, the outcome may have been successful. He felt that time had worked against him.

With the breadth and depth of interactions that the seven participants discussed, the function and operation of the TTO as an intermediary was conspicuous (Hargadon and Sutton, 1997, Hargadon and Douglas, 2001, Chesbrough, 2003b).

Context can identify factors beyond the control of the TTO, such as ecosystems and geography. Unlike the San Francisco area or the Boston area, the Atlanta area lacked an ecosystem of starting companies, licensing intellectual property, and raising significant capital from institutional venture capital firms. With Boston approximately 1,000 miles away and San Francisco approximately 2,500 away, Atlanta is far from the centers of venture capital in the US.

University policy was an important factor in Nicol’s observation that he had learned to involve university lawyers early in a collaboration process, despite the lawyers’ limitations. Taylor felt that the university’s emphasis in certain situations on granting nonexclusive licenses and

Recurring themes in successful incidents reflected the innovation themes of Hargadon (1998) and Murray and O'Mahony (2007): brokering, adapting, collaborating, coaching, building trust, sharing and combining knowledge, and learning. Participants drew direct connections between collaborating, aligning goals, and managing expectations as a key to successful incidents.

Recurring themes in unsuccessful incidents included learning about oneself and one’s environment (i.e., what is within or beyond one’s control); failing to align goals, establish trust, and manage processes; and failing to manage resources.

Unsuccessful incidents can resemble successful incidents; for example, Nicol’s unsuccessful incident could have ended successfully, and Owen’s successful incident could have ended unsuccessfully. Unsuccessful incidents tended to identify factors that technology transfer officers felt were beyond their control: for example, an industry executive declining to take action, a professor declining the TTO’s assistance, a professor losing interest in a startup and returning to his laboratory, and a professor and an entrepreneur setting an early deadline for a license negotiation. Unsuccessful incidents exemplified failures to align goals and manage expectations.

The technology transfer operation at the Georgia Institute of Technology provides a case of a TTO initiating and supporting an innovation process with specific conditions, actions, and resources. From
the perspective of technology transfer officers, they operated in a difficult environment that placed unusual demands on decision making, problem solving, and team learning in an innovation process (e.g., Weick, 1969, Child and Smith, 1987, Burgelman, 1991, and Brown and Eisenhardt, 1997).

**University of Utah**

The University of Utah, located in Salt Lake City, Utah, US, was established in 1850. The student population at the university at the time of this study was approximately 31,000, comprising approximately 23,000 undergraduate students and approximately 8,000 graduate students. At this time of this study, the TTO was referred to as Technology Commercialization Office.

The TTO employed approximately 15 people at the time of this study. Four participated in interviews: Ursula, Varney, Whitney, and Xian. The table below presents the main themes of the interviews.

**Table 7: University of Utah participants and interview themes**

<table>
<thead>
<tr>
<th>Participant</th>
<th>Themes of incidents</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Successful</strong></td>
<td><strong>Unsuccessful</strong></td>
</tr>
<tr>
<td>Ursula</td>
<td>Adapting, networking, and collaborating</td>
<td>Failing to establish trust and align goals</td>
</tr>
<tr>
<td>Varney</td>
<td>Managing resources and processes</td>
<td>Learning patience and persistence</td>
</tr>
<tr>
<td>Whitney</td>
<td>Networking, collaborating, and learning</td>
<td>Failing to establish trust and align goals</td>
</tr>
<tr>
<td>Xian</td>
<td>Analyzing, collaborating, networking, and sharing knowledge</td>
<td>Failing to build teams</td>
</tr>
</tbody>
</table>
Each incident typically involved one technology, and the technologies discussed in incidents at this TTO applied to carbon sequestration, diagnostic microchips, engineered materials, measurement devices, medical devices, renewable energy, and water treatment. (Full descriptions and discussions of these incidents are provided in the appendix.)

These eight incidents composed a case study of a TTO engaging in an innovation process with evidence of conditions and actions. Conditions of disclosure, access, and reward were present. Actions included accumulating and analyzing knowledge, adapting to opportunities and the environment, anticipating problems, assessing opportunities, brokering knowledge, building networks, coaching, collaborating with faculty, collaborating with colleagues in the TTO, collaborating with industry executives and venture capitalists outside the TTO, combining knowledge, developing relationships, leading and managing projects, learning, managing expectations, negotiating, persisting despite big challenges, planning and monitoring and adjusting as necessary, researching (markets, industries, etc.), and reusing and sharing information. Important themes were adapting to changing circumstances and organizational learning (Simon, 1991, Walsh and Ungson, 1991, Grant, 1996),

Connecting with both conditions and actions was risk. The connection with conditions was that reward is a condition, and reward and risk figured in the minds of academic inventors, venture capitalists, industry executives, and technology transfer officers. University policy tended toward avoiding risk rather than embracing opportunity. Risk appeared as a counterpoint to reward (Tversky and Kahneman, 1992). The risk of enforcing patent rights for a TTO was that the expense is high, and the TTO may realize little or no reward; however, there are risks in
avoiding patent rights enforcement, as academic inventors may see no reward in making disclosures or obtaining patents if the university fails to enforce patent rights. Identifying risk, understanding risk, mitigating risk, and managing risk can become important to the process as technology transfer officers, and TTOs as organizations, take such actions and develop policies requiring such actions.

The theme of trust was recurrent. Relationships built on trust were mentioned in successful incidents, and a breakdown of trust or an absence of trust was discussed in unsuccessful incidents.

An emphasis on transparency (in Xian’s incident) at the University of Utah TTO was consistent with the same emphasis (in Kelly’s incident) at the University of Southampton.

Resources were frequently mentioned. Human resources included startup executives most prominently, notably in Ursula’s incidents. She also mentioned capital as a key resource; rising legal costs were decreasing the financial resources of TTOs. Participants also mentioned the strategy to get eventual products to market (a function of human resources), the requisite cost (a function of capital resources), and time (which itself is a resource): in summary, the strategy to market, the cost to market, and the time to market. The role that resources played in the incidents is prominent in participants’ evaluating strategy, cost, and time to market. Both Varney and Whitney discussed the importance of time. In this case, as in the other cases, the emphasis on resources was consistent with a resource-based ethos rather than a resource-based view.

The function and operation of the TTO as an intermediary was evident, with Ursula describing the TTO “as a service business.”
Recognizing the geographical limitation of the TTO away from major centers of venture capital, the TTO also saw an advantage of geography in nearby resorts that attract venture capitalists and industry executives.

University policy was an important factor, and the TTO was involved in engaging the university bureaucracy and attempting to cut red tape (and often succeeding).

Themes occurring most often in successful incidents included adapting, networking, collaborating, sharing knowledge, and learning. Managing processes and managing resources were also important themes.

Themes occurring most often in unsuccessful incidents included failures in establishing trust, aligning goals, and building teams.

Unsuccessful incidents tended to identify the same factors seen in the case studies of the other three university TTOs: “the wrong people” including academic inventors, startup executives, and investors; misalignment of goals; mismanagement of expectations; and an absence of trust. Both Varney and Whitney felt that, in their persistence and desire to build relationships, they had prolonged the duration of unsuccessful incidents. The participants also indicated that certain factors were sometimes beyond their control, such as a professor losing interest in a startup.

The University of Utah’s TTO affords a case study of a TTO initiating, supporting, and improving an innovation process with specific conditions, actions, and resources. This TTO developed a co-evolutionary model (Kaplan and Tripsis, 2008) emphasizing networks, processes, and
boundaries (Pettigrew and Fenton, 2000) to facilitate organizational learning (e.g., Nonaka, 1994, Glyn, 1996, Amabile et al., 1996) and to measure organizational performance (Teece, 1999)

**Cross-case analysis**

This cross-case analysis is an examination of the four university cases across the themes of conditions, actions, resources, and environment.

From perspectives of both the literature of innovation and organization theory and the empirical data in this study, conditions and actions were recurrent themes that the conceptual framework denotes.

Emergent themes included perceptions of resources and environmental factors. Another emergent theme was a perception of risk as a counterbalance to reward. All of the emergent themes occurred throughout the four university cases. The addition of emergent themes and a taxonomy of actions led to the resultant framework.

Pettigrew and Fenton, 2000) are most evident in environmental factors, such as university policy, affecting process.

Qualitative data analysis showed that categories were the same four – conditions, actions, resources, and environment – across the four universities. More than 95 percent of the nodes were consistent across all universities. This is important, as these categories and nodes align with conditions and actions, or process (Mohr, 1982).

Each incident had a general theme. Though less important than the consistency in conditions in actions, these general themes provided further evidence of similarities across the university case studies. For example, in successful incidents, the general theme of sharing knowledge was evident in incidents recounted by Alex and Blair (University of Manchester), Lindsey (University of Southampton), Riley (Georgia Tech), and Xian (University of Utah); combining knowledge, Blair and Drew (University of Manchester) and Payne and Quinn (Georgia Tech); reusing knowledge, Blair (University of Manchester) and Kelly (University of Southampton); managing resources, Owen (Georgia Tech) and Varney (University of Utah); collaborating, Drew and Hayden (University of Manchester), Kelly (University of Southampton), Quinn, Sloan, and Taylor (Georgia Tech), and Ursula, Whitney, and Xian (University of Utah); aligning and managing goals, Ellis (University of Manchester), Morgan (University of Southampton), and Nicol (Georgia Tech); building trust, Gale (University of Manchester), Morgan (University of Southampton), and Taylor (Georgia Tech); persisting, Inga (University of Manchester) and Lindsey (University of Southampton); and learning, Jordan (University of Southampton), Riley and Taylor (Georgia Tech), and Whitney (University of Utah).
General themes in unsuccessful incidents included: failing to align goals, a general theme in incidents from Alex (University of Manchester), Payne (Georgia Tech), and Ursula and Whitney (University of Utah); failing to manage process, Alex and Cameron (University of Manchester), Lindsey (University of Southampton), Owen, Riley, and Taylor (Georgia Tech); failing to manage people, Cameron, Franklin, Gale, and Hayden (University of Manchester), Morgan (University of Southampton), and Xian (University of Utah); learning from failure what is within and beyond one’s control, Kelly (University of Southampton), and Nicol and Quinn (Georgia Tech); failing to summon or manage resources, Blair, Cameron, Drew, Franklin, and Hayden (University of Manchester) and Owen and Taylor (Georgia Tech); and failing to build trust, Sloan (Georgia Tech) and Ursula and Whitney (University of Utah).

More specific themes of conditions, actions, resources, and environment lend more insight to process.

In successful incidents, these actions were identified: accumulating, adapting, analyzing, anticipating, assessing opportunities, brokering, building networks, building relationships, building trust, coaching, collaborating, combining and recombining, complementing strengths and limitations, encouraging and inspiring, leading, learning, listening, managing expectations, managing projects, negotiating, persisting, planning-monitoring-adjusting, researching industries, researching intellectual property, researching markets, researching products, researching technologies, reusing information, sharing information, and talking.
### Table 8: Successful incidents: actions and conditions

<table>
<thead>
<tr>
<th>Actions</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accumulating</td>
<td>Access</td>
</tr>
<tr>
<td>Adapting</td>
<td>Disclosure</td>
</tr>
<tr>
<td>Analyzing</td>
<td>Reward</td>
</tr>
<tr>
<td>Anticipating</td>
<td>Risk</td>
</tr>
<tr>
<td>Assessing opportunities</td>
<td></td>
</tr>
<tr>
<td>Brokering</td>
<td></td>
</tr>
<tr>
<td>Building networks</td>
<td></td>
</tr>
<tr>
<td>Building relationships</td>
<td></td>
</tr>
<tr>
<td>Building trust</td>
<td></td>
</tr>
<tr>
<td>Coaching</td>
<td></td>
</tr>
<tr>
<td>Collaborating</td>
<td></td>
</tr>
<tr>
<td>Combining and recombining</td>
<td></td>
</tr>
<tr>
<td>Complementing strengths and limitations</td>
<td></td>
</tr>
<tr>
<td>Encouraging and inspiring</td>
<td></td>
</tr>
<tr>
<td>Leading</td>
<td></td>
</tr>
<tr>
<td>Learning</td>
<td></td>
</tr>
<tr>
<td>Listening</td>
<td></td>
</tr>
<tr>
<td>Managing expectations</td>
<td></td>
</tr>
<tr>
<td>Managing projects</td>
<td></td>
</tr>
<tr>
<td>Negotiating</td>
<td></td>
</tr>
<tr>
<td>Persisting</td>
<td></td>
</tr>
<tr>
<td>Planning, monitoring, and adjusting</td>
<td></td>
</tr>
<tr>
<td>Researching industries</td>
<td></td>
</tr>
<tr>
<td>Researching IP</td>
<td></td>
</tr>
<tr>
<td>Researching markets</td>
<td></td>
</tr>
<tr>
<td>Researching products</td>
<td></td>
</tr>
<tr>
<td>Researching technologies</td>
<td></td>
</tr>
<tr>
<td>Reusing</td>
<td></td>
</tr>
<tr>
<td>Sharing</td>
<td></td>
</tr>
<tr>
<td>Talking</td>
<td></td>
</tr>
<tr>
<td>Conditions</td>
<td></td>
</tr>
</tbody>
</table>
### Table 9: Unsuccessful incidents: actions, inactions, and conditions

<table>
<thead>
<tr>
<th>Actions and inactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accumulating</td>
</tr>
<tr>
<td>Brokering</td>
</tr>
<tr>
<td>Collaborating</td>
</tr>
<tr>
<td>Combining and recombining</td>
</tr>
<tr>
<td>Complementing strengths and limitations</td>
</tr>
<tr>
<td>Failing to align goals</td>
</tr>
<tr>
<td>Failing to hire an effective CEO</td>
</tr>
<tr>
<td>Failing to manage expectations</td>
</tr>
<tr>
<td>Failing to manage the project</td>
</tr>
<tr>
<td>Inaction: entrepreneur</td>
</tr>
<tr>
<td>Inaction: industry executive</td>
</tr>
<tr>
<td>Inaction: inventor</td>
</tr>
<tr>
<td>Inaction: investor</td>
</tr>
<tr>
<td>Inaction: licensee</td>
</tr>
<tr>
<td>Inaction: licensor</td>
</tr>
<tr>
<td>Incorrectly analyzing industries</td>
</tr>
<tr>
<td>Incorrectly analyzing markets</td>
</tr>
<tr>
<td>Incorrectly analyzing products</td>
</tr>
<tr>
<td>Learning</td>
</tr>
<tr>
<td>Negotiating: problems with inventors</td>
</tr>
<tr>
<td>Negotiating: problems with investors</td>
</tr>
<tr>
<td>Negotiating: problems with licensees</td>
</tr>
<tr>
<td>Persisting</td>
</tr>
<tr>
<td>Reusing</td>
</tr>
<tr>
<td>Sharing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access</td>
</tr>
<tr>
<td>Disclosure</td>
</tr>
<tr>
<td>Reward</td>
</tr>
<tr>
<td>Risk</td>
</tr>
</tbody>
</table>

In unsuccessful incidents, these actions and inactions were identified: accumulating, brokering, collaborating, combining and recombining, complementing strengths and limitations, failing to align goals, failing to hire an effective CEO, failing to manage expectations, failing to manage the project, inaction: entrepreneur, inaction: industry executive, inaction: inventor, inaction: investor, inaction: licensee,
inaction: licensor, incorrectly analyzing industries, incorrectly analyzing markets, incorrectly analyzing products, learning, negotiating: problems with inventors, negotiating: problems with investors, negotiating: problems with licensees, persisting, reusing, and sharing.

Actions present in both successful and unsuccessful incidents were accumulating, brokering, collaborating, combining and recombining, complementing strengths and limitations, learning, negotiating, persisting, reusing, and sharing. The discussion of negotiations in unsuccessful incidents generally involved problems with inventors, investors, or licensees. The presence of such actions in both successful and unsuccessful incidents indicates that other actions or conditions may have more effect on an outcome. In many incidents, some actions occurred after the failure was evident (e.g., learning and sharing).

Actions that were present in successful incidents, and absent in unsuccessful incidents, were: adapting, analyzing, anticipating, assessing opportunities, building networks, building relationships, building trust, coaching, encouraging and inspiring, leading, listening, managing expectations, managing projects, planning-monitoring-adjusting, researching industries, researching IP, researching markets, researching products, researching technologies, and talking. These actions indicate a mindful and systematic process (Weick 2005, 2006a, Chesbrough and Teece, 1996, Hargadon 2001, 2003, Argyris and Schon, 1978).

Actions or inactions present in unsuccessful incidents, and absent in successful incidents, were: failing to align goals, failing to hire an effective CEO, failing to manage expectations, failing to manage the project, inaction: entrepreneur, inaction: industry executive, inaction: inventor, inaction: investor, inaction: licensee, inaction: licensor, incorrectly analyzing industries, incorrectly analyzing markets, and incorrectly analyzing products. In sum, these suggest failures and
inactions either inside or outside the control of the technology transfer officer. They often combine with actions present in both successful and unsuccessful incidents to show that rarely was process wholly inadequate; however, participants most often referred to these failures as impetus to change process within their control.

The table shows that the three categories (i.e., (1) actions present in successful and unsuccessful incidents, (2) actions present in successful incidents and absent in unsuccessful incidents, and (3) actions and inactions present in unsuccessful incidents absent in successful incidents) entail clusters of mutually exclusive actions.

Table 10: A comparison of actions by successful and unsuccessful incidents

<table>
<thead>
<tr>
<th>Actions present in successful and unsuccessful incidents</th>
<th>Actions present in successful incidents and absent in unsuccessful incidents</th>
<th>Actions and inactions present in unsuccessful incidents and absent in successful incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accumulating</td>
<td>Adapting</td>
<td>Failing to align goals</td>
</tr>
<tr>
<td>Brokerage</td>
<td>Analyzing</td>
<td>Failing to hire an effective CEO</td>
</tr>
<tr>
<td>Collaborating</td>
<td>Anticipating</td>
<td>Failing to manage expectations</td>
</tr>
<tr>
<td>Combining and recombining</td>
<td>Assessing opportunities</td>
<td>Inaction: entrepreneur</td>
</tr>
<tr>
<td>Complementing strengths and limitations</td>
<td>Building networks</td>
<td>Inaction: industry executive</td>
</tr>
<tr>
<td>Learning</td>
<td>Building relationships</td>
<td>Inaction: inventor</td>
</tr>
<tr>
<td>Negotiating</td>
<td>Building trust</td>
<td>Inaction: licensee</td>
</tr>
<tr>
<td>Persisting</td>
<td>Coaching</td>
<td>Incorrectly analyzing industries</td>
</tr>
<tr>
<td>Reusing</td>
<td>Encouraging and inspiring</td>
<td>Incorrectly analyzing markets</td>
</tr>
<tr>
<td>Sharing</td>
<td>Leading</td>
<td>Incorrectly analyzing products</td>
</tr>
<tr>
<td>Learning</td>
<td>Listening</td>
<td></td>
</tr>
<tr>
<td>Negotiating</td>
<td>Managing expectations</td>
<td></td>
</tr>
<tr>
<td>Persisting</td>
<td>Managing projects</td>
<td></td>
</tr>
<tr>
<td>Reusing</td>
<td>Planning, monitoring, and adjusting</td>
<td></td>
</tr>
<tr>
<td>Sharing</td>
<td>Researching industries</td>
<td></td>
</tr>
<tr>
<td>Inactions: entrepreneur</td>
<td>Researching IP</td>
<td></td>
</tr>
<tr>
<td>Inactions: industry executive</td>
<td>Researching markets</td>
<td></td>
</tr>
<tr>
<td>Inactions: investor</td>
<td>Researching products</td>
<td></td>
</tr>
<tr>
<td>Inactions: licensee</td>
<td>Researching technologies</td>
<td></td>
</tr>
<tr>
<td>Inactions: licensee</td>
<td>Talking</td>
<td></td>
</tr>
</tbody>
</table>

Conditions of disclosure, access, and reward were the same in both successful incidents and unsuccessful incidents. As a counterpoise to reward, risk emerged as an addition to these conditions. Perceptions of rewards are important, but they must preponderate perceptions of risks (Tversky and Kahneman, 1974, 1981, 1992, Kahneman and Tversky, 1979). Potential losses can incorrectly appear to exceed potential gain.

Resources also emerged as an addition to the framework. Resources in successful incidents were capital, licenses (which are contracts stipulating cash flows), networks, people (entrepreneurs or startup CEOs, industry executives, inventors), plans to commercialize the technology (with details on the strategy to market, the cost to market, or the time to market), technology, and time – all are assets. In unsuccessful incidents, resources (or their absence) were liabilities: capital problems, license problems, network problems, people problems (entrepreneurs or startup CEOs, industry executives, inventors), plan problems (with the strategy to market, the cost to market, or time to market), technology problems, or time problems.

Participants frequently discussed resources, generally describing them as sufficient in successful incidents and insufficient in unsuccessful incidents. This discussion of resources may suggest a resource-based view (Penrose, 1959, Wernerfelt, 1984, 1995, Rumelt, 1997, Barney et al., 2001, Barney et al., 2011, Priem and Butler, 2001, Helfat and Peteraf, 2003). Powers and McDougall (2005) apply a resource-based view to university technology transfer; however, key concepts of the resource-based view seem to have little or no application to university technology transfer offices or universities generally. For example, the concept of sustainable competitive advantage has little or no utility to university TTOs, which have little control over their resources. Further, criteria for evaluating resources in the resource-based view – viz., resources must be
valuable, rare, inimitable, and non-substitutable – generally fail to apply to the resources available to a university TTO. Resources, however, are important in the process of university technology transfer (Lockett and Wright, 2005, O'Shea et al., 2005). Rather than looking at a TTO through a resource-based view, understanding that a TTO has a resource-based ethos may prove a more helpful perspective, as technology transfer officers’ perception of resources profoundly affects the beliefs, assumptions, and practices of the TTO.

Consistent with the observations of technology transfer officers, the table presents resources from successful and unsuccessful incidents. The identification of resources and capabilities is the same in both sets of incidents, but each set is the converse of the other.

**Table 11: Successful and unsuccessful incidents: resources**

<table>
<thead>
<tr>
<th>Successful incidents</th>
<th>Unsuccessful incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>Capital problems</td>
</tr>
<tr>
<td>Intellectual property</td>
<td>Intellectual property problems</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Knowledge problems</td>
</tr>
<tr>
<td>License</td>
<td>License problems</td>
</tr>
<tr>
<td>Network</td>
<td>Network problems</td>
</tr>
<tr>
<td>People: entrepreneurs or startup CEOs</td>
<td>People problems: entrepreneurs or startup CEOs</td>
</tr>
<tr>
<td>People: industry executives</td>
<td>People problems: industry executives</td>
</tr>
<tr>
<td>People: inventors</td>
<td>People problems: inventors</td>
</tr>
<tr>
<td>Plan: cost to market</td>
<td>Plan problems: cost to market</td>
</tr>
<tr>
<td>Plan: strategy to market</td>
<td>Plan problems: strategy to market</td>
</tr>
<tr>
<td>Plan: time to market</td>
<td>Plan problems: time to market</td>
</tr>
<tr>
<td>Technology</td>
<td>Technology problems</td>
</tr>
<tr>
<td>Time</td>
<td>Time problems</td>
</tr>
</tbody>
</table>

This study showed that some resources are more obvious than others. Capital as a financial resource is necessary for a TTO to operate and often to launch a startup. Knowledge as a resource is evident and important. People, as human resources, are obviously necessary: inventors, technology transfer officers, investors to fund startups,
industry executives to secure licenses, and lawyers to prosecute patents, for example. Technology and intellectual property (qua patents or know-how) are another obvious resource. Networks of people are an important and obvious necessity (e.g., Pettigrew and Fenton, 2000, Chesbrough 2003a, 2011). Participants tended to classify networks as a resource; whether they are defined as a resource or a capability in this context is less important, though the resource-based view tends to define networks as a capability rather than a resource.

Environment varied little in successful and unsuccessful incidents, as both operated under a similar environment. However, unlike conditions, which remained the same in successful and unsuccessful incidents, environment in unsuccessful incidents often included a technology transfer officer’s observation that the invention was either too early or too late for the market.

Table 12: Successful and unsuccessful incidents: environment

<table>
<thead>
<tr>
<th>Successful incidents</th>
<th>Unsuccessful incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital markets</td>
<td>Capital markets</td>
</tr>
<tr>
<td>Government funds for university research</td>
<td>Government funds for university research</td>
</tr>
<tr>
<td>Government IP policy</td>
<td>Government IP policy</td>
</tr>
<tr>
<td>Government regulatory policy</td>
<td>Government regulatory policy</td>
</tr>
<tr>
<td>University policies</td>
<td>Market environment: too early for the invention</td>
</tr>
<tr>
<td></td>
<td>Market environment: too late for the invention</td>
</tr>
<tr>
<td></td>
<td>University policies</td>
</tr>
</tbody>
</table>

4.3 Other similarities and dissimilarities

The final category collected references to similarities and differences between technology transfer offices in the UK and the US.
Similarities among the TTOs were numerous. Years pass between discovery and market entry. During that time, TTOs as organizations work to adapt to manifold changes in disclosures, access, rewards, risks, resources, and the environment. Incidents that appeared successful (or unsuccessful) previously seemed unsuccessful (or successful). Most of the incidents could have occurred at a small TTO or a large TTO, in the UK or in the US. Qualitative data analysis supports the preponderance of similarities in codes and themes across all four TTOs.

Difference between UK and US TTOs noted in prior studies (e.g., Hofmann et al., 2002, Decter et al., 2007) remained evident; for example, UK TTOs tend to have fewer disclosures and patents. UK TTOs tend to focus relatively more resources on relatively fewer projects; UK TTOs tend to aim and fire their resources with a rifle, whereas US TTOs tend to prefer a shotgun, scattering their shots among relatively more technologies. The cause of this practice among US TTOs may originate with more disclosures. To encourage more disclosures from more faculty, US TTOs tend to devote at least some resources and activities, which may include a patent application, to more discoveries.

As a matter of law, US TTOs must comply with provisions of the Bayh-Dole Act of 1980, which requires universities to work toward commercialization of inventions derived from national government grants; thus, US TTOs can claim compliance with the law by providing at least some resources to a significant percentage of disclosures. Government and legal compliance loomed over US TTOs, as many participants talked about ensuring compliance with government and university regulations, managing lawyers, administering issues surrounding conflicts of interest, and engaging university administrators to relax policies that, in the assessments of US technology transfer officers, limit their ability to fulfill the mission of the TTO. US technology
transfer officers talked much more about developing an ecosystem like Silicon Valley's and mentioned Silicon Valley in their attempts to build even a minute scale of the collaborative networks in Atlanta or Salt Lake City. As some US participants looked enviously at Silicon Valley's access to early-stage capital, some UK participants looked enviously at the US in general for such access to capital. Geography can affect perspective.

Less obvious resources are go-to-market plans and time. The plans, defining a strategy to go to market, relevant costs to execute the strategy, and relevant time period for the plan, were a resource often mentioned in whole or in part. In successful incidents, the plans were considered an asset; in unsuccessful incidents, a liability. In either case, the plans represent a resource for an innovation process particularly with startups that a TTO actively participates in launching. The plans encapsulate cumulative knowledge of innovation. Time as a resource is a recurrent theme. Technology transfer officers seemed to feel that time worked for them in successful incidents and against them in unsuccessful incidents. In most incidents, whether successful or unsuccessful, the time that passed between the initial disclosure and the classification of the incident as successful or unsuccessful was a period of years, sometimes more than a decade. Environments tend to change as the years pass.

Five themes on the environment were consistent: capital markets, government funds for university research, government policy on intellectual property, government regulatory policy, and university policies. Whether these environmental factors were favorable (in the successful incidents) or unfavorable (in unsuccessful incidents) depended on the specific situation and context. Two themes were mentioned only in unsuccessful incidents, and both referred to the market environment: viz., whether a technology was too early for the market, and whether a technology was too late for the market. Participants noted that
environments change, and sometimes abruptly; e.g., capital markets changed quickly during a period of several months, and sometimes several weeks, in 2008. A sharp decline in public equity markets led to fewer initial public offerings with ramifications for venture capitalists, (who reported lower investment returns), institutional investors (who directed investments to other alternatives), industry executives (who often saw a decline in the market capitalizations or valuations of their companies and in their budgets for sponsoring university research), and politicians (who often decreased or delayed funds for university research). Though capital markets are beyond the influence of TTOs, technology transfer officers can sometimes influence government budgets, intellectual property policy, and regulatory policy (e.g., policies for the approval of medical devices). TTOs may have influence on university policy, but many participants noted frequent conflicts with, and apparent inconsistencies within, university policies.

Differences among the four TTOs often derived from their organization structure. The University of Manchester's large TTO differed from the University of Southampton's smaller TTO, where collaboration managers worked with faculty on obtaining research grants and commercializing intellectual property. At the other three universities, a completely separate office administers the grant activity. The TTO at the University of Utah became an organization within the business school, and the University of Manchester's TTO is an entity legally separate from the university. None of these differences seemed to have an effect on the fundamental innovation process and the significant similarity among the processes at the four technology transfer offices.
4.4 Resultant framework

The conceptual framework – identifying themes of adaptation, cognition, and structure, noting the contributions of certain innovation models, and positioning conditions and actions in the context of a university technology transfer office – developed through this study into a resultant framework, which portrays the connections among conditions, actions, resources, and environment in a university TTO context. The figure below depicts the resultant framework.

The resultant framework makes no change to the conditions of disclosure and access. The third condition, reward, is now contiguous to risk, which is an addition to conditions. Reward is necessary but not sufficient. If a perception of risk (irrespective of whether risk is correctly or incorrectly assessed or perceived) is too high, that perception can negate or overwhelm a perception of reward.

Actions in the resultant framework subsume the actions of the conceptual framework and add numerous actions discussed in detail in a subsequent section and displayed in tables. Moreover, this study organizes those actions into (1) actions present in both successful and unsuccessful incidents, (2) actions present only in successful incidents, and (3) actions present only in unsuccessful incidents.

Another addition to the framework is environment, which, unlike actions, is often largely or entirely beyond the control of a technology transfer officer. The state of a national economy and the number of initial public offerings in a public equity market are environmental factors clearly beyond the control of a technology transfer officer. A technology transfer office or officer, however, can sometimes influence university policies or government policies. Economic and market conditions and
government and institutional policies may provide to a TTO advantages at times and disadvantages at other times. Although the causes and effects of environment are beyond the control of a TTO, this study explicitly identifies the significant interactivity among environment, conditions, actions, and another addition, which is resources.

The resultant framework explicitly notes resources, some more obvious (e.g., capital, people, and technology) and others less obvious (e.g., plans and time). Further, the framework emphasizes that resources have an effect on, and are affected by, conditions, actions, and environment.

This study follows common convention with the use of arrows in figures: a unidirectional arrow indicates antecedence (chronologically, conceptually, etc.) or causation, and a bidirectional arrow indicates interactivity. In this study, “interactivity” means the possibility of two (or more) conditions or actions influencing each other.

The conceptual framework, consistent with the literature, viz., Murray and O’Mahony (2007), presents a unidirectional arrow to reflect conditions as the antecedent for actions (Mohr, 1982); however, empirical data in this study show that interactivity occurs as the process iterates among conditions, actions, resources, and environmental factors. Actions can eventually affect conditions; for example, successful actions can encourage disclosure compliance, and unsuccessful actions can discourage disclosure compliance; disclosure compliance indubitably affects a TTO. Thus, the resultant framework shows that arrows are bidirectional as the process iterates among conditions, actions, resources, and environmental factors. Reflexivity is evident in the case studies. Conditions, actions, resources, environment, and context affect, shape, or
influenced one another in each of the four university TTOs throughout successful and unsuccessful incidents.

**Figure 2:** A resultant framework for context, conditions, actions, resources, and environment in an innovation process of university technology transfer

<table>
<thead>
<tr>
<th>Literature of Innovation</th>
<th>Innovation Models</th>
<th>University Technology Transfer Offices</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptation, Cognition, and Structure</td>
<td>User, Open, and Cumulative</td>
<td>Context</td>
<td>Disclosure</td>
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<tr>
<td></td>
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<td></td>
<td>Access</td>
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<td>Reward</td>
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<td></td>
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<td>Risk</td>
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<tr>
<td>Environment Factors</td>
<td>Resource-based ethos</td>
<td>Factors within a TTO’s influence</td>
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<tr>
<td></td>
<td></td>
<td>Factors beyond a TTO’s influence</td>
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</tbody>
</table>

Highlights in **bold italics** indicate additions to the conceptual framework.
5. Conclusion

This section provides a summary of the research and a discussion of this study’s contributions to the literature and practice of innovation and university technology transfer. This section also considers limitations of this study, implications of this research, and opportunities for further research.

5.1 Summary

This study began with theory informing empirical practice and empirical practice evincing theory. The literature of innovation in organization theory – especially the themes of adaptation and cognition – offered theory that guided the research question and suggested the methodology; both the initial and resultant conceptual frameworks are grounded in theory found in the literature and practice evidenced in fieldwork.

Anchored firmly in theory and practice, the application of recent models of innovation (e.g., Chesbrough’s open innovation model and Murray and O’Mahony’s cumulative innovation model) helped frame this study’s investigation of university technology transfer. Through the lens of these models, this research took a new perspective of the literature of technology transfer – i.e., the perspective of technology transfer officers – that revealed an opportunity to ascertain, explore, and explain innovation processes within university technology transfer organizations.

The author’s long experience with university TTOs also influenced the application of theory, the research question, and the methodology of this study; in conversations during a period of more than 15 years, scores
of university technology transfer officers unanimously and unambiguously told the author that they found the studies of TTOs in academic journals inaccurate or useless. They felt that (1) the quantitative studies focused on numerical inputs and outputs (which they said, at best, reflect little of what occurs and why in a TTO and, at worst, misrepresent the practice of university technology transfer) and failed to capture an innovation process that occurs between inputs and outputs, and (2) the qualitative studies typically began with structured or semi-structured interviews that made dubious and false assumptions. Thus, the methodology of this study focused on the critical incidents that university technology transfer officers said shaped the processes in their organizations.

With a fresh approach, this study commenced, asking whether innovation processes operate within university technology transfer organizations. From the evidence in this research, the answer was yes. How did the processes operate? Technology transfer officers, at two UK universities and two US universities, similarly traversed topographies of conditions, actions, resources, and environment over periods of years.

Beginning with a conceptual framework derived from the literature, this study developed the resultant framework, which augmented the connections among conditions, actions, resources, and environment within the context of a university technology transfer office. The resultant framework explained much more than the conceptual framework.

The resultant framework made no change to the two conditions of disclosure and access; however, the third condition, reward, emerged to encompasses the effect of risk. Reward was necessary but not sufficient. If a perception of risk is too high, irrespective of whether risk is
accurately or inaccurately assessed or perceived, then that perception can negate or overwhelm a perception of reward.

Actions in the resultant framework subsumed and greatly supplemented the actions of the conceptual framework. Further, this study organized those actions into (1) actions present in both successful and unsuccessful incidents, (2) actions present only in successful incidents, and (3) actions present only in unsuccessful incidents. The study also added environment; unlike actions, environment was largely or entirely beyond the control of a TTO. Whether a national economy experienced recession or robust growth is well beyond a TTO’s control; a TTO, however, can influence university and government policies. This study identified the important interactivity among environment, conditions, actions, and resources. The resultant framework explicitly noted that resources, some more obvious (e.g., capital, people, and technology) and others less obvious (e.g., plans and time), had an effect on and were affected by conditions, actions, and environment.

Thus, the resultant framework met the definition of process set by Mohr (1982) – a process as a set or series of perceptible conditions and actions that together influence or result in a distinct outcome – and the definition of innovation offered by Schumpeter (1934) – an innovation as new combinations of knowledge or other resources – while capturing and explicating an expansion of the conceptual framework as well as insights to innovation processes of university TTOs.

Why did this innovation process operate thus? The foundation for the answer to this question resided in the literature of innovation: to wit, adaptation, cognition, and structure. With their objective of turning invention into innovation, technology transfer officers adapted and learned. They operated within present structures and experimented with
new ones. To the extent that technology transfer officers were innovators, the literature of innovation explicated broad reasons, and the results of this study provided specific reasons, additional interactions, and specific actions: i.e., what technology transfer officers actually do, and why, in the innovation process of universities in the UK and the US.

5.2 Contributions

This study contributes to both the academic and practical understanding of university technology transfer offices. Among the contributions are these:

1. The study answered the research question. The study identified a process (Lockett and Wright, 2005, O'Shea et al., 2005), expanded conditions (Mohr, 1982) and materially built on actions (Murray and O'Mahony, 2007) within the context of university technology transfer the UK and the US. Further, the study detected, situated, and identified new insights on both resources (i.e., a resource-based ethos) and environment (e.g., environmental factors within a TTO's influence and environmental factors beyond a TTO's influence), noting the presence and effect of both and adding them to the conceptual framework of an innovation process as explicated by Hargadon and by Murray and O'Mahony.

2. The study presented results derived from a qualitative study, exploring and explaining the process of innovation in the context of this study. By focusing on the process between input and output, this qualitative study expatiated an understanding
of quantitative studies generally concentrating on inputs (e.g., disclosures) and outputs (e.g., licenses).

3. This study offered and explicated the organizational perspective of technology transfer officers. The research, presentation, and analysis herein gave voice to the thoughts and actions of technology transfer officers as they worked to improve their TTO as an organization and their innovation processes within the TTO. The study lent insight to their process of sensemaking. From the collection of perspectives from each organization emerged a deeper understanding of what the organization did, why, and to what effect in each of the technology transfer offices.

4. This is the first study to document and analyze what technology transfer officers actually did, how and what they learned, and how they modified and improved their actions as they worked to advance intellectual property toward commercial success. In this sense, this study followed the tradition of Mintzberg’s research into what business managers actually do (Mintzberg, 1973, 1975).

5. The perspective of the researcher informed this study. The researcher’s experience was unusual (and perhaps unique in certain contexts), as the researcher worked closely with more than 30 technology transfer offices for more than 15 years, both as confidant and as adversary, all of which established a relationship of trust with, and special access to, technology transfer offices and their staff.
6. The study of four university TTOs, rather than one or two typical in many other studies, provided a useful perspective, especially because these four TTOs have much more in common with most other university TTOs in the UK and the US. Most of the studies of one or two TTOs focus on the technology transfer offices of the most prestigious universities, which possess advantages sui generis.

7. The comparison of successful and unsuccessful incidents contributed particularly to a deeper comprehension of which actions tend to emerge (a) in both successful and unsuccessful incidents, (b) only in successful incidents, and (c) only in unsuccessful incidents. These clusters lent insight to mapping and navigating the innovation process in university TTOs.

8. Identification of a resource-based ethos assisted in explaining a perspective of technology transfer officers. A resource-based ethos helped express an organizational culture (i.e., the values and norms) of a TTO organization. In this study, TTO staff gave a high priority to their perception of the presence or absence of resources in many successful and unsuccessful incidents. Moreover, the staff also connected their perception of resources (as distinct from the actual presence or absence of resources) tightly to conditions, actions, and environment.

9. The expansion of actions gave a more robust explanation of what technology transfer officers do in an innovation process. The incidents, both successful and unsuccessful, show which actions they combined, how, and to what effect.
10. The addition of risk to countervail reward illuminated how the innovation process operated with antecedent conditions. Previous studies (e.g., Murray and O’Mahony, 2007) established the importance of reward. This study supported that conclusion and explained how perceptions of reward combined with perceptions of risk to motivate cognitive and behavioral processes and outcomes.

11. The addition of environment contributed to an understanding of causes and effects beyond the control of TTOs (such as an economic recession) and sometimes within the influence of TTOs (such as a university policy). Earlier studies tend to exclude the nuance and effects of environment with no recognition of what TTOs may and may not influence or control. Environment changed, sometimes abruptly and sometimes slowly, but the effects of such changes influenced a TTO’s conditions, actions, and resources. Environment contributed to the innovation process and helped explain it.

12. This study highlighted the period of years that often pass between disclosure and commercial results – time as a resource, with opportunity and limitation. Brief periods, such as days, weeks, or months, can lend themselves to economic measures of input and output; however, over period of years, even a decade, in a context as complex as a TTO, tracing, measuring, and evaluating only economic factors as a performance metric is practically or truly impossible. Thus, understanding cognitive and behavioral factors becomes more important. This study showed what TTO staff thought, how they perceived actions and events, how they performed, what they learned, and how learning informed their thoughts and
actions over periods of years. Incidents in this study underscored the tension between immediate action and patience, between seizing opportunities and allowing opportunities to develop, and between hoping each day that a telephone call would lead to a breakthrough deal and simultaneously understanding that a deal may take years upon years of work before an unambiguous outcome became clear.

13. This study lent understanding to what and how TTO staff learned from their experiences and how they shared, brokered, combined, reused, and contributed to the knowledge and action of the TTO as an organization.

14. The comparison of UK and US technology transfer organizations, large and small, noted differences identified in other studies and, more important, allowed many similarities to emerge from the incidents themselves. Economic metrics of input and output tended to identify differences, for example, in research funds, number of TTO staff, disclosures, patents, material transfer agreements, licenses, and startups. Incidents tended to identify the similarities of how TTO staff think and act. Understanding such similarities contributed to an understanding of an innovation process in technology transfer organizations.

5.3 Limitations

Limitations of this study included the universities’ two nations, the use of a sample, and exclusion of the smallest and largest technology transfer organizations.
The study was conducted in two nations, the UK and the US, which stand as the two nations with the most university technology transfer. Had the study included universities from other nations, perhaps generalizability for the entire population would improve. (Including universities from other nations, however, was beyond the objectives and feasibility of this study.).

Participants were a sample of approximately 25 percent of the technology transfer staff at each university. For each TTO, the sample was representative of a cross section of TTO staff with the final sample representing diversity across these dimensions: (1) length of experience in TTO work at that university, (2) length of experience in TTO work at another university, (3) length of work experience outside of TTO work, (4) function, such as evaluating technologies for patenting, or licensing patents to major corporations, or assisting university researchers in starting a venture, (5) manager of others in the office, (6) technology expertise, such as life sciences, physical sciences, or software, (7) highest level of degree, such as bachelor’s, master’s, or doctorate, and (8) educational concentration of the degree or degrees, such as business, engineering, or science. Perhaps a census, rather than a sample, would have yielded slightly different results.

This study excluded the smallest university TTOs (i.e., those with five or fewer staff) and the largest TTOs (i.e., those with 40 or more staff). Perhaps results would have been different had the study included such technology transfer organizations.
5.4 Implications

The results of this study hold implications for technology transfer officers, university administrators, venture capitalists, corporate executives, and government policy makers.

Technology transfer officers can view the resultant framework as a map toward more effective practice and performance evaluation. (Indeed, since the completion of this study, two university TTOs are employing the resultant framework to assess and improve their strategies and operations.) The map can help them arrive at a deeper apperception of their TTO’s advantages, limitations, opportunities, and potential challenges. The framework as a map can also help TTO staff understand conditions, actions, resources, and environment as a coherent system of interconnections; actions, for example, never operate in vacuo. To get from one point to another can require a concatenation of effective actions, sufficient resources, amendable conditions, and a felicitous environment.

In addition to the resultant framework as a map, technology transfer officers can refer to the study’s identification of numerous actions of successful and unsuccessful incidents, and those actions can suggest how to traverse difficult terrain and what bounds the journey. A TTO can develop systematic processes that flow directly from the results of the research and that explicitly focus on actions unique to successful incidents and actions unique to unsuccessful incidents. Attention to such actions before a project begins, throughout a project, and in an analysis after a project concludes can assist a TTO in its performance.

The study also presents conditions, actions, resources, and environment as a set of topographical tools for a technology transfer officer to use in making strategy and operational maps for a TTO (Kaplan
and Norton, 2004). Understanding the functions and connections of these tools and expressly recognizing their strengths and limitations can improve outcomes. For example, rewards are an important condition, yet this study showed that perceptions of risk are also important, and at times perhaps more important. Understanding and balancing perceptions of risk and reward (e.g., from both the perspective of a technology transfer officer and an inventor) can build trust more effectively between the two, and building trust is an important action for success.

The study provides support for technology transfer officers to emphasize organizational learning. Though the process imposes a cost on a TTO, the benefits can far exceed the costs.

University administrators, venture capitalists, corporate executives, and government policy makers can gain a deeper appreciation of how a TTO can operate and, with that knowledge, how they can work more effectively with a TTO. This research presented the perspective of technology transfer officers, and their experiences offer a deep reservoir of knowledge. Understanding their experiences – e.g., motivations, limitations, and goals of technology transfer officers – should benefit those interacting with TTOs.

Some university administrators, especially presidents of US institutions, focus on input-output metrics, particularly on receipts from royalties. A reliance on simplistic metrics can lead to counterproductive policies and practices such as inhibiting access to and collaboration with industry by broadly claiming ownership of intellectual property that may result from collaboration and reducing rewards for academic inventors by increasing the university’s share of royalty income. An appreciation of innovation processes within a TTO could lead university administrators to establish more coherent policies for TTOs and more accurate metrics.
for their performance; for example, this study showed that the multiyear time periods between invention and innovation and the complexity of an innovation process can make input-output metrics look meaningless. Cognitive and behavioral metrics – assessing what technology transfer officers have learned and whether they have modified their actions accordingly during a certain period of time – could prove useful in evaluating performance over periods of years.

Venture capitalists and corporate executives who sponsor university research and license intellectual property from universities can glean a broader, deeper appreciation for what TTOs do, how they operate, and why. Transactions between technology transfer officers and either venture capitalists or corporate executives require negotiation. A greater appreciation of TTOs’ objectives, operations, and constraints can lead to better transactions, which in turn can lead to repeat transactions, more effective networks, and other mutual benefits. For example, in this study, technology transfer officers from all four universities mentioned the benefits of publicity from successful transactions; such publicity can benefit not only universities but also venture capitalists and corporate executives, who may then see more opportunities from universities.

Chief innovation officers and other corporate executives may see parallels with their roles as intermediaries working to turn inventions into products. The concept of open innovation supports the role of intermediary, and corporate executives often face similar challenges of disadvantageous conditions, insufficient resources, and oppressive environments. Thus, benefits for corporate executives can look similar to the benefits for university technology transfer officers. The resultant framework may benefit a chief innovation officer’s organization, which is indeed a commercial technology transfer organization.
Government policy makers can more fully understand the effects and costs of policies, from research funding to invention patenting, on technology transfer offices. In the US, for example, government policies requiring universities to attempt to commercialize government-funded inventions can lead to wasteful expenditures on patents and overprotection of intellectual property, thereby misallocating resources and inhibiting innovation. The US government spends billions of dollars annually on university research in the hope that such research leads to inventions that in turn create economic activity, yet the government makes no funding available to university TTOs for translating research into commercial activity. A logical inference is that policy makers believe that innovation ends with invention. By understanding TTOs’ innovation processes, policy makers may see benefit in lessening the cost of regulatory compliance and making direct funding available for university TTOs to move inventions toward commercial utility.

5.5 Further research

The resultant framework has immediate utility for technology transfer officers in understanding and improving strategy, organization, execution, and systems; however, further research could improve the utility of the framework.

With this qualitative study as a foundation, a quantitative study could amplify an understanding of conditions, actions, resources, and environment in an innovation process within university technology transfer offices.

Additional research could extend this study to university technology transfer offices in other nations. Moreover, a study of the
complete scale of TTOs, from those with the fewest staff to those with the most staff, could add further insight. A further comparative study could include perspectives and results from all of the occupational and functional positions in a TTO (e.g., clerical, scientific, legal, commercial, executive) to explore differences and similarities of roles in their innovation process.

Dyer, Gregersen, and Christensen (Dyer et al., 2008, Dyer et al., 2009) begin with a qualitative study of entrepreneurs, both successful and unsuccessful, and continued with a quantitative study that presents key insights on how successful entrepreneurs think and behave. With a similar objective and approach, research building on this study could provide further insight on the cognition and behavior of successful technology transfer officers. Such research could assist in selecting, training, and developing TTO staff.

The theme of adapting recurred frequently in successful incidents and suggests that technology transfer officers and offices possess a level of adaptive capacity. Further research to understand adaptive capacity could contribute to the theory and practice of innovation.

Further research could also study the concept of a resource-based ethos in technology transfer offices specifically and universities generally. The resource-based ethos could link to studies in strategy and organization.

Another study could test the resultant framework in commercial organizations; what is found in and learned from such research could offer benefits to both commercial and university technology transfer organizations.
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Appendix: Additional case data and analysis

This appendix presents additional data and analysis of the four case studies (one from each of the four universities). The case studies contain the series of critical incidents. Each participant discussed two critical incidents, one a successful incident and the other an unsuccessful incident. To maintain the ethical conduct of this research, this study refers to participants by pseudonym. Participants from the University of Manchester have pseudonyms beginning with letters A through I (viz., Alex, Blair, Cameron, Drew, Ellis, Franklin, Gale, Hayden, and Inga). Participants from the University of Southampton have pseudonyms beginning with letters J through M (viz., Jordan, Kelly, Lindsey, and Morgan). Participants from the Georgia Institute of Technology have pseudonyms beginning with letters N through T (viz., Nicol, Owen, Payne, Quinn, Riley, Sloan, and Taylor). Participants from the University of Utah have pseudonyms beginning with letters U through X (viz., Ursula, Varney, Whitney, and Xian).

University of Manchester

The University of Manchester, located in Manchester, UK, was formed in 2004 with the merger of the University of Manchester Institute of Science and Technology and the Victoria University of Manchester. The student population at the university is approximately 40,000, comprising approximately 29,000 undergraduate students and approximately 11,000 graduate students. University of Manchester Intellectual Property Limited is the technology transfer office for the university.
Interviews

At the time of this study, the TTO employed approximately 35 people. Nine participated in interviews: Alex, Blair, Cameron, Drew, Ellis, Franklin, Gale, Hayden, and Inga. The table below presents the main themes of the interviews.

University of Manchester participants and interview themes

<table>
<thead>
<tr>
<th>Participant</th>
<th>Themes of incidents</th>
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<tbody>
<tr>
<td></td>
<td>Successful</td>
</tr>
<tr>
<td>Alex</td>
<td>Sharing knowledge from experiences</td>
</tr>
<tr>
<td>Blair</td>
<td>Sharing, combining, and reusing knowledge</td>
</tr>
<tr>
<td>Cameron</td>
<td>Managing actions and resources</td>
</tr>
<tr>
<td>Drew</td>
<td>Combining knowledge, communicating, and collaborating</td>
</tr>
<tr>
<td>Ellis</td>
<td>Managing goals, networks, and people</td>
</tr>
<tr>
<td>Franklin</td>
<td>Managing people and opportunities</td>
</tr>
<tr>
<td>Gale</td>
<td>Establishing trust to enable success</td>
</tr>
<tr>
<td>Hayden</td>
<td>Collaborating and building teams</td>
</tr>
<tr>
<td>Inga</td>
<td>Leading and persisting</td>
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</tbody>
</table>
1. Alex

**Alex’s successful incident**

The intellectual property comprised two patents in computational chemistry. The inventors were a team of researchers who had commercialized other inventions. A small German company showed interest. The company seemed to have no experience in licensing, as the executives, who were scientists by training, revealed naiveté by informally agreeing to terms with the university scientists; the terms were impractical and extremely disadvantageous to the company, so the TTO negotiated terms that could allow the company to invest further in developing the technology and bringing products to market. Many times during the relationship, the TTO had to explain the restrictions and implications of the license because the company executives often assumed that the license gave them more rights than indeed it conferred to them. But the relationships between the university and the company grew, and university researchers joined the company’s advisory board. This has been a time-intensive process especially in making sure that the researchers, and the company, have protection for the intellectual property and that the relationship between the researchers and company executives is both productive and legally compliant.

**Alex’s comments on the successful incident**

Alex said that the relationship has been a financial success, as major pharmaceutical companies are now interested in the technology. But more important than the financial success is the operational success, she said, because the TTO successfully applied lessons learned in how to more effectively negotiate and manage the licensing process. In this
incident, she said, the TTO managed effectively the researchers and the company executives by sharing information. Within the TTO, the sharing of information and experience was equally important. “I happily share what I do – talk to my colleagues and suggest things because of the experience I have. So that is just generally within the team here. Sort of embedded,” she said. “So that all these things are captured, we have got something now called a licensing checklist. People coming later learned a lot more from our experiences and caught on quite quickly. And there are associations that we share, that I have been involved in, that we network. So we do share our experiences. That’s how we build our knowledge and experience,” she said.

**Researcher’s comments on Alex’s successful incident**

This incident meets the conditions of disclosure, access, and reward. The inventors made disclosure to the TTO, the inventors and the TTO provide access to industry, and the researchers and the TTO (and the company) received financial rewards. The TTO actively shared information with researchers and company executives; this activity of sharing was significant in this successful episode.

**Alex’s unsuccessful incident**

The second incident involves two complementary patents, one for extruding materials and the other for welding materials, that resulted from university research with industrial partners. One of the industry partners licensed the patents but for several years, while making minimum payments under the terms of the license, appeared to make no effort to commercialize the technology. A product champion at the
company then left for another company. Growth in the market slowed. After several more years, the company terminated the license, paid a settlement fee, and returned control of the patents to the university. Within a few months, the inventor, who still worked for the university, met an executive at a North American company who expressed great interest. Although representatives from the company continued to express interest in licensing, they eventually selected a Canadian technology that seemed to require less investment to bring to market. The university inventor began to develop doubts about the efficacy of the technology, but then another company came forward, licensed the patents, and began to make a significant investment in the technology. Timing became an issue, because only several more years remained before the patents expired. Although progress was made in field trials, there were difficulties between the inventor and the company; there were news stories about the company being an acquisition target, and progress seemed to stop. Then the patents expired. The university recovered all of its costs through licensee fees, but this was a failure because the technology seemed so promising.

**Alex’s comments on the unsuccessful incident**

Alex said that she learned from the process that the license agreement should change, and she worked with legal advisors to give the TTO more options to enforce the license terms more quickly. She felt that she had been too patient with licensees, and the expiration of the patents before commercialization was the outcome. Consequently, licensing agreements became more rigorous, with more rights for the university to terminate the licenses if the licensee fails to perform.
She said that she learned the importance of stipulating in the license agreement the capital investment required by the licensee, and the period of time in which the licensee must make the investment to stay in compliance with the agreement.

She said that she also learned that the cooperation of the university inventor was so important. In this incident, he seemed to lose interest after several years, and he became uncooperative with licensees. She said that the TTO failed to manage the inventor's expectations; he was a professor with no experience in industry. He delayed publishing his research in the hope of achieving commercial success. His disappointment left a lasting impression on her.

**Researcher's comment on Alex's unsuccessful incident**

From this incident, the role of the TTO as intermediary is evident. The TTO must carefully manage university researchers and industry partners. The importance of capital as a resource is evident; the importance of resources is emerging. The capability of networking with industry and marketing to potential licensees is also emerging. Resources and capabilities are additions to the conceptual framework, which focuses on conditions and actions.

2. Blair

**Blair's successful incident**

A successful incident involved an information technology startup. An issue arose over the ownership of the intellectual property because
the academic inventor had worked with a consultant outside the university, and they both contributed to the invention. The TTO resolved the issue by recognizing that the consultant had significant industry experience. The TTO proposed a startup with the consultant becoming chairman of the company. Through his network, he completed a marketing research project and a cost engineering project. As a result, the startup had repositioned marketing and reduced engineering costs. The TTO resolved questions on freedom to operate after learning of potential infringement on other companies’ patents. Impressed, a venture capital firm invested £500,000 in an initial round. Product trials were getting successful results. The startup, in business only for six months, was planning to raise a second round of funding soon. Blair was involved in setting up the company, getting the necessary license and other agreements in place among the university, the inventor, the consultant, and the venture capital firm. She assisted with hiring employees. She worked on budgets and forecasts, analyzed marketing data, and attended board meetings. The TTO provided accountancy and legal assistance.

Blair’s comments on the successful incident

Blair attributed the success mainly to the chairman of the startup. She said, “He’s been absolutely instrumental in keeping the team glued together and keeping it on track.”

Blair noted that other key people had been identified through the TTO’s network of connections with venture capital firms and Manchester Business School. She said, “The networks are absolutely essential. It seems that’s the only way to get anywhere – to know the right people. If you can speak to somebody who knows about technology and industry, especially in the market research. Another case which I’m looking into is
a scanner. It just so happened that a visiting professor at the university has worked for many years in the food industry on automation and scanning. And he’s had hundreds of contacts in the food industry. He got us meetings with supermarkets and their supplier, and we’ve progressed a huge rate in comparison with if we had to go back to cold calling. So a network is absolutely invaluable.”

She continued on the topic of networking: “There’s various networking events around the local area. I go to several of them… We have a fairly extensive network. I’m not sure it’s fully utilized but that’s probably more down to the individuals rather than anything fundamentally wrong.”

She also observed that the startup has had sufficient capital thus far: “The money was sufficient to complete the required tasks. The technology is much closer to market and much less technically challenging than others.” She emphasized the importance of this: “The funding matches the requirement for the technology advancement. The investment of £500,000 was sufficient to hire the right people, to do the necessary work, and again we’ve been able to fund external consultants to speed up where required because we’ve had that additional amount of cash. If we’ve had £200,000 or £300,000 less we would have really struggled to get anywhere because we couldn’t have hired people to do it, we wouldn’t have had the expertise, and we would have been in a stall situation.”

Blair also offered an overview of the TTO’s operation: “The process starts with a disclosure from an academic. That is then either a phone call to one of our commercialization executives or so some sort of communication. The commercialization executive goes out to the academic and has an interview with them and discloses the information
right in their venture report and probably, in most cases, if there’s IP there, takes it through what we call a technology evaluation process. That is a largely paper based exercise with the research being carried out by the commercialization executive, but at any time they can approach us for information. We’ve recently introduced a new system where a summary of current technologies being evaluated goes out by email to everyone and requests assistance or advice on a particular case. At the end of six to eight weeks of evaluation we then have a meeting where everyone is invited to attend and thrash out the review. We get a copy of the report beforehand and provide input and provide shared experience from network contacts and try and as a group evaluate whether or not this is a disclosure which is worth proceeding with, and if so how. That’s sort of the way it is at the moment. We have a fairly form-based system that we go through that evaluates four areas: the technology itself, the market, the IP, and the team, which is usually just the academic. We start off with about 300 disclosures a year, and we end up really working on about 10 percent of those and taking them forward in some way. So it is a fairly rigorous and uncompromising slicing process. So from that substantive technology evaluation stage, they drop through the loop and go nowhere or they go to a venture manager who works on it toward a spinout or they go into a licensing manager who works on it toward a license. In both of those cases the process is much more flexible, and it largely depends on the entrepreneurial attitude of the person who’s managing the project as to who they contact and whether or not they engage with other people. For example, the venture managers in our team have recently set up regular monthly meetings between each other to discuss the projects they are working on, the problems, and see if we got any contacts that we can share to solve something. And we can see each other on a daily basis informally. We have full access to anyone if we think they might be of some help on more operational issues. We have the legal team. We have external lawyers who we can call on. We have access to all the other
academics in the university. I’ve been looking into trying to pull together multiple people across the university to work on a particular technology. So graphene is a new material that is potentially quite exciting, and we have academics scattered across different departments. We have physics, materials, chemistry, etc., and so I’ve been sort of trying to identify people in each department and get them to collaborate towards more long-term technology development. In that process I’ve been meeting these people, and one of the people I met actually resulted in additional disclosure, and the process feeds back on itself. There is Knowledge Vine, which is an email based communication system where you can ask a single question of a group of people in a wider community across the UK technology transfer institutions. Those are quite useful.”

**Researcher’s comments on Blair’s successful incident**

This incident reveals a brokering process: sharing information, combining information (even from a network), and reusing knowledge gleaned from diverse sources. The interview also indicates connections with process conditions of disclosure of knowledge, access to knowledge, and rewards, which include not only financial rewards but also rewards of personal satisfaction and peer acceptance.

**Blair’s unsuccessful incident**

In this incident, the inventor, a research scientist at the university, made a discovery in physical chemistry. Developing this invention required additional funding. Blair, who had joined the TTO recently, succeeded in obtaining £100,000 to start. When further funding was necessary, she sourced another £50,000. At the time of the interview, she
was working to secure the next £100,000 for the inventor. To facilitate funding, Blair at the outset convinced the inventor to set aggressive milestones with short time frames. Thus far the inventor was meeting the milestones, and interest was increasing among people at the university and in venture capital firms, including MTI, a venture capital firm managing an early-stage fund for the university, even though this invention failed to meet the MTI’s investment criteria. She was using that enthusiasm to obtain grants from the Carbon Trust and the North West Development Agency. Blair was also attempting to create interest among angel investors and chemical companies. A chemical company with a captive venture capital group could make an investment, or a chemical company could sponsor additional research and obtain rights to the intellectual property. She had just started looking at funding sources outside the UK such as the US Department of Defense.

**Blair’s comments on the unsuccessful incident**

Blair said that she considered this an unsuccessful incident because she feared she would fail at obtaining all the necessary funding. Despite all of the progress that she had made in her relatively brief time at the TTO, Blair said that she was beginning to have concerns that the inventor’s time and the funds had been wasted. She said, “This is so high impact if it works. The temptation was to push forward with commercialization.”

**Researcher’s comments on the unsuccessful incident**

This incident underscores the importance of capital as a resource and networks as a capability. Blair has profound concerns that are
evident of an innovation process: i.e., understanding that some endeavors will fail, yet desiring to avoid failure. March (1994) captures this in his discussion of the fundamental difference between exploration and exploitation. In exploration, the probability of success is small in any one situation; reluctance to accept failure, however, is typically strong.

3. Cameron

**Cameron’s successful incident**

A startup had succeeded in selling services based on a university invention from approximately six years earlier. Companies in the pharmaceutical industry were customers. One concern at the time of invention disclosure was that the technology was at the earliest stage. Cameron and other members of his team identified numerous risk factors that they would have to manage effectively to move the intellectual property, including patents, to commercial success.

Cameron worked closely from the first disclosure with the three inventors, all university scientists. The essence of the invention was software that could provide data on how and why therapeutic molecules were active or inactive. The invention held the promise of saving time and significantly reducing cost. “So we saw value in that at that early stage, and we highlighted that project as one that should receive principal development funding.” The TTO invested approximately £80,000. Cameron took responsibility for the project (which became a series of projects). He hired an industry expert as a consultant and project manager to accelerate the process of obtaining UK government funding, which soon followed. “That financial support alongside ours gave us more fire power. We could do more experiments. We could make a
stronger IP asset and a more compelling case ultimately to potential licensees or investors."

Cameron continued to work closely with the principal inventor: "We also ensured that the lead academic was financed to embark upon what was called an enterprise fellowship. So...he was given time out of his academic duties to go and study business, which I think has been quite transformational in his view of life on the outside world to the point where it became apparent during those projects. He was becoming committed to commercializing this intellectual property in the form of a spin-off company. We’re beginning to see the shape up of what might be a management team take place. So my project manager was taking a keen interest in the project and asked me whether he could join the company ultimately and relinquish his duties as a project manager on my team. So we managed that transition. We gave him a period of secondment during which we remunerated him while he worked on behalf of the would-be company.” The startup team was officially formed, the company was launched, a business plan was written, and it was pitched to investors.

Cameron identified a local venture capital fund, which agreed to provide not only capital but also the assistance of a partner with an extensive network in the pharmaceutical industry; that partner could make key introductions in the selling process. The startup accepted capital from that firm approximately two years ago. Since then, said Cameron, “The company’s gone from strength to strength. They are achieving partnerships with pharmaceutical companies on a global basis. If I had to point to a project that there is in my portfolio that is likely to deliver us significant capital gain within the next two years, I would wager that this company would be delivering that return towards us.”
Cameron’s comments on the successful incident

Cameron reflected on this incident: “So I try to look at the reasons for why I believe this is a success. It’s a combination of things.”

Cameron said that at the outset he and the other members of the TTO team were extremely careful in their analysis “to understand how this technology might be applied ultimately and what the benefits were. And to understand its unique properties. We were very keen to use our external network in doing that assessment to understand from people being in the pharmaceutical industry whether they saw benefit in this and whether it was a compelling case or not.”

Cameron said that with the intellectual property the TTO “managed to secure very broad positions from initially what was quite a narrow data search. So that was kind of a neat trick provided we could exemplify the technology during proof or principal.” During the proof of principle phase, the team of scientists validated the broad position of the patents.

Cameron then explained the scientific team could do the proof of principle work only because the TTO has secured sufficient funding “from outside the organization as well as within.”

Cameron then commented on the people who formed the startup team. “What I think is massively important when you’re commercializing a technology through forming a new business,” he said, “is that we have a tight-knit team of individuals who are all committed to forming a venture to the point where [they] take a personal risk and pursue this. The academics involved were all prepared to relinquish their academic duties and form the company because they were so passionate about the
opportunity, which caused a feud within the university that needed to be managed. These were bright guys. The university had mapped out for these individuals an academic career with responsibilities that they were commensurate with people of their ability. So the university was making a contribution beyond the IP. It was going to contribute these people ultimately.” Referring to the startup team, he said, “These guys are absolutely committed to this. When I go to board meetings the consistent story is of over delivering against expectations. I’ve been an observer on plenty of boards where the converse situation is true, and this leads to all kinds of cash flow issues.”

Cameron talked about his role with the startup at that moment. “I serve as an observer on the board of the company so I’m able to keep a window on that world. I’m very pleased about the way it’s developing, and it’s at the point now where it’s raising some additional finance so you can take it to the next level. The discussion now is how large a chunk of cash should we take in given that the company is commercially active and we’ll be breaking even in the next year or so.”

Cameron noted that the success of this startup was, in part, enabled by work that the TTO had done even before this first disclosure was made. This company “was built on the infrastructure that we mapped out ahead of time for a venture of this type,” he said. He was referring to the TTO’s organizational architecture as the infrastructure.

Cameron also highlighted the importance of the TTO’s policy of focusing its resources only on those projects (e.g., startups) that could yield the highest return with the greatest probability of success as determined by the TTO’s analysis (to which external experts contributed). Cameron described the TTO’s policy, which he said was typical of UK TTOs, as “interventionist,” by which term he meant that, if a TTO analysis
determined that an investment in a technology was appropriate, then the
TTO took an active role from the start by providing resources, including
people, to move the technology along a commercial path. He said that he
and several other members of the team had visited in recent months six
US TTOs: Cornell University (only the medical school in the city of New
York, not the main campus), the University of California at Los Angeles,
the University of California at San Diego, the University of Chicago, the
University of Washington, and Yale University. Cameron said that earlier
he had visited the TTOs at Harvard University and the Massachusetts
Institute of Technology. Cameron said that he and the others from the
University of Manchester “were struck by the extent to which individual
academics were given licenses and expected to move projects forward by
themselves.” The US process tends to obtain patents and to expect
academic inventors either to take the lead or to participate significantly in
marketing their inventions. Cameron said that the Manchester TTO finds
only one disclosure in ten appropriate for investment, then the TTO
works to “wrap financial support and infrastructure around those
projects to incubate them.” He noted that the US TTO policy is influenced,
if not determined, by the Bayh-Dole Act, a US law that requires US
universities to attempt to commercialize all inventions resulting from
federal government funding. US TTOs, he said, have a greater ability than
UK TTOs to market early-stage technologies, and US licensees are more
willing than UK licensees to accept early-stage intellectual property.

Cameron said that this project did overcome a challenge of
geography, as Manchester is far from London, which is the UK venture
capital center. Manchester, he said, is neither Boston nor New York nor
Silicon Valley, which are the three biggest centers of venture capital in the
US. Yet, he observed, proximity did offer some assistance to this startup,
as “some major pharmaceutical companies are not too far away,” and the
proximity accelerated the selling process. Overall, he said, he had
observed from his visits to the US that, for US universities, success is not only a function of effective technology transfer and strong research, but also the external environment, such as venture capital and industry-sponsored research, that supports TTOs at Harvard University, the Massachusetts Institute of Technology, and Stanford University.

**Researcher’s comments on the successful incident**

Cameron clearly identifies an innovation process similar to a typical process in most commercial enterprises, including global firms and venture capital firms: conducting a careful analysis of technology, markets, industries, and capital investment in a process combining expertise that is internal and external to the organization.

He identifies highly collaborative activities that lead to broad protection for intellectual property, sufficient capital, and a strong team comprising the university inventors and business people with relevant knowledge and experience. The TTO infrastructure summoned resources and capabilities, such as networks, to support the project. Also evident is context. For example, the context of the Bayh-Dole Act requires US TTOs to devote resources to all their inventions under federal funding. Without that mandate, a different model of commercialization developed in the UK, a model more closely aligned with investment models used in industry. Another contextual factor is geography. Cameron noted the disadvantage of Manchester’s relatively distant location from London’s venture capital center; however, he also underscored Manchester’s comparatively close location to pharmaceutical companies, which were customers for the startup.
Cameron’s unsuccessful incident

Cameron started telling this incident by saying, “It’s much less easy to talk about this kind of project, I have to say. I’m going to be as candid as I possibly can and point to my own shortcomings in this project as well, which again is not something I particularly enjoy doing. So bear in mind this is less easy for me than the first example.” The intellectual property encompassed a therapeutic compound discovered by a scientist at the University of Manchester and developed by that scientist and another scientist, who held an affiliation with another university; thus, two scientists and two universities were involved in this invention. The Manchester TTO decided that the compound was appropriate for investment because it could become an important drug with unique properties benefiting cancer patients. The project progressed to proof of principle, yet problems became evident. It appeared that neither scientist possessed sufficient expertise in medicinal therapies to achieve successful outcomes of commercial interest. Cameron said, “So it was naive on our part. We should have made sure those experiments were refereed by, endorsed by, a medicinal chemist who understood how, what mechanisms are best to achieve the objective. We did that later in the project. We should have done that at the base of the project. So that was a mistake.”

Funding was running out. Cameron identified two potential sources of capital. One was a generalist venture capital firm that could provide no expertise in, or particular access to, the pharmaceutical industry. The other potential source was an early-stage investment firm that would invest capital, assist in key development work, and plan to license the intellectual property to a pharmaceutical company. “We thought that was a great scheme for us,” Cameron said. The investment firm had just opened. Cameron said, “I met the chief exec. We liked each
other, and they were looking for their first project and their first partnership with a university. We were looking to get some funding. It seemed like a marriage made in heaven.” The investment firm committed a total of £1.4 million with milestones and invested £300,000 in the first series. “We actually never got past the first milestone,” Cameron said. The scientist at another university repeatedly failed to deliver his experiment results on time. The investment firm began to develop negative perceptions of the scientist and the science, Cameron explained. The investment firm hired a contract research organization to conduct tests, and it failed to replicate the university's results. The contract research organization performed the tests incorrectly, but the investment firm continued to lose confidence in the technology and the scientists. After approximately one year, the investment firm decided against further investment and abandoned the project.

The intellectual property remained with the University of Manchester, and Cameron hired a contract research organization in Germany that was gradually making progress toward commercialization. Though approximately eight years passed since the first disclosure, the potential for eventual commercial and therapeutic success remains.

**Cameron’s comments on the unsuccessful incident**

Cameron said, “The whole thing has taken a long time, has been fraught with political issues. Joint discovery is an incredibly difficult area anyway, and to do it on a tight budget is very big itself. But the people side, the delivery side, and our due diligence...it could have been better.” Cameron said, the investors “fell down because firstly they hadn’t done their due diligence of our IP asset, and our due diligence on their capability probably could have been a lot better. There’s an old adage
that failing to plan is like planning to fail. I just feel that it’s always easy to see these things retrospectively. But when you’re in the trenches you don’t quite see it that way. At the time of getting that deal with the venture capital firm, I was a hero around these parts. It seemed like a great deal. What a fantastic guy I was! It was only three months later that people realized I couldn’t walk on water after all.”

Cameron said that this incident led to “learning that we’re taking advantage of right now. So we have since that time not funded a proof of principal project in the drug discovery area for two reasons. One is we don’t feel we have the fiscal firepower to do these projects technically. So we think we’re wasting our money. The second is that the MTI fund has no appetite for spinout businesses that are in the pharmaceutical discovery area.” Cameron said he is working with others inside and outside the TTO to develop a new funding model for drug discovery. He is investigating options for government funding and nongovernment funding (e.g., he had secured approximately £5 million from a foundation for drug discovery) and for industry funding to co-develop intellectual property. He was scheduled to make a presentation of his findings and recommendations to the TTO’s board of directors in several months.

**Researcher’s comments on Cameron’s unsuccessful incident**

Clearly this incident was difficult, even painful, for Cameron to discuss. The promise of the technology seemed to blind him to problems that later become more evident. Ultimately, a weak scientific team, insufficient capital, and an absence of process, such as the failure to carefully conduct due diligence, led to what Cameron considered an unsuccessful incident, irrespective of the eventual outcome. In attempting to create a new commercialization process for drug discovery,
he is essentially brokering knowledge and developing a process with sufficient resources and capabilities. Again, resources and capabilities play an important role with conditions and actions.

4. Drew

Drew’s successful incident

Several years earlier a patent involving a chemical compound had been issued to the TTO. Though a few companies had expressed potential interest before and soon after the patent issuance, nothing had happened, and the patent remained in the TTO files until Drew joined the TTO staff. Drew could see that the technology was at an early – and highly risky – stage, and she felt she could understand why, despite the promise of the technology, no companies had expressed serious interest in taking a license. Drew’s idea was to mitigate the risk by seeking a company to collaborate and enter a development agreement with the university, team the company’s scientists with the university’s researchers, and develop the intellectual property.

Drew found a company interested in this collaboration. The company then licensed the technology exclusively for three years and could extend the license if the intellectual property progressed toward a product launch; if the company, however, fails to meet quarterly milestones, the TTO can terminate the agreement immediately. The benefits for the university included industry collaboration for the research laboratory and a licensee for the TTO. In a license agreement, the TTO generally receives fees (often tens of thousands of pounds, and sometimes hundreds of thousands of pounds) at the time the agreement is executed by the licensee and the TTO. In this incident, however, Drew
decided to forgo all fees at the time of license execution; only if the company generates revenue from the intellectual property would the TTO receive any fees. Drew said she negotiated a more generous royalty fee by forgoing initial fees. The disadvantages were that the TTO continued to bear the patent costs and that the university could lose intellectual property by sharing it with the company; Drew, however, worked with legal and other advisors to protect the intellectual property and felt that the potential for success far outweighed the risks. Drew also said that the company and the university would jointly own any discoveries from this collaboration.

Though the TTO had yet to receive royalty fees from this arrangement, Drew believed that this was a new approach that she could use with other patents in therapeutics. Her involvement was ongoing, as she attended quarterly meetings at the company to review milestones, and she was often meeting monthly with university scientists and company officers and researchers.

**Drew’s comments on the successful incident**

Drew said that she was unaware of any TTO using a combination of a license and a development agreement as she had in this incident. She said she spent much time trying to solve all of the problems that kept companies from licensing technologies at the earliest stages. She talked with people in the TTO, she looked at prior agreements that the TTO had signed, and she tried to find a new solution, or a new combination of solutions. Feeling proud of this new agreement structure, she said, “What I came away with is a sense of satisfaction that we are, you know, on the right path.”
**Researcher’s comments on Drew’s successful incident**

Drew presented an incident critical to her sense of success and her contribution to the TTO. In combining and recombining ideas, talking and listening to others in the TTO, reusing ideas, gaining interest from and collaborating with industry executives, and anticipating problems – Drew exhibited many actions entailed in an innovation process. She also satisfied and adjusted conditions by making disclosure and offering access to industry partners while postponing a financial reward yet immediately realizing other rewards for the TTO and the university, especially the research scientists.

**Drew’s unsuccessful incident**

Drew had an oncology patent in the portfolio she managed. The technology was technically interesting and commercially promising. The two inventors were junior faculty at the university, with little research experience and no commercial experience. The TTO gave them proof of principle funding, and the inventors met every milestone with ease, on time and on budget, Drew said. She considered this incident unsuccessful because the technology required an investment of at least £200,000 to meet the next development milestones. No company, venture capital firm, or charitable foundation was interested in providing the funds because the technology was too early; the probability of failure was too high. Yet the only option for her to increase the probability of commercial success was to get funding to continue development of the technology, she said. She felt that insurmountable obstacles blocked every path forward. She said that she thought she had industry partners in the project, “but they say well, do your cardiotox, and then let’s talk. And to do the cardiotox, I need money. To get money, I need an industry partner.
So it’s really a vicious cycle that I find myself in right now. I’m trying to tap every resource that I have to try and get some kind of money into the study so I can take it to that point, which would actually transform the project, in the sense that it could go onto a successful license, or we would have to kill it. So, it’s at that point, which is really frustrating at times, and really exciting at times, when I have conversations with industry. We have this great opportunity, which is, yeah, high risk. But then, you know, it’s extremely high returns as well.”

**Drew’s comments on the unsuccessful incident**

Drew said that she has frequently consulted with her colleagues at the TTO for assistance. She said, “We have a very, very good team here. We all get along really well. We exchange information. There is no, you know, territorial behavior in the sense of this is my portfolio and I’m not going to share my information with you, and I’m not going to share my knowledge about other projects. The team we have is really good. And we bounce ideas off each other. So if I’m stuck, if I need some information, I can just, you know, walk into a colleague’s office, have a chat, and discuss and come back and add that information. And we do use our network extensively, and I really do. And I don’t have a problem in asking people if, you know, if I can bounce ideas off people, or if I can pick somebody’s brain, I just go ahead and do it. We don’t think twice. And, you know, the whole atmosphere here is that kind of thing is encouraged. I also ask colleagues or outside experts to look at something, to get a second pair of eyes to look at something. And I adopt that strategy for almost anything. So I will gather information as long as it will progress my project.” Drew said that she thought it was important to take a long view because “sometimes, you know, a drug takes 15 years to hit the market.”
Researcher's comments on Drew's unsuccessful incident

Drew's frustration was conspicuous. It was an intellectual frustration, not an emotional one. She felt she had a puzzle to solve, and she was thinking and talking through her process to see what she had missed or where she had erred. In her comments about the unsuccessful incident, she essentially recited her process of actions: accumulating, analyzing, anticipating, assessing, collaborating, seeking advice, researching, planning, and managing expectations. She seemed to productively employ her frustration in her actions and attempt to reassure herself that sometimes patience is necessary.

5. Ellis

Ellis’ successful incident

“This is a success, but it started as a failure,” Ellis said. A university researcher made a disclosure to the TTO on a discovery involving quantum dots. The TTO liked the opportunity and began to prosecute a patent. The challenge was finding the optimal application of the technology. Ellis said, “We were struggling to find market applications because, well, you could compare quantum dots to sugar. Sugar goes in so many different things...cakes, fizzy drinks...so which application for sugar is best, you know, to make a super cake or super soda? It was quite difficult to actually pin down any particular applications.”

Eventually the TTO team decided to focus on the electronics industry, liquid crystal display televisions particularly. A startup was
formed and staffed, and the academic inventor left the university and joined the firm full time.

But the firm made almost no progress over the first three years. Ellis said that the startup had two presidents during that period, and neither one seemed to sufficiently understand the technology. The third president joined the firm and refocused it on medical imaging applications. Over a period of five years since he started with the company, he had eventually guided the company to high revenue growth and profit.

Ellis noted that the technology disclosure had been made to the TTO more than 11 years earlier and only now was the technology a commercial success. He said the technology and the company seemed a failure for so long. For years, Ellis had assisted the company in trying to find customers. Again and again his efforts seemed fruitless. He recalled. “I used to send out these little nanoparticles – one gram or two grams of these dots in little test tubes. I finally had them stored in the fridge in the [TTO’s] kitchen for convenience. So [the company] has moved on so much.”

Ellis’ comments on the successful incident

Ellis attributed most of the company’s success to the third president, who had more industry experience than the first two. None of the three, however, had experience in the electronics or imaging industries. The third president had a deeper understanding of how to turn a technology into a product and then bring a product to market, Ellis said. He also noted how important the external environment is: “We may have just been too early in focusing on the television market.” But the
third president seemed to understand the importance of timing with both technologies and markets, as market growth rates are beyond the control of a startup.

Ellis also noted the importance of building a network with potential customers and licensees. “I think one thing that is important is to try and forge as many relationships with key global businesses, whether it be companies like Siemens or AstraZeneca, and making them aware of the technology that we have here and asking them where they are going [with technology] in five years. Try and get a picture of the landscape, the technological landscape. Seeing things that those companies are going to be facing in the next five to ten years and seeing where we can match or have that capability to assist and where we can collaborate with them.” He said, “There are companies that have come in to talk to us, and they are saying that they are no longer doing R&D themselves, and that’s why they are seeking university technologies.” He said that more collaboration with industry would provide a better understanding of how universities could offer solutions to industry problems. Often universities are “churning out technologies that are solutions looking for a problem,” he said.

**Researcher’s comments on Ellis’ successful incident**

This incident clearly showed the long periods of time – more than a decade in this incident – between invention disclosure and the first glimpse of commercial success. The incident also highlighted how a human resource – i.e., the third president – could lead what Ellis described as a “transformation” of the startup. Ellis also underscored the action of building networks and their benefit; the third president was
found through the TTOs network, and his ability to build a network of customers allowed the company to grow.

Ellis’ unsuccessful incident

The technology in this incident was a portable, disposable biosensor, which could determine certain levels of chemicals. The academic inventor had envisaged emergency medical technicians using the biosensor to determine the level of drugs in the bloodstream of an unconscious patient. Another application was a device to sense the level of alcohol in wine during and after the fermenting process. The TTO made the decision to pursue the device for the wine industry. Shortly after taking that decision, the TTO hired Ellis, and his responsibilities included moving the biosensor device into the market for use by the wine industry.

Ellis explained that the biosensor contained an enzyme on a chip, which was dipped into a vat of fermenting wine and then immediately produced a reading of the alcohol level. The biosensor was useful at many stages throughout the winemaking process. The device seemed to add precision and control that the industry sought. Product extensions, which would give even greater control, were evident to Ellis, to the inventor, and to potential customers. The biosensor could replace unreliable and imprecise devices that were sometimes centuries old, such as a eudiometer.

The TTO formed a startup, and Ellis began more market and industry research. He worked on the ergonomics of the device; for example, a worker using the device would be wearing gloves, so important questions were how big the buttons should be on the device
and where the buttons should be located. The device had a drop-proof and splash-proof design. He also worked on sales projections: how many people at a winery would use a device, how many times would each person use it. He developed a price-volume model and set pricing strategies for a distribution channel. He set up a product distribution networks in France, Germany, and South Africa. The startup easily raised capital of £1.3 million from one investment firm. Staff was hired – including a chief executive officer, a technical director from a major laboratory, and a manufacturing director – and production and sales plans were executed.

After two years of operation, the startup failed. The startup failed because the product failed. The device failed to detect accurately the alcohol content of the full spectrum of wines. The device had particular difficulty with red wines. While the biosensor could accurately and reliably test alcohol levels in some wines, those wines were a tiny percentage of all wines.

**Ellis’ comments on the unsuccessful incident**

The device was insufficiently robust. Ellis said, "We were rushing too quickly to try and get things to market. We needed more testing, more pilot testing done of all different variations of wine. So I think there was certainly a knowledge gap."

Ellis observed that the patent was sound, potential customers voiced strong interest and intent to purchase, and distributors sough exclusive rights; however, the prototype was insufficiently tested. He said that when he joined the TTO, his assumption was that the prototype was robust.
In retrospect, Ellis said, the project and the startup never had “a real wine specialist,” an expert with the technical knowledge of wine, who could have rigorously challenged key assumptions and tested prototypes in the field. “I think that if we had that experience and that knowledge on board at that earliest stage, we could have worked around the technical problems,” said Ellis.

The main lesson he said he had learned was that “you have to make sure that the product works and that it’s fit for purpose.” But he took that a step further. “So I try to pass on the knowledge I gained from that whole experience to other colleagues,” he said.

**Researcher’s comments on Ellis’ unsuccessful incident**

Ellis described an incident that was not only unsuccessful but also his first project with the TTO. The incident exhibited an enormous rupture in an innovation process that can occur when assumptions are mistaken for facts.

6. Franklin

**Franklin’s successful incident**

The invention, first disclosed to the TTO more than 10 years earlier, involved a therapeutic formulation applied during or after surgery to reduce skin scarring. The inventor was both an acclaimed scientist and an experienced administrator at the university. The funding for the research was significant and expansive, covering a theme of research and investigation both broad and deep. Franklin explained that, while the
inventor was conducting research “and getting closer to a practical application, he then went out to major corporations internationally, articulated his vision, and tried to license the technology. Although he had a lot of interest, he could not get the uptake he wanted for a licensing program,” so he decided to start a company. The inventor “talked to the venture community...and he made a very large number of presentations...a big, big road show. At the end of the day he did raise enough capital to get this started as a spinout company, and then through that he made other connections, and that’s when it got listed on the stock market and brought further capital behind it,” said Franklin. The company went on to raise tens of millions of pounds. Years later the company had difficulty in acquiring certain regulatory approvals because of questions of efficacy, and the company began its significant cash position to purchase intellectual property to develop a more robust product line.

**Franklin’s comments on the successful incident**

Franklin emphasized the importance of “big science, major research themes” that lead to invention and can then progress to translational innovation. Large thematic research grants can more effectively support early-stage development, whereas a series of small discrete research grants are less likely to bring an invention sufficiently close to market to justify an investment from venture capital or industry.

Franklin commented on the importance of persistence. The inventor “tried licensing but that didn’t particularly get the traction that he thought was appropriate, so we’ve gone the spinout route. And we could flip that round. We could look at some companies that have tried
spinouts. They've not succeeded as spinouts, but we then successfully licensed them.”

Among the benefits of this success has been media coverage, which has helped make industrial firms and venture capital firms more aware of the TTO. “He is so charismatic he has had a lot of press profile...which is good for the company and is good for us because by association the university’s name gets mentioned.”

Franklin noted that the inventor has helped the TTO add to its network because that investors and potential investors come to meet the inventor and often meet other entrepreneurs and technology transfer officers at the university.

Another reason he cited this as successful was that an academic entrepreneur led the startup. “He has become a role model,” Franklin said of the inventor. “When other [researchers say they] cannot do tech transfer because it interferes with [the university’s] science and standing, he can turn around and say, ‘That’s not the case for me. Why should it be the case for you?’” So we can always point to him, even though he’s exceptional in his energy and his personality, we can always say, ‘Look, it is possible to do the two.’” Franklin said, “There’s nothing like an academic who’s been there, done it, led it, run it, and managed by a tech transfer office to show what’s really possible.”

This startup was also a financial success for the TTO. “We’ve been able to sell shares along the way and recover the money we put into it for patenting,” said Franklin.

Franklin said that the success of this startup informed “the way we interact with our community. That means that you have to invest yourself
and work alongside people [i.e., inventors] who can then be encouraged to see licensing, spinouts, and sale of IP as something complementary within science. Not everything does happen as an invention disclosure. It’s neat and manageable for us to think of life in those terms, but probably that’s not how to really extend and embed intellectual property that has potential.”

An important lesson, Franklin said, was that “not everything has to fall to the tech transfer office. You don’t have to feel the burden to be turning out the numbers and talking up the stories when you can get people like that [viz., the inventor] to get to communities...you wouldn’t otherwise get to as a tech transfer office.”

**Researcher’s comments on Franklin’s successful incident**

Conditions of disclosure, access, and reward are manifest. Disclosure occurred more informally than formally, yet disclosure was made. Access to the technology was given to potential licensees internationally and to potential investors. Reward provides incentive, yet financial gain is only one standard of reward; publicity and peer acclaim are sufficient incentives in certain cases.

**Franklin’s unsuccessful incident**

This incident involved a startup based on a medical device for photodynamic therapy. A research scientist, apart from the teaching faculty, made the discovery at a cancer research institute at the university.
Funding for this research came from an external organization that had its own technology transfer staff. But that staff had expertise mainly in licensing drugs, and this invention fell under the classification of a medical device. Franklin had engaged in a discussion with the managing director of the external organization with the objective of learning how the university TTO could become more effective in licensing drugs, and the managing director had said that she was interested in learning more about how the university TTO operated. Franklin suggested to her that the two TTOs collaborate so that they could learn as they worked together. The managing director agreed that made sense and recommended this technology as a first project. She said that there was a patent and a scientist eager to commercialize the intellectual property, and she made an introduction to the scientist for Franklin. “So I went to meet with him, and I got very excited about the prospects,” said Franklin. “Then we took it into our process. We...put forward a business plan for how this could be managed, commercialized.”

The situation was complex, he said, because of numerous questions including how to best operate the technology, which market to first pursue, and what regulatory strategy to pursue. Franklin said the university TTO developed the business plan and presented it to the external organization, which accepted the plan and “then released the [intellectual property] to us under a revenue share to manage it. We put it through our system, our project management system. We helped support the patents, and we continued with the business planning. We started getting the approvals for the medical device and all those sorts of things,” said Franklin.

He explained that next “we went out to talk to people who would be interested in...funding such a technology. We presented it to a number of contacts I had in the investment banking community in the City of
London, and one of them...got very interested in it and said that they would raise some cash, but if they did so they would wish to appoint a chairman of the company – their nominee, in other words. We thought this is all very exciting. It was the first time I had...[a technology with] big attraction with a big investment bank.” The investment bank raised several million pounds as startup capital and appointed a chairman. The chairman had no particular background in bringing new medical devices to market, but his experience included success in turnaround situations in the City. “He wasn’t as hands on as a chairman-mentor as we have typically used for our other startups,” said Franklin.

The startup targeted the cosmetics market, specifically beauty spas and salons, which would employ the device in treatments to improve the appearance of skin. The device quickly became popular with celebrities and many others. Rapidly growing demand enabled the investment bank to raise another round of capital.

The public markets were soaring, and shareholders’ expectations for the startup were rising. Then the markets crashed. After the crash, “there was a long, long period of the company trying to trade its way through. But the initiative had been lost,” said Franklin. The company continued to make sales and invest in research and development to miniaturize the device, but the full market rollout became extremely slow. “A lot of companies came in and were challenging on the patents,” said Franklin. “So all the time they were burning money, they hadn’t raised enough for a big fighting fund.”

The company was acquired, and in the end the investment was a financial success for the university TTO. Franklin said he considered this incident unsuccessful because the process was unsuccessful.
Franklin’s comments on the unsuccessful incident

Franklin said he would describe this incident as “suboptimal” rather than unsuccessful because the incident included some important successes.

As Franklin thought about the lessons of this experience, he said, “We were a bit hands off.” The investment bank had appointed the chairman, whose management style was hands off. “We should have complemented him with somebody who would still provide leadership of the company but wasn’t an investor nominee.”

Franklin said that the TTO wants to avoid the liability of actively managing a startup, so the TTO tries to appoint the right managers and then just receives information as a shareholder. But in this case the investment bank, not the TTO, appointed the chairman. Although the TTO’s project manager joined the startup, he had little influence.

Franklin also said that, in retrospect, he thinks the TTO should have sold some (but not all) of its shares in the second round of financing. Instead, the TTO held on to all its shares. “We didn’t sell at that stage because we were still thinking about the prospects. We probably should have taken cash out at that time…but we didn’t.”

“We know the importance of speed and being close to things,” said Franklin. In this case, he felt the TTO was too slow and too distant. Even though technology can take many years to commercialize, Franklin said, the TTO knows “the value of time, in particular.”

Franklin also noted the importance of organizational learning. The project manager who left the TTO to join the startup had worked closely with Franklin before leaving the TTO. After the startup was acquired, he
Franklin returned to the TTO as a consultant with another TTO startup. “I don’t take people back as employees [after they have joined a firm spun out of the TTO] because I think that’s a bad practice.” He started working as a consultant to that recent TTO startup and then became an employee of that company. “I’ve put [a TTO] project manager alongside him so that he’s adding value to the project, and one of my managers is then learning from him, learning from his experience, so this has clearly contracted a lot of the time that we would have otherwise have spent.” Franklin continued, “It’s really then a way of leveraging [our TTO experience]. This has happened on at least a few occasions when someone has left and gone with the startup company, and has provided that consistency. Then [the TTO can] hire these people back as consultants, and their learning really is reused and recombined, and becomes part of the accumulation of learning in the organization.” At any time, Franklin said, approximately five consultants, all former TTO project managers, were working with TTO startups. “I can only influence what they do in a sense,” said Franklin. “They are in and out, providing learning experience. I think that’s pretty important. Why should we lose that?”

Franklin said, “Another dimension of that is that when I’ve had a good experience of a managing director in a spinout I try to get them to be a board member of another spinout. Or they become a chairman of another spinout. Or a mentor of another spinout.” They number another five, Franklin observed, so in addition to the TTO staff there are approximately another 10 people “in a fluid network” who worked closely and frequently with the TTO. “That’s a high percentage of the total staffing,” Franklin said. Too much more than that and you don’t learn, you just create activity.”
Franklin said that he has also asked entrepreneurs to talk to the TTO’s board of directors about their experience with the TTO. “Everybody recognizes that there are things to learn,” said Franklin.

The TTO also had an entrepreneur in residence. She worked closely with technology transfer officers to give them the perspective of an entrepreneur. She also helped them with selling skills, not just project managing.

Collaboration is encouraged within the TTO and with industry partners, said Franklin. The TTO has a co-managed fund with a major pharmaceutical company and, Franklin said, “you’ve got the potential licensee sitting there with you providing proof of principle money, which we are matching, and development funding, and informing you about the progress of those projects. That’s where innovation happens because we are informed by people who know the marketplace and to a large degree know the type of technology so that can add real value as we go through, rather than us sitting in our silo, developing something.”

Franklin observed that the university’s policy on intellectual property encourages academics to work with the TTO. “We have a very generous reward sharing policy ...that definitely works for us because it is an incentive for academics to disclose ideas. The prescribed formula is that if there’s no funding required by the university, so no proof of principle funding, or no management services from us, then the split is 85 to the academic and 15 to the university. If we put in proof of principle money, no matter how much that is, we get another 15 percent, so then it’s 70 and 30. And then if we supply active management services – so we are marketing, project managing, and so on – we can do two things. We can either get another 15 percent for that, so the maximum the university can every have is 45 percent and the academic 55 percent. Or they can
stay at 70 and 30 but they agree we are paid a fee from the monies we raise. So it’s a pretty good deal.”

Franklin explained that “the policy also says that if they can demonstrate to the university or to us in that guise that they can commercialize such technology themselves – they have the right networks – then they can stand outside of the [TTO] process. I think that’s good. It is an extra incentive to disclosure because you know that if you bring something to us and you prove that you can do this yourself through your own networks or colleagues then you can be released anyhow, so what’s the fear in talking about it? There’s no grabbing away. And if we can convince the discloser that, though they think they have these networks they are not the right ones, why don’t they work with us. Even if we take it on as a project, they see the substantial benefits anyhow, so that’s tremendously liberating as a policy. That’s good for us because the university is saying to us, ‘All you need is cover your costs over a period of time,’ then we can be a facilitating activity, not a profit maximizing one. We know that that’s okay if you’re the academic discloser and you’re seeing a substantial benefit, even though we’re maybe doing a lot of the work in putting in the effort, that doesn’t matter, because the understanding is that that’s where the reward should go. The university is not looking for me to maximize their return for it. So I think the policy at the university is very important.”

Franklin noted that essential to the learning process is a systematic annual review of the TTO. “I go around the campus, I ask, ‘Have there been any problems with this policy? Are there any things in the policy you would like to see changed?’ So we get feedback from the academic community. We discuss the same with the administrators. And I also have a good relationship with an experienced intellectual property lawyer, so we check the law, how the law’s moved, and we particularly
look to see what has been going on in the United States just to make sure that we anticipate any legal problems that might arise. It’s a very extensive review annually.”

Another important policy, said Franklin, is that academic inventors who have been successful in intellectual property activities (excluding financial returns) can use those activities in their case for promotion. “A number of people have been promoted on that basis, from senior lecturer to professor,” Franklin said. He has cited those professors as examples in conversations with junior faculty because they showed that intellectual property activities could further their pursuit of professional objectives.

**Researcher’s comments on Franklin’s unsuccessful incident**

Franklin’s unsuccessful incident showed that even an incident considered unsuccessful, or suboptimal, could become rich in learning.

7. **Gale**

**Gale’s successful incident**

This incident involved an academic inventor who made a disclosure to the TTO and requested proof of principle funding of approximately £70,000. The TTO approved and funded the project and assigned a TTO project manager to assist the academic inventor. The proof of principle project continued for approximately two years. The inventor and project manager met often, discussed progress, and monitored the project milestones, which the inventor continued to meet. The inventor and the TTO agreed that the next step in the process was to
form a startup, and Gale became more involved in the process. Gale talked about the time he spent with the inventor to ensure mutual understanding of concerns and potential issues. Gale put in place articles of association and a shareholders agreement. With the legal issues, Gale also explained to the inventor the startup’s responsibilities for legal and financial records and reports, and the TTO would assist with those duties and activities until such time that the startup could economically assume those responsibilities.

Gale mentioned that the TTO, as part of its process, asked inventors for warranties that the inventions operate as the inventors have described. This is important, he said, because the TTO in turn has to make similar warranties to investors or licensees. Gale said that inventors often wonder about such warranties and delay the process only because they have never made such warranties previously. That’s especially true, he said, with relatively young inventors. Although the inventor in this case was relatively young, Gale said, there were no issues once the inventor understood what the warranty statement was and why he was asked by the TTO to sign it.

With formation of the startup in place, the TTO project manager assisted the startup in identifying an investment firm interested in placing £300,000 in the startup. With the introduction of an external investor, Gale said, the situation became complex. The inventor had just gone through a process with the TTO and must again go through a similar process with the TTO and the external investor. Gale said that his position was difficult in such situations, because both the university and the inventor require protection of their interests. Further, he said, investors always ask for warranties that the university is unwilling to sign because the warranties entail significant risk of litigation. This time, however, the negotiations went quickly and comparatively easily.
The startup received the investment and hired an operational team. The project manager left the TTO and joined the startup. The startup became a successful company.

**Gale’s comments on the successful incident**

Gale noted that the project manager was helpful throughout the legal process because he understood the legal and financial issues, and he had built a relationship of trust with the inventor during a period of two years. Although the project manager clearly worked for the TTO, the inventor trusted his knowledge, experience, and judgment. Gale said that his own interaction with inventors almost always involved legal and financial matters, and those discussions tend to leave little opportunity to build a business relationship with the inventor, so the project manager plays a key role throughout TTO processes.

He said he considered this incident a success because the process moved so efficiently. This was a success, he said, not only because of what happened but also because of what did not happen. For example, sometimes in such situations, three law firms become involved: one for the investor, one for the inventor, and one for the TTO. Disagreements and demands could multiply rapidly. Legal expenses become material.

**Researcher’s comments on Gale’s successful incident**

Gale brought attention to the importance of process and the issue of trust. Trust is key to ensuring that process works – trust not only in people (e.g., the inventor’s trust in the project manager) but also in the process itself (e.g., the project manager’s trust in the TTO system and the
assurance he could then convey to the inventor). Trust became a foundation for learning, specifically in this case the inventor's learning the TTO process. In this case, conditions of disclosure, access, and reward are evident from another perspective; Gale made clear disclosure to the inventor of the TTO’s legal and financial duties, gave access to the TTO’s legal and financial resources, and ended with at least two clear rewards. The reward for the inventor was a successful startup. The reward for Gale was the satisfaction of an efficient process and a job well done.

**Gale’s unsuccessful incident**

Gale said that his unsuccessful incident involved intellectual property owned by two universities, one of which was the University of Manchester. The academic inventor, who taught and conducted research at the University of Manchester, requested proof of principle funding for this invention. An external investor provided the proof of principle funds because the intention was to quickly create a startup even though the technology was at an early stage – “too early,” Gale said.

Despite intentions for a quick launch, delays followed delays, Gale noted. The intellectual property owned by two universities required an agreement between those universities, and that took months to complete. Gale then had to put agreements in place among the inventor, the investors, and the TTO. With the technology at such an early stage, certain agreements became more complex, for example, to ensure that specific criteria and compliance issues would allow specific tax benefits, said Gale. “So what should have been a relatively straightforward process in putting together subscription agreements and assignments of IP became a really tortuous, extended process,” he said.
The TTO assigned a project manager at the start, but he left the TTO. So the TTO appointed another project manager, who had just recently joined the TTO and had no experience in the TTO process. The transition between project managers caused even more delay.

Amid the delays, the inventor became concerned about the warranties he had to sign. Although the inventor had been enthusiastic at the start, Gale said, the delays had an effect. “We had an academic who, at the end of the day, became very nervous about lots of things,” Gale observed.

The delays continued for more than one year, but eventually the company launched.

Gale’s comments on the unsuccessful incident

Gale said that, since this incident, he has worked more on teaching academics how the TTO process operates and why. He said the difficulty is that academics share many concerns, but each academic seems to have one unique concern that is the most important to him or her. Often academics find it difficult to express that concern.

Gale said that he and his staff devote time regularly and frequently to improving the standard documents that the TTO typically used. The goal was always to make the agreements simpler and easier to understand, yet comprehensive enough to protect the university.

Gale said that he has often thought about how to predict which academics would succeed at a startup.
Gale said that this experience had made him more sensitive to intervening in the process when delays start. One approach he had successfully used since this incident is to get in a conference room all of the decision makers without their lawyers and with the mutual agreement that by day’s end the decision makers will have resolved all the issues. “I wish I had done that years ago,” said Gale, “It’s more effective than email.” He noted, “Unfortunately, it’s... not always easy to get everybody that you need together, together.”

Gale said that, although he and his group work to learn from errors, he felt they could do better by creating a formal process to ask, at the end of every project, what went well, what went poorly, and why.

**Researcher’s comments on Gale’s unsuccessful incident**

Often, especially at TTOs, property rights require legal protection for innovation to occur, or to allow innovation to occur. In this unsuccessful incident, Gale performed many of the actions of an innovation process – e.g., brokering, collaborating, and negotiating – but the process was unsuccessful to him. Yet he felt that the learning he derived from this incident had helped him and would continue to help him improve the process.
8. Hayden

**Hayden’s successful incident**

The successful incident comprised two episodes, Hayden said, because they were equally important, and they were the most critical. The first episode involved a license agreement; the second, a startup.

The technology in the first episode involved intellectual property for detecting leakages and blockages in gas pipelines. An oil and gas distribution company funded the research and development of the technology at the university; then the TTO licensed the technology to an oil and gas services company in an agreement involving the TTO, the distribution company, and the services company.

The inventors and their university laboratory worked on the research and development for nearly a decade. The oil and gas distribution company, a subsidiary of a global oil and gas company, had been trying to solve specific problems for many years in pigging, a pipeline inspection and maintenance process. An executive at the distribution company had a relationship with the university and made introductions, which led to discussions between university researchers and company researchers and officers. The distribution company and the university agreed on a research plan with annual milestones. Each year the university researchers met the milestones and received funding for the next year. As the researchers made discoveries, the TTO filed patents throughout the world.

In collaboration with the distribution company, the TTO sought licensees for the technology. Of several potential licensees, the TTO selected one, and they reached an agreement. The license agreement
called for significant translational funding because of the time and expense of transferring the know-how behind the patents. This knowledge transfer partnership allowed the services company and the university to share resources seamlessly. Hayden said the collaboration among “the university, the oil company, and the licensee has just been built on strong personal relationships. Lots of really good engagement. Lots of honesty. The whole thing has been a huge success.”

The second episode involved an inventor, a technology, and a startup in the wastewater treatment industry. The inventor came to the university looking for technology and commercial assistance. He had an invention that could significantly reduce cost and improve quality in wastewater treatment. With years of experience in the wastewater industry, he believed that he could use his invention to develop a scalable process.

The university agreed to work with him. He conducted his research at a university laboratory in close collaboration with university researchers. The intellectual property began to build during two years, so the TTO created a startup to bring the technology to market. Through the TTO network, the startup attracted experienced scientists and executives, who had credibility with venture capital firms. After raising capital, the startup commenced operations and became a successful enterprise.

**Hayden's comments on the successful incident**

“The reason why these have been successful is...industry focus,” Hayden said. “Someone knew exactly what the industry needed first...If you can get that true understanding of what the problems are and true identification of [the process] to solve the problems, then you’re on the
right track, and you've built really strong relationships along the way. That’s the key to these two projects,” said Hayden.

Hayden emphasized the importance of the teams: not only how well people within the scientific, industry, and TTO teams worked together, but also how well each team collaborated with the other teams.

Hayden observed that neither of these projects was a technology push; both were, in essence, a market pull. “We started with knowledge of a specific problem” in the market, said Hayden, and then developed technology to solve the specific problem. Hayden commented that often a TTO starts with a technology and attempts to push it to the market – a solution seeking a problem, “and the problem may not exist,” said Hayden.

Early intervention could help, Hayden suggested. “As early as possible [in] the typical research process [the TTO] should see if that [technology] maps onto any problem that resonates strongly in the industry,” said Hayden. This is a process of “collaborating, cooperating, and sharing knowledge” that leads to relationships and partnerships between university laboratories and the TTO and even within the TTO, said Hayden. The key is “to establish an ongoing dialogue, and then wrap process around it.” That can prove difficult, however. “You can’t force people to engage in a particular way, can you, but you can try and create the right environment for them to contribute...and build trust in each other. I think you only build trust in relationships if, you know, if people know each other personally. I encourage them to go to clients’ offices or to go out on a visit to a company with the academic. In getting there in the car or on the train, they’re getting to know each other. And sharing meals together, you get to know each other personally. And I think there’s nothing like building strong personal relationships with the people you’re working with so you have them respond to you better and
have them trust you and have actually glued together something that then is more likely to work,” Hayden said.

**Researcher’s comments on Hayden’s successful incident**

Hayden made clear that he believed he had learned the importance of industry collaboration (to ensure market pull rather than technology push) and great teams (to facilitate the innovation process).

**Hayden’s unsuccessful incident**

The unsuccessful incident comprised three episodes. The first involved a social enterprise. An academic developed a software package of tools for online engagement of stakeholders in social enterprises. The invention failed to meet the criteria for a patent but offers utility in exchanging information and engaging stakeholders in a community of interest.

The inventor, said Hayden, “had a particular approach and a particular energy and a particular passion for this,” and she sought assistance from the TTO. The academic inventor’s goal was to raise approximately £100,000 to develop this package and then offer it to other social enterprises. She had no profit motive, only a social mission to help others.

Hayden said that providing her with TTO funds would fall beyond the TTO’s mission and university policy. “We were unable to identify a case that would justify an investment,” Hayden said.
The second episode involved the TTO’s experience with two academic inventors. They are creative, said Hayden, and they frequently make invention disclosures, “but when we’ve engaged with them to pursue those ideas, they’re very enthusiastic but subsequently the whole thing runs out of steam...because the inventors ultimately can be pushed down the commercial tracks so far, but you reach a point where it gets harder and harder. They are starting to have to answer questions that are not within their own technical domain, not within their own experience. And they’re unwilling to go there; they’re unwilling to see that if their expertise is to be taken out into the real world...[and] integrated into some other technology. There will be different problems to be solved, some other skills to learn, some other disciplines to understand. And then [they indicate that they] don’t want to go there...not explicitly, of course...but [I see] their lack of engagement and pulling back and wanting to go back to the research phase, wanting to go back to the comfort zone.”

Hayden said that he had these two academic inventors in mind because their case is so vivid, but many other academics behaved similarly. Many academic inventors, he said, are investing their time and other resources in inventions and attempts to start commercial enterprises, so they engage with the TTO, and generally the TTO provides services to them. “But we don’t find out until too late that they’re not really going to go the journey with us. They’re going to get to a certain point, start to get really uncomfortable and start to just disengage and become pretty flaky.”

The third episode involved a renewable energy technology. Hayden said that the academic inventor is well respected, and the invention is highly regarded, though the technology requires further development. The market potential is significant. This was unsuccessful, he said, because to take the next step toward commercialization would
require an investment of approximately £10 million. Hayden said that he has worked to raise the capital, but a seed investment round of £10 million has been beyond the capabilities of the TTO.

“This has potentially huge commercial benefit, huge environmental benefit,” said Hayden, and there had been no interest from venture capital firms or industrial companies. Virtually all of the investment in renewable energy have gone to solar or wind, said Hayden, and this technology is marine. “Wind projects and solar projects were the incumbent technologies, and everyone wanted to invest in those,” Hayden said.

**Hayden’s comments on the unsuccessful incident**

Hayden said he considered the social enterprise project unsuccessful “because I really feel frustrated that we have not engaged with it in a way that we could or should have been able to. So I feel that was a case where we failed because it didn’t fit with our policy.” He wanted the TTO to develop a capability to assist social enterprises. Since then he had been working with UK government officials, social enterprise executives, and university administrators to reach a solution. “There’s no mechanism for these [inventions for social enterprise] to be recognized and developed within the system,” Hayden said, so finding a mechanism was the first challenge.

Hayden said he considered the second of the three episodes unsuccessful because it highlighted what he termed “a cultural issue,” a reference to a culture of invention, rather than a culture of innovation, among many research scientists. Hayden said that the TTO could filter out researchers, who sought seed capital as simply another source of
grant funds, but many other inventors seemed interested initially, and perhaps were genuinely interested, but insufficiently committed, skilled, or experienced to persevere with a new venture.

He said he considered this a cultural issue in another sense of the term, a reference to UK culture. “I think there’s a real feel of failure amongst the UK community, and I think it’s perhaps a cultural personality thing as well. If you tried something and you failed, that’s something to be really ashamed of, and actually it’s a bad personal reflection, and it’s going to impact your career pretty significantly. And that thought is a bigger factor than the fact that they might be a huge success.”

Hayden made a comparison to the US, where he has visited technology transfer offices and venture capital firms. “I think in the US there’s – and I’m generalizing hugely with all of this – an attitude that if you failed, hey, at least you had a go, and now you’ve learnt lots and you can do it better next time,” he said.

He noted that “[academics] don’t have the tools, really, to be able to assess the risk properly. Because it’s still a minority activity for academics to become engaged with spinout companies, it’s definitely not the norm, it’s an unusual choice to make and a career risk for one to take. You know you can be much safer if you just continue to pursue the climb through researching, publishing. So, that’s the safe option that everyone recognizes and respects. I really don’t think that academics understand the [venture capital] community, and it’s quite difficult to set expectations. I think that’s part of our role. We try to gradually explain to them what sorts of questions that will be asked of them, what sort of pressures will be put on them, what kind of demands will be made of them. And the fact that there will not really be any give in those sorts of demands.”
The third episode was unsuccessful because the TTO simply lacked the network and resources to raise the capital for the renewable energy project, Hayden said. He would like that access to capital, he said, but rarely does a project seem to require such a large seed round.

**Researcher’s comments on Hayden’s unsuccessful incident**

Hayden’s three episodes had two themes in common: capital resources and human resources. The social enterprise project and the renewable energy project were unsuccessful because of the unavailability of capital. The episode referring to academic inventors was considered unsuccessful by Hayden, though in this example the resources are human, not capital.

9. Inga

**Inga’s successful incident**

The successful incident involved an invention for medical imaging with particular application in oncology. The inventor began developing the concept more than 13 years earlier. The inventor continued research on the technology over several years and made disclosures to describe his discoveries. The TTO filed patents in key nations throughout the world.

After several years, the TTO concluded that the technology was sufficiently robust to justify a startup investment. At approximately one-half the cost of other imaging technology, this invention generated larger images of demonstrably superior quality to medical imaging technology available in the market at that time. Inga became the product manager, a
role she eagerly assumed because she found the technology, and the potential, so exciting, she said. But the project proved more difficult than she had imagined. “We were ahead of the market really,” said Inga, “We were too early. We spent two years trying to raise funding. That was difficult going.” Inga said that she spent much of her time on this project because it was so difficult to make commercial progress and because the technology held such promise.

Eventually the project became too time intensive, Inga said, that she had to involve a TTO colleague, who became the project manager.

Inga continued to notice that problems with the project kept mounting, even though approximately £400,000 had been invested in the startup. A few years after leaving the project, she again became project manager. “I was asked to take the project back and have a fresh look at it because...it had run out of steam...and out of money.” Inga said that “the general view was that it was going to be killed off as a project.”

During the next year, Inga developed a new plan and raised additional capital. The new funding allowed the company to hire a few people with industry experience. Inga also worked to create interest among medical imaging companies that could collaborate on research or acquire the startup.

The startup then began to thrive. “It’s now got life in it,” said Inga. “I’m particularly pleased to take something that was nearly dead and to breathe life into it. It was very enjoyable rescue exercise. It was very hard work jetting around the world in some cases to meet [industry executives], at very short notice, who showed interest in it. It was an example to me. I managed to get one person interested, and you can use that and say [that person] had an interest in it. Then you find you can
gradually get plates spinning. Once you've got several plates spinning, you can get another one spinning. [It was] a process of building a community of people that said that [the technology] was valuable and they were interested. It's suddenly gotten self sustaining.”

**Inga’s comments on the successful incident**

Inga reflected on the life of the intellectual property and the project. “There are very, very long time scales. I mean, it is quite alarming because you come here [to the TTO] to make your contribution to the world and it takes 10 years to get that contribution realized. There are occasions obviously when that [time] is less, [e.g.,] in the particular case of software; we've got some [of those] formed and sold in three, four years.” She compared the software industry to the medical imaging equipment industry by saying, “In medical imaging, it's the inertia of the industry. If you want a Philips or a Siemens to adopt a technology, it means they’re going to have to invest £200 million to make it work, and it takes an awful lot of time to break through that inertia and get that engagement secured.”

Inga noted that growth in the medical imaging equipment market during the past 10 years has helped the startup.

Inga said that this incident “taught me that if you believe in something – and obviously you need to make sure that you don’t have rose tinted spectacles – if you have a realistic view of the potential, and that fires you up, you have to get personally passionate about it. You have to become very focused on building on whatever value you’ve got. You need to be thinking very hard about how you can grow that opportunity, but also how you can use that interest to lead…and build momentum to
keep plugging away. I’ve seen really good projects that ticked all the right boxes...and need a really focused, energetic, and driven person who becomes personally connected with it and emotionally connected to really make it stick. I mean, a simple example is a [TTO project with a] technology for processing wool so you can make woolen garments that can be machine-washed. This is essentially a robust, low cost, durable technique for making wool fabric machine washable. You’d think that’s easy to license, but it isn’t. We’re just about to do our first license deal on it, [and] it’s been really difficult. But it’s been driven by one of my colleagues who is a fighter. It’s not a case of being aggressive; it’s just a case of being persistent. Really believing in it and working hard to keep it moving and keep selling it in the right way to the right people.”

Inga said she spends much time building networks, going to industry conferences, and meeting executives at their companies. Networks are important, she said, and so is using creativity to exploit the networks, creatively associating people in your network. Inga said she keeps a long list of what companies and their executives need and want in technology, and she endeavors to match those needs and wants with the interests of research scientists at the university. But persistence is really important, she said, persistence in building networks, employing creative solutions, and pushing toward commercialization success. She said that persistence and passion are critical.

The process always starts with one person, Inga said, but it always requires more people. But if an inventor is “endlessly excited,” then an investor may become excited. “ If you get enough investors excited, you can start talking to potential CEOs, and they get excited,” said Inga. And their excitement in turn encourages the inventor, she said. The passion encourages people to persist.
Then networks can build quickly, said Inga. She referred to Metcalfe’s law, which, she said, showed how rapidly networks and their utility could grow. “That’s something I certainly feel is very important. Being in this business is not what you know; it’s who you know,” she said.

Inga said that she had been working on building networks internationally, especially on the European continent, in the United States, in Australia, and in China.

**Researcher’s comments on Inga’s successful incident**

Inga’s remarks revealed a strong sense of entrepreneurship and leadership. Actions are important, but persistence in those actions is often necessary for success.

**Inga’s unsuccessful incident**

The technology involved a sensor with wide application, including the measurement of pollutants in rivers and of chlorine in swimming pools. The academic inventor made the initial discovery while he worked at another university 10 years earlier. When he joined the University of Manchester, the other university entered a cooperation agreement with Manchester’s TTO to allow for commercial pursuits. The inventor continued working on the sensor, which seemed to offer advantages of accuracy and low cost. Higher accuracy derived from the new technology, and lower cost derived from a new production process for manufacturing the biosensor. Cost projections were so low that inventor began to consider the invention a disposable sensor. The advantages allowed the
invention to appear superior to products and methods available in the market.

The TTO formed a startup, and Inga became the project manager. The startup raised more than £400,000 in capital and hired a small team. The team focused on executing the business plan, which included eventual large-scale production. Only by manufacturing the biosensors in high volume could they become the lowest-cost product, and a low price point was important to achieve rapid market penetration. It was an exciting and challenging time, Inga said.

The challenges became severe. The scientists and engineers were unable to achieve the level of accuracy necessary. Moreover, they were also unable to devise a mass production system to consistently perform at a necessary standard of quality. Within three years of the startup’s launch, the company’s cash, and the investor’s patience, were running out.

The inventor remained enthusiastic, said Inga. He had moved from the University of Manchester to another university, however, and his new position limited the time he could devote to the startup.

**Inga’s comments on the unsuccessful incident**

Inga said that she made a terrible mistake by failing to involve design engineers and process engineers at an early stage. She said that scientists often assume that, if they see a device work once in a lab, then they can make it work all the time. Process engineers have a different perspective. Scientists and technology transfer officers are optimists. “We can see the glass half full in here, and scientists think they’ve seen it completely full if [the invention] works once on the bench. Okay, it didn’t
work the other nine times out of ten, but it worked one time out ten; therefore, we can make it ten times out of ten,” said Inga. She added that the real questions are: how realistic, and how expensive, is it to achieve that ten out of ten performance?

Inga said that her offers of assistance to the company were usually declined or dismissed. “I said to them that if they needed a fresh pair of eyes to look at these [challenges], please give me a call. They wanted to succeed without help. You can’t afford to have that degree of pride,” she said.

One positive factor, Inga said, was that the cooperation between the inventor’s first university and the University of Manchester was effective. “There were early negotiations between the [two] universities about how should we structure this company, what were the shareholdings, what would be fair and reasonable equity. Some negotiation, but no conflict. It turned into a very positive relationship with them as an actual shareholder,” Inga said.

Another positive factor was the inventor’s commitment to the startup. Inga said, “His personal drive didn’t change. He was always and still is passionate about this particular project. Some [inventors] lose interest, but he has always been a tremendous enthusiast for what he had developed. At one stage towards the end, when casts got very tight, he actually put some money into it himself. So that’s always a great sign. It was not a huge quantity, but he put in £10,000 or something like that. That was eventually converted into shares. So he didn’t play a difficult game, and he tried to do as much as he could for the company.”

Inga reflected on the entire incident and said, “It’s a slow learning process to become an expert in the market and an expert in technology
and an expert in what you need to do to get technology to market. That’s why process is most important.”

**Researcher’s comments on Inga’s unsuccessful incident**

Inga believed that had she given design and process engineers access to the process, the outcome would have been better. The project would have benefited, in her assessment, from learning and collaborating with experts. The startup seemed insular and resistant to learning from people outside the company.

**University of Southampton**

The University of Southampton, located in Southampton, UK, traces its origins to 1862 and became a full university in 1952. The student population at the university is approximately 23,000, comprising approximately 16,000 undergraduate students and approximately 7,000 graduate students. University of Southampton Research and Innovation Services is the technology transfer office for the university.

**Interviews**

At the time of this study, the TTO employed approximately 15 people. Four participated in interviews: Jordan, Kelly, Lindsey, and Morgan. The table below presents the main themes of the interviews.
University of Southampton participants and interview themes

<table>
<thead>
<tr>
<th>Participant</th>
<th>Successful</th>
<th>Unsuccessful</th>
</tr>
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<tbody>
<tr>
<td>Jordan</td>
<td>Engaging people, experimenting, learning</td>
<td>Failing to adapt in a changing environment</td>
</tr>
<tr>
<td>Kelly</td>
<td>Reusing knowledge and collaborating</td>
<td>Learning what is within or beyond one's control</td>
</tr>
<tr>
<td>Lindsey</td>
<td>Persisting, networking, and sharing knowledge</td>
<td>Attempts to manage without process</td>
</tr>
<tr>
<td>Morgan</td>
<td>Establishing trust and aligning goals</td>
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10. Jordan

Jordan's successful incident

Jordan began by pondering and questioning the classification of successful and unsuccessful incidents. "Well, I guess where I would have some difficulty is behind the premise of the question, which is, things are either successes or failures. I think my attitude is things just are. Because we're on a process, everything we do, if you like, is an experiment, a journey of discovery and along the way, we learn things. Sometimes we learn them from things which didn't go as we expect, and sometimes we learn some things which go better than expected. But I really would try not to have the 'things that have succeeded or failed' kind of attitude. We get on, we do the best we can and, I mean, outcomes are what the outcomes are."

Jordan stopped speaking and waited for a reaction. The researcher suggested that Jordan consider this: what makes an experiment he would like to repeat, or what makes a journey he would like to retake?
Jordan responded, “I still slightly disagree with the premise, but if I can pull it around something, I would say the big area in both is actually the academic engagement in the process.”

He thought for a moment and continued, saying, “Those which have worked well, in general, tend to be those where the academics are well engaged. They are what I would call coachable in the things that they’re not experienced in, and they work together as a team with people, either from within our [TTO] office or people externally from the commercial environment, but actually to move things forward.”

**Jordan’s comments on the successful incident**

Jordan observed, “The other stuff is secondary. So you might say, ‘Well, what about the quality of the idea they’ve got?’ Well, actually, some of what we found taking people through the process – even if it’s not such a good idea – is that they actually learn about the process, and then they can come back later with a probably much better understanding. We have had situations where in the first meeting they’ve actually understood why their ideas shouldn’t go forward, and then they come back six months later with a really good idea and the proper understanding.”

Jordan explained that he has learned that there was relatively less technology risk and more market risk in university innovation. He believed there was less technology risk because the academic inventors at the university were often world experts with the technology. The scientists’ expertise reduced the technology risk. Market risk, however, was high. He felt that the key for the TTO to reduce market risk was to
use the market expertise of industry partners and collaborate with them. “We tend to focus on longstanding relationships with our industry partners,” Jordan said. With many companies reducing their research and development budgets, collaboration with universities became more attractive to companies. Furthermore, TTOs could avoid pushing inventions toward the market by collaborating with companies that would pull inventions and innovations to market.

Jordan added that intellectual property came from two research sources: government funds and industry research collaborations. With industry, companies sponsoring research then licensed the resulting patents. With government funds, research grants were larger, and opportunities were bigger, so the TTO would form startups to commercialize the intellectual property. “The risks are bigger too, but sometimes a startup is the only way.”

The people in the TTO were essential to the process of engagement, Jordan said. “The job that the people here do is extremely broad. It covers so many different things. Not everyone can be an expert in everything. So you have to know your limits, then you tap the gurus, or one of the gurus, who has that knowledge that you need. [In the TTO] I think the complexity of the job, and the way in which it changes from month to month, the job evolves. It’s a very complex landscape, and everything is changing. We have to go at a rapid pace. I mean, just look at what’s happened in the investment environment in the last few years. We have to deal with the ambiguity because that’s the way the world is. The world isn’t like a computer simulation where everything’s known. And especially, a lot of big issues are the people issues. People are not like physical equations. You can’t write down an equation for how a person’s gong to react, and work out the equation and see what’s going to happen,” said Jordan.
“Almost everything we do is a rich learning experience,” Jordan concluded.

**Researcher’s comments on Jordan’s successful incident**

Jordan began by saying, in essence, that there are no successful incidents or unsuccessful incidents; there are just incidents. Yet he quickly identified “engagement” as most important to “what has worked well.” What he has captured is an attitude of wisdom (1991), which in this case means a sensitivity to what works well without a rigid focus on what is a success or a failure. The strong emphasis is on learning from an experiment or an experience, not on the classification of success or failure.

**Jordan’s unsuccessful incident**

Jordan said, “Where things have not worked as well is where engagement was missing. In the early days for us, we made mistakes in assuming that the academic artist would not want to get involved in all the legal details that were going on. Actually, they felt they were being patronized when we did that, and what we discovered very quickly is that academics have a tremendous voracity and ability to consume information, analyze it and act on it. We found that was equally true of things like legal agreements, patents, IP, etc. So I think that was an area where we made mistakes of not engaging them fully and giving them some transparency of all aspects of the process.”
Jordan observed, “Where we’ve given up on things, is where we’ve had academic groups who are completely stuck in their mind as to how this is to be done. They are not coachable in any way. They will not take advice from anybody that it could be different. And at that point, we take a view, ‘Well, if they’re not listening to this advice, they won’t be listening to their customers, they won’t be listening to their investors and their stakeholders.’ And that’s not a good recipe for a corporate or a commercial activity anyway, so we tend to let those things fade away if that turned out to the circumstances. So I would put it all around the ability of people to engage, be transparent on all sides, and to learn from each other.”

When asked how he determined who is coachable, potentially coachable, and uncoachable, Jordan replied, “I think that’s an interesting one. I mean, much of it through the early stages is just a gut reaction. When [the academic inventor] comes in, how enthusiastic is he? How much, how open is he, how much is he listening in that process as opposed to transmitting in that process? I think it’s one of those intuitive link episodes where early on, you get the feeling one way or the other.”

**Jordan’s comments on the unsuccessful incident**

Jordan paused and thought for a moment. He said, “I guess the question was, where do you gauge the line? Where are there people who can be encouraged in the right direction, whereas where are there people who will always be stuck within their current confines? I’ve had people who have gone through the process, stalled, found it quite difficult to get re-engaged, but then at the end of it they fully appreciated it, and they’ve learned, and they’ve gone on to do good things.”
Jordan said that equally important to coaching is “our own willingness to be open and sharing. So it’s not that they’re the obstacles but, as I said earlier, we’ve made mistakes in this space as well by making assumptions. So we’ve got to be coachable by them, and they’re got to be coachable by us.”

Jordan added, “Some of our difficulties have been where we haven’t paid too much attention to getting the right CEO, the right person from the corporate background alongside the academics. And part of that, I guess, is a learning experience because one of the first times I did when I arrived here [at the University of Southampton] and began working on a startup was to come up with five candidates. We had them all in for informal conversations with the academic team and, [the academic team] were quite clear saying, ‘Oh, this guy would be great.’ And I was out there saying, actually, no. [The CEO] has got to be able to do the following things. And they had never recruited a CEO before. They didn’t understand what one did, what they were looking for in one. And so we went through a big learning experience in that...what the role is...what characteristics you’re looking for in that person. So and I think we’ve made, big mistakes is actually not paying enough attention to that, or even letting the company get going without having a CEO in place. And where it really has worked well, we put the effort into pairing a world-class academic up with a world-class CEO.”

Jordan emphasized that he no interest in TTO metrics. “What you measure is what you get,” he said, “but we want to know that we’re well engaged, that the academic community feels we’re doing a really good job for them.”
Researcher’s comments on Jordan’s unsuccessful incident

As with the successful incident, Jordan underscored the need for engaging with people, understanding them, and sharing knowledge. He also highlighted the importance of adapting in a rapidly changing environment.

11. Kelly

Kelly’s successful incident

The intellectual property involved a discovery in materials science approximately eight years earlier. Kelly said that the TTO identified the potential of the invention and filed a patent application. The academic inventors continued working on the technology, and the TTO kept prosecuting patents, as the scope of application became extensive. Kelly said, “It was very much a platform technology that could generate new materials effectively.”

Kelly said that the TTO had significant experience with similar inventions. “We had a high level of expertise together with an important piece of IP,” she explained.

A strong relationship between the scientific team and the technology transfer officers, particularly Kelly, was helpful. “Really, the scientists...were very much open to new applications, to expand on their research.” In contrast, scientists sometimes want to focus on just one application and view other applications as a distraction, she said.
The scientists were eager for an external CEO, Kelly said. The TTO, using its network in the financial community of early-stage investors, identified several candidates for the CEO position. The TTO influenced the CEO decision but avoided dictating the decision, Kelly noted. The CEO got the startup off to a fast and successful launch, she said, and he had been effective. “The key to success was very much bringing an external CEO, who created opportunities and hired the team. We built a very strong relationship, a trusting relationship, with them. And once we managed to get a first round of investment, [the CEO] built the business. And that is still a very successful company, which recently listed on the AIM.”

**Kelly’s comments on the successful incident**

Kelly said that the cooperation among the scientists and the TTO was extensive and effective, and the collaboration provided a sound foundation for subsequent success. She explained that TTO did nothing special for this team of scientists that included a mix of less experienced and more experienced academics. She said that the TTO took care to follow its process with them.

Kelly elaborated on the TTO process. “It’s really a two-way process,” she said. “For the new faculty, we need to build a relationship with them to increase, to grow, that confidence in our ability to deliver for them. So that’s very much an imperative process. So you may need information from them, but equally, they want to be reassured and see how we present the project for them. Often, we may want to progress much faster than they’re able to follow, and that began to happen here. So there’s an information gathering around the technology, the invention,
the marketing. I mean, a lot of the work eventually we would do, but we also require significant input from our scientists. And doing that process, you start to gauge whether or not, how much it is important to them, and how high on their priority list it is. That is also a way to determine what and how engaged they are, how much they want to get that technology to go out there.”

**Researcher’s comments on Kelly’s successful incident**

In this incident, the conditions – disclosure, access, and reward – are evident, as are actions of collaborating (e.g., among scientists, technology transfer officers, venture capitalists, and an entrepreneur) and reusing knowledge (e.g., the TTO’s experience with similar inventions).

**Kelly’s unsuccessful incident**

Kelly said that she had thought of several examples of incidents she considered unsuccessful, but she declined to provide a specific incident. Instead, she said she preferred to talk about what unsuccessful incidents typically have in common.

Kelly said one factor is that the unsuccessful incidents are “the cases where the technology tends to be so very early.”

A second factor in unsuccessful incidents is that the technology has “so many wide applications. That is really difficult to focus on.”

A third factor is managing expectations with academics. “I think the challenge is, in the excitement of it all, it’s pinning down the right
approach with the academics and getting them to understand what we can and can’t do. In some of these situations, the academics have lost their excitement, and even their interest in commercialization, because they felt the TTO was taking too much time to put together a startup. Kelly said, “There will always be cases where we think there is a potential there. We’re not quite sure what it is yet, and we’re still looking for it. But [the academic scientists] decide not to go further. There’s a moment where they may say they’ve had enough, that sort of thing.”

Kelly’s comments on the unsuccessful incident

Kelly believed that the TTO had made and would continue to make improvements in the commercialization process mainly through training and developing the TTO team. “The core team is a group we call ‘collaboration managers,’ and their role really is to assist academics, or faculties within the school, to understand what they want to do. Then [the collaboration managers] help them throughout their whole research life cycle, trying to find funding for an idea, negotiate the contract with a potential party, and then look at the output of the research for commercial licensure. So [collaboration managers] cover the whole spectrum… and they have very strong relationship with academics – understand what they want to do, where they want to go, and build that relationship because they’re more able to pinpoint when something comes up of potential commercial interest. So that’s really how we operate. And it’s leaving the opportunities to emerge through meetings or getting together. And then we also encourage multidisciplinary activity across schools. That’s another aspect which helps identify new potential commercial opportunities across boundaries. That has generated more potential innovations coming through, like bringing medics together with
physicists, and that sort of thing. So that’s another thing that we try to channel, by facilitating those sorts of interactions.

**Researcher’s comments on Kelly’s unsuccessful incident**

To address the lessons of unsuccessful incidents, Kelly has focused on what is within her control – the people in the TTO office – and acknowledged what is beyond her control (e.g., technology acceptance by the market).

**12. Lindsey**

**Lindsey’s successful incident**

An academic inventor, who had worked in industry for many years, designed a new water wheel. He brought the invention to Lindsey, who was intrigued because of the low-technology design. “I really, really struggled to generate interest here initially. And I really do think that was because it wasn’t sexy, it wasn’t a high tech invention,” Lindsey said.

Lindsey said that the inventor’s industry experience lent credibility to the invention, and the inventor presented Lindsey with basic industry and market research. “He had a very high level of commercial awareness... and passion and enthusiasm for this. And he had a compelling assessment of the market. Okay, he had done all the work that maybe I was supposed to do, but he’d done that in advance, and I couldn’t undermine the market assessment he presented. It was realistic,” said Lindsey.
Lindsey said he often talked about the invention to others at the TTO, and eventually they became interested. They consulted intellectual property experts and concluded that the invention could get patent protection.

Lindsey talked to a venture capital firm, and two partners of the firm became interested and planned to start preliminary due diligence.

Several weeks later, Lindsey said, he was meeting at the TTO with two investors in another project. After they finished their work for the day, the three went to a nearby pub. “I just saw the opportunity to introduce this idea to them,” said Lindsey. “So I said, ‘I know you’re sponsoring this project, but there’s also something else you might be interested in.’ That’s how it happened.” The two investors were interested and returned to the TTO a few weeks later to listen to a presentation. The two investors liked the presentation, Lindsey said, and offered to provide funding to commercialize the invention.

**Lindsey’s comments on the successful incident**

Lindsey said that, upon reflection, this incident was successful because of the inventor’s commercial sensitivity and knowledge and the invention’s fundamental operation. He said that the incident also affirmed the value of networking and sharing information.

Lindsey noted that the academic inventor’s knowledge of applications and markets was unusual. “One of the areas where we add value to academics is trying to inform them, educate them, guide them about the application for their technology. It seems to be the case [that], although they’re very focused on what the technology is and how it’s been
created, they have precious little idea from a holistic approach – a thinking-outside-the-box approach – how this technology could be applied for benefit. That’s something that we can help with either directly or by introducing industry [experts] to them to discuss how to make a technology into an application.”

**Researcher’s comments on Lindsey’s successful incident**

Lindsey’s perseverance is noteworthy. He could have given the invention less attention when others showed no interest. His enthusiasm for the inventor and the invention seems to have convinced others at the TTO and investors to listen to why he felt the invention held potential for commercial success.

**Lindsey’s unsuccessful incident**

An inventor from outside the university brought his early-stage technology to the university for further research and development. Scientists at the university took the research project and made progress. The TTO formed a startup. The outside inventor then claimed to own all of the intellectual property and wanted to take full control of the startup. The startup efforts stopped because of the position taken by the outside inventor.

**Lindsey’s comments on the unsuccessful incident**

Lindsey said that the outside inventor had essentially an idea and neither the technical expertise nor the business skill to implement the
idea. Lindsey said he could understand why the inventor wanted to own and operate the startup. “My takeaway from this is, you need to explain to the inventor straightaway that someone else may be the right person to take the idea forward to the market,” said Lindsey.

**Researcher’s comments on Lindsey’s unsuccessful incident**

This incident seemed to show an absence of process, or an absence of adherence to process; for example, the outside inventor’s intentions and expectations appeared to surprise technology transfer officers after the startup was formed.

**13. Morgan**

**Morgan’s successful incident**

Two academic scientists made a discovery and filed a disclosure with the TTO. The TTO evaluated the technology and assessed the market. The TTO decided that the technology and market were too small for the TTO invest resources. Morgan said that the TTO released the intellectual property to the academic scientists so that they could pursue a small business.

The scientists took the intellectual property and formed a startup. They found a person who would make a relatively small investment in the firm and would operate the company, as the scientists wanted to remain with the university.
A significant problem occurred, Morgan said, when the scientists continued their research at the university on the technology. The investor felt that the startup should automatically possess full intellectual property rights to subsequent discoveries. The university policy was much more restrictive. Morgan said this issue required extensive negotiation among the investor, the scientists, university administrators, and technology transfer officers. The investor and the scientists took one side, the university administrators took another, and the TTO was placed in the middle. They eventually arrived at an agreement.

The startup has increased sales and has sponsored research at the university with the scientists who helped found the firm.

**Morgan’s comments on the successful incident**

Morgan said this was an extremely difficult situation for her. The incident caused difficulty in building relationships with academics because they wonder whether a technology transfer officer puts their interests first, or the university’s interests first. This created a problem of trust, she said.

“The university takes the view that, well, yes, we’ll hand over the IP, but we need to make sure that we don’t hand over more than we absolutely have to,” said Morgan. “And the academic says, ‘It's my work that generated [the startup], and now I'm being prevented from doing my research or starting a business.’”

“I think it is actually quite easy to identify the scope of the IP,” said Morgan. She said that the university needed a clearer, fairer policy – one that all the stakeholders understood from the start.
Morgan returned to the issue of trust. “Until we resolve this, it’s an ongoing tension. And when academics think we are policing their activity, we can see the relationship break down, and they can really try to work against us.”

**Researcher’s comments on Morgan’s successful incident**

Though Morgan called this a successful incident, it did highlight the difficulty of managing and merging interests at times when goals conflict among scientists, venture capitalists, university administrators, and technology transfer officers. Morgan clearly believed that a foundation of personal trust (which is a basis for such actions as collaboration) and a clear, fair university policy on intellectual property rights (which are necessary to facilitate conditions such as disclosures and access) were necessary.

**Morgan’s unsuccessful incident**

This incident involved an academic inventor in bitter conflict with the CEO of a startup. The academic inventor approximately six years earlier had filed a disclosure, and the TTO pursued a patent, which was awarded and later used as the technological basis for a startup.

The TTO formed and nurtured the startup, said Morgan. The TTO identified candidates for the startup team, including CEO candidates. The academic inventor and the TTO agreed on the CEO; he was the academic inventor’s first choice. The TTO team also felt he was the leading candidate. The CEO raised an initial round of capital, and operations commenced.
The academic inventor remained at the university, continuing his research and teaching courses. He occasionally advised the startup on technical issues, and he remained a shareholder.

After approximately two years had passed since the startup began operations, the CEO and others at the startup claimed that the academic inventor was competing with them. Morgan said the CEO excluded the academic inventor from further interaction with the startup.

Morgan’s comments on the unsuccessful incident

Morgan said that she felt the CEO was incorrect in his accusations against the academic inventor. “I know the academic so well,” she said, and she believed this was a big misunderstanding. “I think it was very shortsighted at the CEO, and it flies in the face of good practice because you draw on the academic founder for future productive ideas,” Morgan said.

Morgan noted that this situation had an adverse effect on other academics. They heard about the incident and became cautious in working with the TTO because they felt the TTO should have taken action to protect or defend the academic inventor.

“My particular take on this is I think we need to be able to monitor those [situations] and get in much more quickly if it’s heading in that direction. I think it’s more important to keep the academic incentivized and involved in the spinout.”

Morgan explained that she and other managers in the office assisted academics both in obtaining research funds and in commercializing their research. The duality of this role is unusual, as
most universities have a completely separate administrative organization performing each operation.

Morgan explained that a few years earlier, "we restructured the two departments and brought together the dedicated tech transfer function and the research function into one. And we took the tech transfer officer role and the [research] contract officer role and put them together in one person, who we call the collaboration manager. So the collaboration managers have that hybrid, very expensive, very broad-scope role. And what we did was to set up a structure that meant every collaboration manager was the first point of contact for a group of academics through our school structure. So each collaboration manager has one or more schools that they are responsible for. So the academic knows which manager to come to. What we have found is that, where it was seen with skepticism by the academic at the outset, it's now highly valued because they know exactly who to talk to. They've built a relationship with that person, and they built an enormous amount of trust. And what we were finding previously was that the tech transfer staff were not seeing the opportunity because they had no other reason than scouting for ideas and opportunities to talk to the academic, so it was more difficult to build the relationship with the academic. Whereas the collaboration managers have responsibility for industry negotiations, sponsored research, and contract negotiation, the academics have more reason to come and talk to us. And that meant that we get earlier finds of some of the possible spinout opportunities. And we have built a very strong trust base with the academic community."

Morgan said that, despite the many advantages of the restructure, the main disadvantage is less time for managers to spend on technology transfer. "When tech transfer officers did find out [about academic's
inventions], they had the time and the energy to exploit it, push it through, nurture it, manage it.”

“We have collaboration managers who have a much better relationship with the academic to know what is going on,” Morgan said, but “quite frankly we have very little time to cull and nurture spinout opportunities. So there is this ongoing tension between building the relationship, working with the academic on a broad portfolio, and then nurturing the ideas as they come through, and having the time to do that.”

**Researcher’s comments on Morgan’s unsuccessful incident**

Morgan seemed to understand the importance of disclosure, access, and rewards. She also seemed to understand the importance of trust. She appeared at times to assume the role of advocate instead of the role of intermediary, and the dual responsibilities of a collaboration manager could explain an inclination toward advocacy.

**Georgia Institute of Technology**

The Georgia Institute of Technology, located in Atlanta, Georgia, US, opened in 1865. The student population at the university is approximately 21,000, comprising approximately 14,000 undergraduate students and approximately 7,000 graduate students. At this time of this study, the TTO comprised the Office of Technology Licensing and Venture Lab.
Introductions

The TTO employed approximately 30 people at the time of this study. Seven participated in interviews: Nicol, Owen, Payne, Quinn, Riley, Sloan, and Taylor. The table below presents the main themes of the interviews.

### Georgia Institute of Technology participants and interview themes

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14. Nicol

Nicol's successful incident

The invention came from a medical devices company that wanted to augment its research and development capabilities. Nicol's team identified several faculty researchers whose scientific and engineering expertise could help the company develop the intellectual property.
Company executives met the university researchers, and a few months later the company began to sponsor research at the university.

“We have a reputation for interdisciplinary engineering,” Nicol said. “So they came to us and they said, well, we would like to talk. And we were able to have a high-level discussion, and they showed a slide presentation, an overview of where they were going. They spent hours talking about a short-term, mid-term, long-term timeframe.”

“We arranged three research contracts. One was with an eminent faculty member who does basic research, and he’d never wanted to work with any company, but he added a lot of value, and the company was surprised because they had never thought about his approach,” Nicol said.

The next year company executives decided that they should open a corporate research and development center next to the university. Nicol introduced executives to government officials who provided state grants as an incentive. During the next year, the company’s research grants to the university increased, as did the corporate research and development operation. The company announced that its corporate headquarters would move to a facility next to the university.

“We did the brokering, the connecting,” said Nicol.

Nicol’s comments on the successful incident

Nicol explained that he had two categories for companies that approach a university. The first category comprised “buyers.” He said, “They know how to ask questions.” They know exactly what they want, and they work efficiently with a university. They know what the
university expects. They also know what universities can and cannot offer. “But the problem,” Nicol said, “is that they are only looking for something specific. Either you happen to have exactly what they want, or not.”

Nicol called the second category “explorers.” Nicol said that the first step with explorers is to get them on campus for an initial visit. “If you are not from the area, you don’t realize that there is $450 million of research on this campus, and by having a chief executive walk through this campus, it just changes their paradigm. Particularly if they are an international company, they have no clue who we are,” Nicol said. “Step two, let’s do what I call an alignment exercise, a technology roadmap of the company. So if company needs robotics and we are putting a lot of work in robotics, we match up, so I don’t have to worry. We do technology alignment to make sure we have a good fit.” Nicol said the explorers are “looking for a long-term holistic relationship.”

Nicol reflected on the research scientist who for the first time engaged in industry-sponsored research. He said that the university receives approximately $50 million annually in industry-sponsored research, “so I obviously have a bias towards industry involvement; but in much of the university, that [bias is] not always shared by others.”

Researcher’s comments on Nicol’s successful incident

Nicol discussed actions such as brokering, connecting, and networking. He also emphasized the importance of alignment, which focused on the fit of objectives, strategies, and resources between a company and a university.
Nicol’s unsuccessful incident

A global company, headquartered in Europe, came to the university looking for assistance with a technology from the company’s research and development laboratory. The primary application for the technology was the automotive industry; however, the technology had secondary and tertiary applications.

Nicol said the company had three objectives, or three major problems for the university to solve. First, the company wanted assistance from university scientists to complete the development work on the invention; the company was eager to get a product into the market. Second, the company had questions about how to manufacture the eventual product; the technology posed production challenges that the company was encountering for the first time. Third, the technology and the eventual product would have implications in public policy, so the company wanted advice on how to frame the public policy implications.

The company’s plans included spinning out this technology into a startup. The company planned to provide capital, perhaps 20 percent of the total capital requirement, and to place orders with the startup. The company believed that its competitors would want to buy products based on the new technology, and perhaps license the technology, so forming an independent startup, rather than a captive subsidiary, could accelerate technology in the industry and product penetration in the market. “[Company executives] really wanted us to be very closely aligned with this startup operation,” said Nicol.

Nicol said that senior company executives, including the head of research and development (who reported directly to the chief scientist at the European parent company’s headquarters), approached the
university; all of them were from the US subsidiary, which was much larger than the other national subsidiaries of this global company. “[The executives] came to us and then we connected and brought together some faculty from mechanical engineering and then material science also in public policy. Right now, there are no regulations [for this technology or eventual product]; you couldn’t drive this product on the road legally. So there are some policy decisions. So, what they want us to do is help make sure that the science was right, help with the engineering, and help with deployment of this. So, if you think about from the resources from a university perspective, they are multiple: business school, public policy school, engineering school, manufacturing and research center, etc. It was a fairly comprehensive undertaking.” Nicol said that the university and the company agreed on a budget proposal of approximately $2.5 million.

During Nicol’s initial meeting with company executives, they set the date for a subsequent meeting, two weeks hence, for the university lawyers and the company lawyers to meet and agree on terms and conditions for the project proposal to proceed. Nicol said that he learned years ago to make sure that the parties’ lawyers entered an agreement as early in the process as possible; otherwise, the risk of delaying or terminating the project increased dramatically, and he and his team would have wasted time. The company and university lawyers met and agreed to terms and conditions, so, Nicol said, “We got the lawyers out of the way.” The project had cleared the first big hurdle, he said.

The discussions between Nicol and company executives proceeded. “We were taking the lead from the company on what was happening on their end. We visited them [at US headquarters]. They came here. We in turn visited their [research and development] facility and made sure that we were serious. There were a lot of follow-up meetings. And it seemed to me that what they were looking for was
funding within the company, corporate R&D, which had a limited budget and would want the divisions to pick it up. So we continued to feed them ideas. Actually one of the faculty members became a consultant to them because of his background, and he was the right guy from a technical perspective.” Nicol said that the meetings were pleasant and productive. They continued during a period of approximately 18 months, during which time relationships strengthened between key people at the company and at the university.

Nicol said that the State of Georgia, where the university is located, has generous incentives for starting a manufacturing facility in the state. “We made sure [company executives] understood those incentives, and we introduced them to the state people.” Nicol said that he hoped the state’s incentives could help fill gaps in the company’s budget for this project.

**Nicol’s comments on the unsuccessful incident**

Nicol said, “So the market was there, we could get the product there, what happened? It just went too slow. The US company could not get the parent company to move forward.”

Nicol noted that there were no barriers and no resource limitations within the university. He said, “I’ve thought about this a lot because I keep trying to find something we could have done to get a better outcome. I haven’t come up with anything yet. That’s not to say we did everything perfectly. But I think the university did everything it could in this case.”

Nicol observed, “Companies are struggling with how much of research do they keep inside, and [are] either reconstituting or evaluating
their corporate R&D function. We hear this numerous times. ‘Well, I am in corporate R&D and if you really want to get the dollars you got to get to the division level R&D.’ So we do deal with the corporate-level people, and they are worrying just about basic research. But the real money, the following funding stream, is at the division. So we need to come together with a corporate person and a division person. So our first questions is, ‘Tell me about how you approach R&D in your firm.’ Big companies and small companies are reorganizing R&D, and they’re wrestling with how to do it.”

Among other lessons learned, from this and other experiences, Nicol said that it is always important to start at the top. In this situation, Nicol said, he never talked to the executives in Europe who would make the decision.

Another lesson, Nicol said, is to get legal issues resolved as soon as possible. “It’s the process that I encourage all our staff to do first, and if it’s big deal. We insist that we start off with the legal discussions. We have too many examples on this campus where the legal discussions became the last thing [to do], because all the negotiations have been done in the absence of legal counsel. If we’ve committed to things we can’t legally do, then we have to explain it. So our process upfront is get legal people involved at the beginning discussions. We had a meeting recently with a big international company, and they were here for two days. We spent an hour and a half with the legal contracting team, and that was on first day. And [the company executives] are European, and they got to ask these questions and, you know, they got answers directly, and they appreciated it. It worked out well. The other thing is this: universities are not prime jobs for legal people, so you have legal people who don’t understand what they are doing. They know the law, but they will have
no idea how to interpret the law, and so they really cause a lot of problems.”

Another lesson is to focus on sound project management, Nicol said. Effective project management not only resolves problems but can also create opportunities. For example, if a faculty member forgets about a meeting with a company executive who has traveled to the university, a problem can ensue. Good project management skills can help make sure that the faculty member shows up at a meeting on time, and that meeting can lead to opportunities for the faculty member and the university.

Nicol said that they try to find creative solutions before problems arise by brainstorming to find opportunities and limit risk. He said, “We try to come up with as many creative solutions as we can. I feel like that’s our job. When a new project comes in, we will get the team together and say, we have got this company, this is who is going to come visit, this is what we know. What do you think? That’s when we start looking for creative ideas and solutions. Without fail, somebody will say, have you thought about taking them here, or I just heard this, or I just met this person. We bring that networking in.”

Networking, especially meetings, are especially important at the university, Nicol said, “Georgia Tech is an entrepreneurial place. I like the university, one of the most entrepreneurial places on the planet. The problem is there are no systems for knowledge management. It does not exist. Well, it exists because of relationships. There is no way to share knowledge electronically, so that relationship is extremely important, extremely important. So we rely on meetings. We don’t have [knowledge management] well organized.”
**Researcher's comments on Nicol's unsuccessful incident**

Nicol observed that sometimes failures occurred for reasons beyond his control, though he still tried to derive learning from that incident. The external environment clearly matters; his observations on the corporate policy decisions on the goals, strategy, and operation of research and development and his emphasis on initial resolution of legal matters, which are determined by university and government policy, showed how he had adapted to the environment. He also highlighted key actions in his process: managing projects, collaborating creatively, and sharing knowledge.

**15. Owen**

**Owen's successful incident**

The intellectual property involved a semiconductor device invented by an academic at the university.

“So as soon as we saw the invention disclosure, we realized there was significant potential for the technology,” said Owen. “So we started looking for markets. Our straightforward, simple assumption was that the primary market for this technology was going to be the military, and so we started looking at military markets. We started looking at heads-up displays for helicopters and night vision; we started looking at guided munitions; we started looking at unmanned aerial vehicles; we started looking at a number of applications and realized that, although all of those will eventually be applications of this technology, there really was not a great fit there because the killer advantages of this technology were the small size and the potential low cost. In some military applications, small
size is a big deal, and in some of them it is not. And low cost really isn’t important to the military; they’ll pay whatever it costs.”

“So we really started focusing in on consumer electronics. We started figuring out the market potential for the technology, and somewhat to our surprise – and certainly to the inventor’s surprise – we identified consumer electronics as the market where the key advantages of small size and low cost would really be a differentiator. [This invention] makes applications possible that wouldn’t have been possible otherwise.”

“At the same time we started looking for markets and applications, we started looking for a person who was an experienced entrepreneur to lead a startup. [The inventor] has a partner, who was a professor at a university in the Midwest. That professor had worked on the technology and had done startups, so we considered simply having the professor take it forward and build a business out of it. [The inventor] wanted the company here in Atlanta because he knew he had to continue improving the technology, which was at such an early stage. The professor in the Midwest wasn’t going to move to Atlanta, so we needed to find someone,” said Owen.

“So we have entrepreneurs in residence here. We bring them into Georgia Tech. We ask them to spend a day or so a week here. They come to our staff meetings, they meet with our professors, and they usually pick a small number of projects they’re interested in – three to six – and they start spending time with the professors and the projects. So one of the entrepreneurs, who had experience in the semiconductor industry, started spending time with [the inventor] and the project manager from our staff here. [The entrepreneur] started a business plan,” said Owen,
“and the plan looked good, so we had the legal work done to form a company.”

“Based on the business plan,” Owen said, “we made a $50,000 grant to the company. Later on we were able to make a $100,000 grant to the company, and finally we put in a $250,000 loan. The second grant and the loan had to be matched, dollar for dollar, by outside funding, so we got funding from the [US] Department of Defense. And the military money helped develop it a little further,” Owen said.

“What was interesting was that [the entrepreneur] started identifying some technology challenges. [The inventor] had originally designed the product with a hermetically sealed package because it had to operate and vacuum. That’s expensive, that’s troublesome. There are only a certain number of facilities that can do that [manufacturing]. It really limited the volume production potential and the volume pricing potential of the product. So with [the entrepreneur’s] strong encouragement, and ours, [the inventor] went back and redesigned, you know, the next-generation product that did not require vacuum packaging. And they got some prototypes back, and they were doing very, very well. So I think there was some value add. You know, we weren’t telling the professor what to do because you can’t tell professors what to do. We were pointing out that if there was an adjustment to the design, the commercial potential would be greatly increased. So [the inventor] went off and did that, and that worked great,” said Owen.

The continuing challenge was raising additional capital, said Owen. “It’s a semiconductor deal, and we needed millions. At some point you had to go through a step function [and raise $5 million at once]. That was tough, and that took a lot longer than I expected, about a year. [The entrepreneur] got a term sheet right away, but it was a bad deal. The
venture capital market was going through a downward spiral because of the financial markets. But [the entrepreneur] made a lot of pitches. After a year he closed on a $5 million series A with a Boston firm. Really there’s not a firm in Atlanta that could have put $5 million into that deal. The only places to get money for a semiconductor deal are Silicon Valley and Boston. If [the entrepreneur] hadn’t raised the series A, the only thing we could have tried to do was license this, probably on very unattractive terms because it’s so early stage, you know, to AMD or a company like that.”

“The company’s doing great now. They’re hiring, and they’re getting design wins. They’re expanding, and they’re getting initial volume production going. They’re going to have to do a series B within the year.”

Owen's comments on the successful incident

“This [project] took a lot of perseverance,” Owen observed, “A lot of it was persistence.”

Researcher’s comments on Owen’s successful incident

Whether this was a successful or an unsuccessful incident was unclear until the conclusion; this showed how unpredictable outcomes often are. Disclosure of intellectual property was evident, as were access and reward among the inventor, the technology transfer officer, the entrepreneur, and venture capitalists. Actions clearly played an important role, including sharing and brokering information and adapting to that information. Resources, both human and capital, also played a key role.
Owen's unsuccessful incident

This invention involved technology for mobile communication devices. The inventor was a professor at the university.

He made a series of disclosures, but the university had yet to file a patent application. One of the problems, Owen said, was that the professor was frequently giving demonstrations of the technology in classrooms and at conferences. Under US patent law, such demonstrations count as public disclosure, which could nullify a patent award. The university had filed a basic patent application covering several early disclosures, but the inventor made improvements that he was demonstrating, and they had no intellectual property protection. Owen said that, even though he and others explained to the inventor that he could end up forfeiting his rights to patent protection, the inventor often ignored them. “It was always a battle,” said Owen. “From day one we had IP troubles.”

A project manager began working on a market analysis, especially in identifying potential customers. “The answer to the question of who is the customer is different in almost every country,” said Owen, “and what we concluded was there the number of purchases was relatively small, and the cycle times for closing a sale would be long.”

“So what do you do about that?” asked Owen. “Well, you go try to win a couple of them,” he said, answering his own question. A company was formed, and a $50,000 grant was awarded to the company.

“And then it came to management. Clearly the professor was not qualified to be a manager. Most professors are not qualified to be managers,” said Owen. Another entrepreneur-in-residence was
interested in the project and had experience in the industry. “In fact, [the entrepreneur] had done two startups in the mobile communications industry, and both were backed by major venture capital firms, and both were really successful,” said Owen. He introduced the entrepreneur to the inventor. Though the inventor seemed to like the entrepreneur at first, troubles started soon. The inventor made an appointment to show his invention to Apple. Owen and the entrepreneur were concerned, but the inventor was unconcerned. Owen said, “I told [the inventor], well, they’ll have the meeting, and they’ll say thank you, and then you’ll see [the invention] on the I-Phone a year from now. There’s not going to be a deal here because you haven’t protected what you’ve got.” The entrepreneur attempted to get an intellectual property agreement for the inventor, but the inventor rebuffed the effort. Commenting on the inventor, Owen said, He just never really understood that there are reasons that people do things the way they do them, and that other people had experience that he didn’t have. He is one of the professors who thought he knew everything.”

Despite the issues with the inventor, Owen said, the entrepreneur “was really enthusiastic about the technology.” The entrepreneur made several pitches and raised an angel round of financing. This was significant, Owen said, because the angel round was big, and the terms were favorable to the startup.

Owen said that, from his perspective, everything was in place: a CEO, a patent application, and a first round of capital. This had turned out a success, he thought.

“And the professor changed his mind,” Owen said. “[The professor, who was the inventor,] said that he wanted a CEO who was on the West Coast and in the music business and that having a CEO who was Atlanta-
based and not out of the music business he didn’t think was the right answer for his company."

Owen said, "[The entrepreneur] quit. The grants we had lined up, I pulled. I had another $100,000 in grant money that I took back. The investors that [the entrepreneur] had lined up basically said, 'Hey, we were investing in [the entrepreneur],' so they left."

**Owen’s comments on the unsuccessful incident**

Owen said that the incident emphasized that "it’s not our company. We can advise, we can encourage, we can hint, we can nudge, but we can’t coerce...because it’s not our deal. In this case, that killed this deal. This shows the limitations of a [TTO] process. When everything works, everything works great. When something critical fails – usually around a professor – then nothing works."

"If I were doing this one differently," Owen said, "I think I would have incorporated the company quicker, and put in management and a board of directions with a license for technology quicker, so that we could have gotten past the situation more quickly. I would have liked this one to move a little faster. It probably took a year to get the deal put together. There may not have been anything that we could have done, but I think if we had gone faster, our chances would have been better."

One of the advantages to speed, Owen said, is “you just get to take more shots on goal. As you know, we’ve got a certain amount of resources, so I encourage my people to make decisions with 80 percent of the data. Don’t wait and try to dive deeper to get 100 percent of the
information, because you never can; you can chase that forever. If you get 80 percent of the information, take a shot.”

The basics for a successful launch, Owen said, are well known: technology, intellectual property protection (such as a patent on the technology), a CEO, and capital. “That’s what we try to focus on,” said Owen. “In this case, a professor just ruined the process.”

Owen said he’s learned the importance of basic management: hiring the right people for his team, working as a team, making sure that projects are managed effectively, sharing knowledge and experiences with his team and faculty, and rewarding excellent performance.

Owen noted that making faculty aware of how the TTO can help them is important, and so is educating them about the process of innovation. “I tell them that invention is turning money into ideas, and innovation is turning ideas into money,” said Owen. “Once we explain the process to [faculty], most of them start to understand what we can do for them.”

The objective, Owen said, is not simply to make his team more effective or the faculty more aware; the objective is to build an ecosystem for university innovation. “If I were at Stanford, or if I were at MIT, I wouldn’t have to do all of this because they’re in ecosystems where that happens. People there know how to do start ups. People know how to get boards of advisors; people know how to raise money. And if you don’t, the professor in the next office does, or his girlfriend does. Here that doesn’t exist.... I think what we’re doing here is way more relevant to most places in the country than what is happening in Silicon Valley and Boston. I mean, they’re really the outliers.”
Thinking about the TTO’s process of innovation, Owen said, “I’m reminded of a story about the Sony acquisition of Columbia Pictures, and Peter Guber was running Columbia. He was explaining that in any given year Columbia would make 12 movies. Three would be absolute blockbusters, three would make a little money, three would lose a little money, and three would be a disaster; that’s just the way the movie business works. And one of the Sony executives looks at him and asks, ‘Why do you choose to make movies that fail?’ Well, that’s the business we’re in.”

“You know, you can’t have Christianity without hell, you can’t have capitalism without bankruptcy, and you can’t have commercialization without some failures,” Owen said.

**Researcher’s comments on Owen’s unsuccessful incident**

Owen expressed frustration with this unsuccessful incident, and his disappointment led him to analyze the incident and identify what he could have done differently; yet he also acknowledged that perhaps this would have reached the same unsuccessful conclusion no matter what he did. His analysis of the situation revealed a desire to learn from an unsuccessful incident, identify errors within his control, and improve the process to avoid such errors in the future.

Owen identified four basics – technology, intellectual property protection (such as a patent on the technology), a CEO, and capital – which are resources: technologies and patents are intangible assets or knowledge resources, a CEO is a human resource, and capital is a financial resource.
The basic management actions, such as sharing knowledge and working in collaboration, were consistent with actions of an innovation process, and so was educating faculty on the TTO’s process.

Creating an ecosystem was essentially Owen’s reference to developing a more robust innovation process within the university. His mention of the ecosystems at Stanford University and the Massachusetts Institute of Technology identified two examples of such ecosystems; to Owen, those are the only two in the US.

Owen concluded his comments by returning to the first observation of this incident: unsuccessful incidents would occur in the innovation process.

16. Payne

Payne’s successful incident

The intellectual property involved technology for more accurate weather forecasts.

Payne said that he met two professors in the earth and atmospheric sciences department several years earlier. The professors’ research focused on historical weather patterns. Payne and the professors thought it was highly unlikely that the research would lead to a disclosure, let alone a patent or a commercial enterprise.

Payne stayed in touch with the professors. A few years after the first meeting, Payne noticed an article by the professors in a top scientific journal. The article, based on the professors’ research, presented data
that hurricane intensity had been increasing. Newspapers and magazines throughout the world featured the article's conclusions, Payne said, because news media were covering current hurricanes and their effects on human life.

The American Meteorological Society invited the professors to speak at a major conference a few months after the journal article appeared. The conference happened to take place in Atlanta, so Payne attended. While the professors were giving their talk, Payne decided to attend a panel discussion on weather forecasting. “One of the panel members was a meteorologist with a major energy trading company. His comments were interesting, so after the panel discussion was over, I went up to him and said hi, and we started talking. It turns out that he's a former student of [the professors].” Payne said he told the meteorologist about the professors’ current research, which was different from the research recently published in the journal article. At the end of the day, Payne brought the meteorologist and the professors together for an informal conversation, from which Payne saw a business opportunity.

After the conference, Payne met with the professors and said that their research could evolve into a business that would provide hurricane-forecasting services. He explained that they should file a disclosure of the intellectual property, but a patent filing was inappropriate. Their invention was know-how. They could license the technology from the university for commercial purposes. The business would require no capital. Most important, the business would need at least one customer, and the cash flow from revenue would sustain the business. The business may never have employees other than the two professors, but it was a startup. Payne said that he and others at the TTO could assist them throughout the process, if the two professors were interested in pursuing this opportunity. They said they were.
“One of the professors was reluctant at first in starting this company because of a bad experience with [the professor’s prior startup] and private investors. So one of the issues was a control issue. There was a venture fund involved [in the professor’s prior startup] so control issues were a big concern,” said Payne. He explained that this startup would have no external investors, and both professors agreed to move forward with the project.

Payne began working with them with a product and a service offering relevant to the market. The first customer was the meteorologist at the major energy trading company (the former student and panel member at the conference).

“Here’s a company that has been started out of the expertise of Georgia Tech faculty and aligned with a market need. [Energy traders] have a tremendous need for any kind of incremental information. This is now the second hurricane season that this energy trading company has used the services of these faculty, and today they’re very successful in what they’re doing. They provide a window that’s 24 to 72 hours ahead of traditional sources, and that window of information is being monetized by the trading company, so there’s a confidence level that has been built. I think there will be some other benefits to the school because of the rapport that is being established with this major energy company. I mean, of course, this is a humongous company.”

Payne’s comments on the successful incident

‘I’ve always been accused of having a non-linear brain, which kind of speaks to, you know, putting random bits of information together, kind
of storing and remembering and connecting information and then having those little epiphanies where it’s like, okay, here’s an insight,” Payne said.

Alignment is important, Payne commented. Aligning technologies and markets is essential, and so is aligning how professors think and behave with a startup that they would find enjoyable and customers would find beneficial. “I need a psychological profile of the faculty member,” said Payne, laughing. “I’m just trying to understand the mindset of the faculty with whom I’m working. I recognize that faculty, you know, have their own agenda with respect to research and publications and supporting their labs and their programs and their students. And then starting a company is not necessarily a primary objective for some. For others it can be, but you just have to understand what they really want.”

“Building trust with the professors took a lot of time,” Payne said, “but there’s no other way to make sure the alignment is there.” The relationship of trust was especially critical in coaching the professors on how to make a presentation to businesspeople, how to respond to their questions, how to understand what matters to business people, and how to follow up after a meeting.

“Building credibility with the trading company took a while,” said Payne. Although the professors had excellent academic credentials, or perhaps because of the academic background, Payne said, the traders were skeptical. “There was a step of faith by the trading company to engage the faculty, and what emerged in my mind was the fact that the meteorologist [the former student] served as the advocate into the trading company. So finding an advocate in the organization, that’s the relationship that made a difference. I could have very candid
conversations with him about decision processes, thought processes, messaging, and presentations,” Payne said.

Payne said he’s enjoyed watching the two professors learn about business and begin to teach other faculty in their department about business fundamentals.

The professors were never motivated by personal compensation, Payne said. They viewed the reward of the startup as applying know-how, learning more about how non-scientists use scientific research, finding research opportunities for their students, teaching their students more effectively, and perhaps offering part-time employment opportunities to their students.

**Researcher’s comments on Payne’s successful incident**

In this incident, the disclosure was informal; it was a disclosure, nonetheless. Payne clearly provided access, and the professors and Payne clearly understood the reward for each of them. The actions of inquiring, collaborating, exchanging information, coaching, and combining knowledge are evident.

**Payne’s unsuccessful incident**

The intellectual property involved layers of materials for integrated circuitry and packaging of circuitry. A university professor had filed a disclosure seven years earlier. The disclosure led to a patent application. The TTO identified the technology as appropriate for a startup and formed a company. An entrepreneur became interested in
the technology; he had known the professor for years, and the professor and the TTO encouraged the entrepreneur to become the chief executive and begin raising capital, Payne said. The entrepreneur raised an initial round of capital and, in collaboration with the professor, hired staff. The professor chose to remain at the university as full-time faculty. The startup commenced operations and met with early success, but the startup was still in an early and fragile state.

“This was a success,” Payne said, “until a major disagreement broke out.” The issue was that the professor had improved the technology and convinced a technology transfer officer to keep from licensing the technology to the startup. The entrepreneur took the position that the startup’s license with the university gave the startup the rights to those improvements. The professor disagreed with the entrepreneur’s position.

Payne explained that the entrepreneur’s position was obvious, and his argument for the technology was strong. The technology transfer officer who sided with the professor felt the relevant language in the license agreement between the university and the startup was ambiguous; she reasoned that university should side with the professor in cases of ambiguity. Moreover, if a faculty member opposes the university granting a license to a specific company, then the TTO refuses to license to that company. Payne said that the professor’s motives were clear; he had a university laboratory to fund and operate, and the technology improvements were to him an opportunity to obtain significant industry and government grants.

The relationship between the entrepreneur and the professor deteriorated rapidly, Payne said. “I was engaged in shuttle diplomacy. Was there any middle ground? Would all the parties agree to it? I was
still trying to get all the facts. So I collaborated with [that technology transfer officer] and explained how big a problem this was becoming.”

Payne said that, during the process of launching the startup, the professor for the first time began engaging with people outside academia. In soliciting customers for the startup’s products, he talked extensively with industry executives and began to see more applications for the technology. He started focusing on improving and adapting the technology for various applications in several industries and on getting industry grants for the research.

Payne said that no resolution was in sight. He feared that the situation would degenerate further, even to the extreme of the startup pursuing litigation against the university and the professor. This incident would have a “huge negative impact” on other inventors at the university and on entrepreneurs and venture capitalists who may hesitate to engage with the TTO in the future.

**Payne’s comments on the unsuccessful incident**

“There was just a breakdown in trust” between the professor and the entrepreneur, said Payne, “and now all there is, you know, is mistrust. How do you change that? I was being brought in after the fact, in the middle of a transaction that is very difficult, particularly with all the tension already.”

Payne said the incident showed that it is important to understand not only the capabilities but also the perspective of a professor. “You have to build rapport with faculty and understand their motives and make sure there is always an alignment. The faculty member is the
person who is instrumental in the early stages, and it’s always important to understand the motives.

**Researcher’s comments on Payne’s unsuccessful incident**

This incident was successful until the academic inventor decided to work against the interests of the startup and to work for the economic interests of his university laboratory. The university’s innovation process had worked and was working until the professor decided to withhold such actions as collaborating, sharing knowledge, and offering new combinations of knowledge.

**17. Quinn**

**Quinn’s successful incident**

The invention involved intellectual property for simulations in neurobiology; specifically, the inventions were computer hardware and software. The inventors were three doctoral students. They had made disclosures to the TTO three years earlier, and the TTO had filed patent applications.

Quinn described the invention as “a supercomputer on your desktop.” He said, “[The inventors’] application was neurobiology. That’s all they really knew. And so they were just really determined to make math fast for scientists. That was their mantra: fast math for scientists. I wasn’t really initially interested in this. I’m really into math and simulations and computers in general, so obviously I was intrigued by it.
But I was also a bit put off by it because maybe the market is 10 of these things, or 20, a year. That’s it.”

“But the technology’s cool, so I started thinking about other applications, other markets, where there was real volume. So I was casting about...thinking about different places that need math fast,” Quinn said. He began to think about aerospace markets and military applications. “I also looked at applications of big math and differential equations. I kept coming back to markets with price sensitivity. I was brainstorming, just making lists,” he said. “I was also asking myself, who’s got a lot of money [to spend on the invention].”

The inventors won a grant of $1.3 million from the US National Institutes of Health to conduct further research on the hardware and software inventions. Quinn said that the grant encouraged the inventors to believe that the neurobiology market was the first and best market for the technology.

Quinn was still thinking about other markets. He had a telephone conversation with his brother, and the conversation led to an idea. Quinn’s brother, trained as a chemical engineer, now managed a quantitative hedge fund in New York. Before joining the TTO, Quinn had worked on modeling genetic algorithms, chaos, and emergent systems, so he felt comfortable talking with his brother about financial modeling, which employs many of the same equations and concepts. During the conversation, Quinn said, “We were talking about modeling a hedging position. I was thinking about Navier-Stokes equations...and then Black-Scholes...and it dawned on me, you know, another place where you really need math fast and you need to do simulations is the financial world, and especially if you think about option pricing. Differential equations play a big role in the modeling that you do for futures market, and differential
equations and prediction and simulation play a big role in more sophisticated hedge fund situations.”

To collect background information, Quinn began a series of conversations with information technology people in the hedge fund and investment banking industries. He said he broadened and deepened his understanding of what they want and why.

Quinn then approached the inventors about using the technology for a supercomputer or supersimulator application for the financial industry. Quinn said he was prepared for them to dislike the idea, but to his surprise they accepted the logic of his argument and decided to focus on the financial industry opportunity as soon as they completed work on the grant from the National Institutes of Health.

Quinn said he continued to find an eager reception in the financial industry for the advantages that the technology provides. He was gradually introducing the inventors to hedge fund managers, traders, and investment bankers who have expressed interest. “It takes time to build relationships, so it’s never too early to start,” said Quinn.

**Quinn’s comments on the successful incident**

Quinn said that the challenge he has had is researchers strive to become domain experts and their focus increasingly narrows. Consequently, they often have little sense of applications, markets, and industries that could benefit from their discoveries. Quinn viewed his role as making connections for them, specifically connecting them with business ideas and business people. “I’m able to make those connections, and I want to actively stimulate that ability in others,” said Quinn.
Researcher’s comments on Quinn’s successful incident

Quinn’s comment showed how he worked to introduce actions in an innovation process – e.g., connecting, combining, and collaborating – with research scientists at the university.

Quinn’s unsuccessful incident

The intellectual property involved wireless data routing and file sharing. The inventor was a professor at the university. The disclosure had been made six years earlier, and the TTO had filed a patent application.

Quinn said that the professor developed a wireless router for residential use. The main advantages of the invention were simple configuration and excellent security. The solution was clever, Quinn said, and he and others at the TTO saw that this could “shift the paradigm for home routers.”

The TTO formed a project team that included a TTO project manager, the professor, and two of his graduate students. “They were all focused on the project, and making real progress, and then the professor got distracted.” Quinn said that suddenly the professor decided that the file sharing should be the most important feature, not security, and not simplicity. The professor and the students “started to go in the exact opposite direction” with product development.

The project stalled, said Quinn. The professor determined that he had to develop a new technology to add features to the eventual product. He returned full time to his laboratory. Quinn said that he continued to
see the professor, and the conversations were always pleasant and informative, but the project came to a halt.

**Quinn’s comments on the unsuccessful incident**

Quinn said, “We’re always on guard for this,” as some professors did lose interest in starting a business. In this incident, Quinn observed that multiple factors either did or could have influenced the professor’s decision: (1) the professor was “seduced by the rapid growth of file sharing solutions in the market,” (2) the professor thought he had a solution to many file sharing problems, (3) the professor chose to allow “feature creep,” an expansion of product features, (4) the professor lost confidence or interest in the disruptive idea, which was “truly radical,” (5) the professor felt more comfortable conducting research rather than developing products, and (6) the professor found product development “dull” and greatly preferred experimentation and invention.

Quinn made another observation, comparing the two incidents he discussed. In the unsuccessful incident, the inventors changed market focus when they should have focused on the initial market. In the successful incident, the inventors changed market focus when they should have.

**Researcher’s comments on Quinn’s unsuccessful incident**

The TTO’s innovation process was progressing until the technology leader of the team decided to stop the progress and return to his university laboratory. He withdrew from the actions of the process.
(e.g., collaboration with the TTO project manager) and effectively terminated the project.

18. Riley

Riley’s successful incident

Riley discussed a program that he created and instituted to make introductions between startups and investors.

Riley explained the background for the program. “We were presented an opportunity to participate in a venture forum that was being held here in Atlanta, and it was through an organization, the Atlanta CEO Council. They had a venture forum that was called the Ion Venture Forum, and it was a one-day event where [venture capitalists] come in and hear pitches [from startups],” said Riley.

“I received from my boss this edict that...or this opportunity to develop a program that would allow people who are attending Ion to come down and experience Georgia Tech and get a sense of the [early-stage] companies that we have here. So we called this the Georgia Tech Innovation Experience, and we had an opportunity to bring [more than] 20 investors down in a captive way to our office here and to the incubator, and we wanted to just give them exposure to the deals and the companies and the experience and the energy here. And so we started to brainstorm about just how investors interact with companies, and we used a framework of this Ion event, these venture fairs, as a backdrop to think about what do we want our event to look like,” said Riley.
“We had some opinions about just how functional some of those events were, and we noticed that in just our past experience that there was not typically a high-level engagement between the entrepreneurs and the investors. And it was interesting because, from our experience when we talked to investors and also to entrepreneurs, entrepreneurs really sometimes questioned those events because they, you know, could never point to a particular deal to happen or new investment relationship that happened because of attending those events. Oftentimes the investors really didn’t engage with the entrepreneurs, and the entrepreneurs didn’t engage with the investors. We see situations where companies would have an opportunity to present, say, and they show up 15 to 20 minutes before their presentation, they present, get a couple of questions, and then they’re gone, so then this whole informal networking with investors really didn’t happen. We observed that even when there was informal networking at cocktail hour...you have all the investors that huddle up in a little circle, and all the entrepreneurs that huddle up in a little circle. So we said we don’t want our event to be like that and we want interactions between the investors and the entrepreneurs. The other thing that we wanted to do is just increase the awareness of [the venture capital] business model,” Riley said.

“So someone [suggested] a wild idea,” Riley said, “and that was what we really need to do is speed dating. Initially there was a lot of concern about if that would even go over well with a conservative group like venture investors. But ultimately, you know, we looked at speed dating in a context of these venture forums, and kept in mind what our high-level objectives were, you know, showcasing this environment, showing these investors that Atlanta could be a source for deals...finding and starting up and growing technology companies, increasing awareness between investors and entrepreneurs. So we just started putting together
the program in a format and keeping in mind all of those particular objectives,” said Riley.

Riley said the event was a big success. “There was a tremendous amount of energy. We received great feedback from all of the participants. I think it was good learning for the participants, and we actually received some comments on ways to improve it, and we implemented those [recommendations] in the second year we did the program,” said Riley.

**Riley’s comments on the successful incident**

Riley explained why he believed the event was successful. “So the key metric was…to what extent a match had been made in these sessions. So each investor would meet with the company. At the end of their five minutes with those companies, [the investors] could determine if they wanted to stay in touch with the company, if they wanted to have a more formal follow-up presentation from the company, if they just wanted to have periodic emails from the company, or if they didn’t want to hear from the company at all. That really was the metric that we used to determine how successful we were. We went back to investors and followed up on our companies six months afterwards to see if those connections had actually happened, and, you know, the companies and the investors were staying in touch as they had indicated.”

Riley said that, after the event, he heard of other universities hosting similar events.


**Researcher’s comments on Riley’s successful incident**

In this incident, entrepreneurs were making a disclosure by giving a pitch to investors; that is different from the disclosure of a discovery by an inventor to a university, but the speed-dating event for startups and investors did provide both disclosure and access. Both entrepreneurs and investors sought reward. During and after the event, such actions as sharing information, analyzing data, assessing opportunities, learning, and managing expectations were evident.

**Riley’s unsuccessful incident**

“We were looking at how we can help our companies with some of...the critical tasks that they were focused on in their early stages of development,” said Riley. “The overall goal [was] to improve the success rate that companies were having, or were going to have, with raising capital...[from] angel investors or [institutional venture capital] investors or [identifying] if the companies needed to pursue a bootstrap effort.”

Riley said he developed an educational program for entrepreneurs leading university startups. He wrote a curriculum comprising five one-day sessions. The program featured angel investors, venture capitalists, and lawyers who made presentations, held panel discussions, and conducted clinics and workshops. Topics included how to approach investors and follow up with them, how to read and negotiate term sheets, how to evaluate debt and equity structures, and how to build a spreadsheet to understand capitalization tables and their implications. One of the workshops allowed entrepreneurs to present their business plans to a panel of four investors, and the investors critiqued the plans. One of the clinics featured an expert in making presentations, and he
worked one-to-one with each entrepreneur attending the clinic to
improve his or her pitch. Approximately 40 companies registered for the
program and participated.

Riley’s comments on the unsuccessful incident

Riley said he believed the incident was unsuccessful because “only
five or six” of the startups found the program beneficial. He said that the
program inefficiently delivered “a lot of resources.” He said he “created
the curriculum from scratch” and the curriculum failed to deliver enough
benefit to enough companies. “I was responding to a perceived need,”
Riley said. “But I don’t think we really had good metrics for defining what
success was going to look like.” In retrospect, he said, one metric would
have been to look at the amount of resources used in the program (i.e., the
cost) and the amount of capital raised by the startups (i.e., the benefit).

Riley said that during the next year he worked to improve the
program. “We actually expanded it into a new offering that we think is
doing a much better job of meeting some of the expectations that we have
for the program,” he said. The new program featured the most popular
events from the first program and combined them with another program,
FastTrac TechVenture, developed by the Ewing Marion Kauffman
Foundation; the combination of the two programs was much more robust
than either one alone, he said. “Then we also opened up [the
program]…to the entire entrepreneur community for the State of
Georgia.” He said that the annual program has been receiving 60 to 100
applications for 15 to 20 places. At the most recent event, three of four
startups received capital from investors at the program, he said. The
program had become successful, the success benefitted the startups and
led to publicity, and the publicity benefited the university.
Researcher's comments on Riley's unsuccessful incident

Riley’s first attempt was unsuccessful by his standards. Yet he persisted, he talked to startups in attendance, and he saw opportunities for improvement. He iterated and advanced the program. In the first year, Riley developed the program in isolation, with no collaborating or knowledge sharing or learning from other programs. After the failure of the first year, he opened his process of developing the program, combining his ideas with ideas from the Kauffman Foundation; those actions led to success.

19. Sloan

Sloan’s successful incident

The intellectual property involved aerospace technology. “The two [academic] inventors published a paper, and that paper generated an invention disclosure and patent filing. The paper also generated a huge amount of interest from the company,” Sloan said. He described the company as a world leader in aeronautics and energy, and the technology applied to both. He thought the company would like to license the technology. “As an institution, we valued the technology very highly, and we thought it was going to revolutionize that industry,” said Sloan, “We thought [the company] would be a great licensing partner.”

“[The TTP] filed a patent quickly. We thought there was high value in this technology, and we worked very closely with our inventors. What we’ve seen over the past several years is a lot of [academic] inventors are looking at technology and believing that this has way more value than what it really does, and that was the path that we went down,” said Sloan.
“After we worked with that company for over a year to attempt to license [the technology] to them, what we found out is that there were company constraints. The company was planning for two or three years out, and they would be taking a huge chance on [this technology] because it was not in their pipeline. Consequently, the value to them was very low versus the value to us, which we believe was much higher than that. So, there did come a turning point where we finally had to say this is not going to result in a license; we just need to recognize that.

“It was a role reversal,” said Sloan, with the two inventors. Sloan explained that inventors typically prefer to get research funds instead of licenses because the research funds have a much greater direct benefit to their laboratories; technology transfer officers, however, prefer to get licenses because their primary role is typically to get licenses and royalties for the university. In this situation, the roles reversed. “I said to the inventors that I think there are real research opportunities here for this technology, not license opportunities… I think we should allow the company to use the technology, let’s continue to work on projects that are critical and projects that are going to bring resources to the institution… This is not going to be a license; this is just going to be a fine collaborative opportunity for all of us.” The inventors thought in this case that a license with a global company could carry prestige, Sloan said, but soon the inventors accepted the plan to approach the company for research grants. “I think there was disappointment there, but what we saw, and the inventors agreed, is that we believe that [the company] will fund research, and this will be critical to our program,” he said.

Sloan approached the company to discuss research grants, and the company agreed. During the next four years, the company sponsored approximately $8 million in research at the university laboratory of the inventors. Sloan said that the funding has allowed graduate students to
conduct research, collaborate with the company's engineers, and, for some, go to work at the company after earning their degrees. Through mutual learning, Sloan said, “technology is getting transferred. While we may not see licensing or royalty revenue from that, research dollars frequently, to us, are as important because it continues the educational process, keeps students coming to Georgia Tech, and keeps researchers publishing. In this particular case, we really, really hoped to license the technology, but it never happened, but the technology transfer process happened, and it continues to happen with this company.”

Sloan said that the company had become the university's “number-one partner in collaborative efforts in [aeronautics and energy], and we want to continue that relationship.”

Sloan’s comments on the successful incident

Sloan summed up the experience: “The really great news here is that [the company] continued to fund research [with the academic inventors], and they continued to expand that particular technology into different projects. We received more [in research] money than we would have received on a license. So the good news here is that, well, we didn’t do a license. The technology is getting transferred and is still being used here at the university for research and development, for educational purposes, which we see as our missions as a university.”

Sloan also observed, “Our technology transfer and commercialization process happens in a number of different ways. It may happen in a license; it may happen with a student going to work for a company; it may happen when there is further research here at the institution; it may happen when there is just a publication. And we decide
to put something in the public domain, which then further creates more interest in that technology. So we see technology transfer actually happening first and commercialization happening later. This is a continuum of an innovation process.”

**Researcher’s comments on Sloan’s successful incident**

Conditions of disclosure, access, and reward are evident, though in this incident the reward was a large research grant. The TTO was closely involved in brokering knowledge, not only the intellectual property of the invention but also the process knowledge of how to create collaboration between the university laboratory and the company.

**Sloan’s unsuccessful incident**

The intellectual property involved an electronics technology. A professor and two postdoctoral scholars made the discovery, which they reported to the TTO in a series of 15 disclosures over a period of a few months.

Several months later, the inventors and an entrepreneur approached the TTO for a license to the technology, as they wanted to form a startup, said Sloan. The entrepreneurs said that the startup wanted to license all the disclosures – the TTO had yet to file a patent application – and that he had to have the license agreement within two weeks because he had two venture capital firms waiting to invest in the startup.
Sloan said they worked long hours every day for the next two weeks, even through a seasonal holiday, to complete the license agreement by the end of the two weeks. “We got the deal done in time,” he said.

Neither the entrepreneur nor his lawyers had negotiated a technology license with a university before this time, Sloan said. “I’ll be quite frank. There were a lot of uncomfortable moments in our office going through contract terms and negotiations. It was very unpleasant because [the lawyers and the entrepreneur] were inexperienced with licensing technology from a university… They gave us a very low offer for the technology, and it just wasn’t acceptable to us; we can’t just give technology away… And there are certain things that an educational institution cannot do in a license, and the [startup’s] attorneys didn’t have knowledge of that. And it was just one of those unfortunate situations where the contract negotiations were very difficult and way more difficult than they should have been.”

During the next five years, “nothing good happened,” said Sloan. In his rush to get a deal with the venture capitalists, the entrepreneur negotiated a terrible deal. He gave so much equity to the venture capitalists that he and the inventors endured extreme dilution, Sloan said. The venture capital firms insisted on such a large percentage of the startup because the technology was so early. “There was so much risk to the technology, the [venture capitalists] wanted a huge [percentage] of equity at the outset,” said Sloan. The venture capital firms seemed to believe that the quantity of disclosures indicated the quality of the technology and eventual products.

The startup had little direction, Sloan said. The two postdoctoral scholars left the university and joined the startup full time. They
continued their research on the technology, but neither one seemed to understand how to use the technology to create a product. “So the company eventually got a chief technology officer who really could guide the direction of their product mix, but [the startup] actually ended up going through three [chief technology officers] before they came up with a product line,” he said.

More than five years passed, and the startup launched its first product, which used none of the technology that the startup had licensed from the university. “Now we may end up getting those technologies back,” said Sloan, and it is most that they likely have lost all of their value in the past five years. “There’s new technology that has replaced this [technology],” he said.

**Sloan’s comments on the unsuccessful incident**

“This was a huge disappointment,” Sloan said. He attributed the failure to four problems.

First, the entrepreneur wanted to move quickly, and there was no time to build a relationship of trust, Sloan said. “Patience is critical,” he said. “Hard negotiations face to face aren’t always the best deals because, for me, I want the long-term relationship to happen. I want to do a license with you today, and I want us to both walk away and feel that we got a good deal, and I want to call you up a year from now and say that I have another technology that I think you should look at. For me, it’s really all about the long-term relationship.”

Second, with the demands imposed by the short time frame, the TTO had no time to conduct due diligence and understand the startup’s
plans. “Patience really is a virtue in this business,” he emphasized. “We allowed ourselves to get forced into a position to license [the technology] to this startup, and [the entrepreneur] called the shots and said they had to have all this technology in order to get the [venture capital] money.”

Third, there was no time to educate the entrepreneur on how universities license technology, what they can and cannot do, and why. Sloan said that ever since this experience “what I now do is let [potential licensees] know what we can do as an institution because there are a large number of federal and state polices and guidelines that we have to follow as an institution. If [a potential licensee] can’t deal with that, then there’s just no reason to go forward.”

Fourth, the TTO acceded to the inventors’ and entrepreneur’s desire to work so fast. “Looking back, we know the deal did not have to get done that fast. But we wanted to be responsive to the inventors. We have a relationship with the professor. We didn’t want to cause him to lose an opportunity.”

Sloan said that not only had he learned from that experience but so had others. He’s made sure that other technology transfer officers understand what happened and why. “Knowledge is cumulative. I think you just build on your knowledge. I saw things that I did in this deal that worked, and I saw things that I did in this deal that didn’t work, and I share what I learned. We have this extreme open-door policy here. It’s a collaborative effort among our licensing professionals...to share information with one another. Yeah, we have set meetings from time to time, and that happens on a weekly basis, but the real work gets done when we walk up and down the hall with an agreement in our hand and say, ‘Can you take a look at this, and [tell me] what would you do in this case?’ Those walks up and down the hall often turn into one-hour
impromptu meetings. There is a lot of good that comes out of those meetings simply because you instantly take knowledge away. We have a lot of people who have been doing [technology transfer] work for years in the office, but they don’t always have all the answers, and there are young people who are creative, and so we frequently collaborate to get deals done. Everyone has a hand in different technologies here at the institution, so what usually happens is the [impromptu meetings] start out with two people and another person comes down the hall and [joins] a conversation and then another person… It may start with two [people] and it may end with five. It starts with a ten-minute conversation and goes to an hour, and we get a lot of work done.”

Sloan reflected on what he termed “the university TTO business.” “I believe this business is a changing business. Our role as a licensing office changes, and it changes with the economy of the country, and it changes with the economy of the institution [and] the focus of the institution. But, at this institution, we have a great outlook as an office on commercializing technology. That’s our priority: commercializing technology.”

Researcher’s comments on Sloan’s unsuccessful incident

Sloan discussed the importance of trust as a basis for relationships, and relationships as a basis for collaboration and other actions such as sharing knowledge, learning, teaching, combining knowledge – especially with colleagues – and reusing knowledge by recognizing from an incident what has succeeded, what has failed, and why.
Taylor said he received a telephone call from a lawyer about that patent. “We had not successfully commercialized [the patent],” said Taylor, “and the lawyer asked a simple question of would we be willing to license this company the rights to the patent on a fully-paid-up basis for less than $100,000.” After a few conversations, Taylor said he determined that $100,000 was the maximum that the company would pay for a license. After additional investigation, Taylor concluded that the university’s patent was a blocking patent; i.e., the university’s patent was blocking the company from practicing one of its own patents. A patent confers on the patent holder the right to keep others from practicing the patent, not the right to practice the patent. Taylor came to believe that the company had determined that it had two options: the first was to obtain a nonexclusive license for the university’s patent; the second was to infringe on the university’s patent and incur the risk of a settlement with the university. Taylor performed an economic analysis of the patent, he said, and, given the assumptions he used, he concluded that the company’s offer of $100,000 was reasonable.

Taylor said that he wanted to learn more about the company and attempt to build a relationship to see if further opportunity existed. As the relationship progressed, he learned that the company intended to use
the patent in a manufacturing process for recycled carpet fiber and the company, based in California, planned to expand its production facilities. Taylor said that he saw an economic development opportunity because of the carpet industry in Georgia. He noted that nearly 80 percent of all the carpet sold in the US is made in Georgia, and the company needed access to recycled carpet fiber. Taylor suggested that the company open a facility in the State of Georgia, and the company agreed.

Taylor said that the terms of the patent license agreement called for a one-time payment of approximately $100,000 for a nonexclusive license, a requirement that the company had to build a facility in the State of Georgia, invest a certain minimum amount of money in the facility, and employ a certain minimum number of people at the facility within a certain period of time. The State of Georgia provided economic incentives for the company, as did the county where the facility was built.

“The company now has a facility of 360,000 square feet [which is approximately 33,500 square meters] and employs over 120 people,” Taylor said, “and the company did it all in half the time we required.” Taylor said analysts in economic development for the State of Georgia determined that the annual economic benefit the company provided to the state was more than $20 million.

“I’d say this is an atypical transfer of technology,” Taylor said with a grin.

**Taylor’s comments on the successful incident**

The key, said Taylor, is always working to understand the motivation of the company that wants to license a technology. That was
difficult in this incident because the company and its lawyer were so secretive, said Taylor. No one at the company wanted to say why they wanted the patent or how they would use the intellectual property. “When we traveled [to the new facility] the first time to see their pilot running, they wanted us to sign nondisclosure agreements,” said Taylor. He said he finally had to tell the company’s lawyer that direct conversations with the company were necessary because the university would grant a license to the company, not the lawyer.

Getting to know the company’s motivations took much time and effort, Taylor said, and TTOs never seem to have enough time. He has wondered what would have happened if he determined he was just too busy and decided against pursuing this.

What was also interesting, Taylor said, was that the lawyer and the company were so secretive that they created a strong suspicion at the TTO; consequently, no one at the TTO trusted anyone at the company. But as the dialogue continued, trust began to build. As the level of trust increased, the conversations became easier, and the collaboration became better, Taylor said.

A TTO generally had four options for creating value with intellectual property, Taylor said. The first was revenue, which included royalties, income from the sale of equity in startups, licensing fees, and reimbursement of expenses (e.g., for patents). The second option was research funds (e.g., a company sponsoring research at the university). The third option was economic development. The fourth was brand development; Taylor said that, by this, he meant building the university’s brand (i.e., the university’s reputation or prestige) through publicity about scientific breakthroughs at the university or about inventors. Such publicity can help a university increase charitable donations from alumni.
and attract top faculty and students, Taylor said. All four options ideally work together, Taylor said. In this incident, the TTO did receive a one-time fee for the license (the first option), the company has sponsored a small research grant for material testing (the second option), the company built a facility and hired workers (the third option), and media coverage of the opening of the facility did feature the university (the fourth option). Taylor said that the company has also hired several students after they received their graduate degrees.

Taylor said this incident reinforced important lessons: the importance of showing patience in relationships, understanding motivations, talking directly with the decision maker, and building trust.

**Researcher’s comments on Taylor’s successful incident**

Building trust can contribute to collaborating, sharing information, and learning – all actions of an innovation process. Disclosure occurred many years before this incident, but it did occur, as did access and reward; all three conditions were present.

**Taylor’s unsuccessful incident**

The technology involved was photovoltaic. A professor made a disclosure approximately seven years earlier. The TTO filed a patent application, and the US Patent and Trademark Office issued a patent approximately three years earlier.

Taylor explained that the disclosure, and thus the patent, resulted from research sponsored by a global company, which took a nonexclusive
license to the patent. The company continued to sponsor significant research programs at the university and continued to obtain nonexclusive license to patents originating in the sponsored research. Had the company wanted exclusive rights, the company would have negotiated for them, and the company would have incurred the significantly higher cost that exclusive patents entailed. By sponsoring research, the cost of obtaining a nonexclusive license was small.

Taylor observed that another reason for a company to take a nonexclusive license was to ensure that no other company would take an exclusive license. A nonexclusive license obviated an exclusive license for other companies. By taking a nonexclusive license, a company gained rights to practice the patent and denied other companies the right to develop a proprietary product based solely on that patent.

In general, when a company intended to develop a proprietary product, the company preferred to take an exclusive license. Taylor remarked that, without an exclusive license, few if any university startups would ever receive venture capital investments.

A startup took a nonexclusive license with the university, Taylor said. The entrepreneur’s preference was to get an exclusive license, but a nonexclusive license was already in place for the technology, so only nonexclusive licenses were available; the company that had sponsored the research that led to the patents had taken a nonexclusive license immediately after patents were issued.

The entrepreneur was joined by the inventor in forming the startup. They hoped that they could attract enough venture capital to commence operations, said Taylor, and then develop proprietary technologies before the next round of funding was necessary.
Taylor said that the startup did raise a seed round of capital from a venture capital firm. The startup began operations and continued for three years; however, the startup never developed a proprietary technology. Unable to raise another round of capital, the startup closed.

**Taylor’s comments on the unsuccessful incident**

Taylor said that the university had a policy encouraging multiple licensees for nonexclusive licenses. The objective was to transfer technology, and nonexclusive licenses created the opportunity to transfer the licenses to as many licensees as practical.

Taylor said his concern was that expectations could become misaligned or mismanaged when a startup took only nonexclusive licenses. From his experience and from others’ experiences, he knew of no startup that had started with only one or more nonexclusive licenses and eventually succeeded in developing proprietary intellectual property and securing sufficient capital.

Taylor said that after this incident, he twice noted the absolute failure rate to entrepreneurs and inventors who wanted to launch a startup only with nonexclusive licenses, and in both instances they decided against forming the startups.

Taylor said he felt he was still conforming to university policy to obtain multiple licensees on nonexclusive licenses, as he would readily do so under the right circumstances of due diligence. He said felt that such startups failed to pass due diligence as they would most likely fail to practice the license.
**Researcher's comments on Taylor’s unsuccessful incident**

In this incident, disclosure and access are obvious. Reward is absent, however, in that the success rate was nil. Taylor's new advice to entrepreneurs and inventors – to wit, in his experience, launching a startup only with nonexclusive licenses leads to failure – conveyed the accumulated knowledge that there is no reward, only failure, under such circumstances.

**University of Utah**

The University of Utah, located in Salt Lake City, Utah, US, was established in 1850. The student population at the university is approximately 31,000, comprising approximately 23,000 undergraduate students and approximately 8,000 graduate students. At this time of this study, the TTO was referred to as Technology Commercialization Office.

**Interviews**

The TTO employed approximately 15 people at the time of this study. Four participated in interviews: Ursula, Varney, Whitney, and Xian. The table below presents the main themes of the interviews.
University of Utah participants and interview themes

<table>
<thead>
<tr>
<th>Participant</th>
<th>Successful</th>
<th>Unsuccessful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ursula</td>
<td>Adapting, networking, and collaborating</td>
<td>Failing to establish trust and align goals</td>
</tr>
<tr>
<td>Varney</td>
<td>Managing resources and processes</td>
<td>Learning patience and persistence</td>
</tr>
<tr>
<td>Whitney</td>
<td>Networking, collaborating, and learning</td>
<td>Failing to establish trust and align goals</td>
</tr>
<tr>
<td>Xian</td>
<td>Analyzing, collaborating, networking, and sharing knowledge</td>
<td>Failing to build teams</td>
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21. Ursula

Ursula’s successful incident

The intellectual property involved a medical device. The inventors were two nurses who worked for the university hospital.

Ursula said that the two inventors designed a simple, clever device to prevent catheter infections, which occasionally cause death. The inventors worked on prototypes for three years. They made presentations to angel investors and venture capitalists, all of whom declined to invest.

The inventors met Ursula by chance, and she suggested that the inventors bring the invention to the TTO for a conversation with her and some of her colleagues. The inventors accepted her offer and met at the TTO with Ursula. She and a few of her colleagues explained how the TTO’s innovation process worked.
The nurses were employed by the university hospital, so they had no affiliation with the university, and the university held no legal or other claim on their intellectual property. The nurses, however, wanted to work with the TTO and donated the intellectual property to the university so that they could participate in the TTO’s commercialization process.

Ursula said that the TTO formed a startup and found a chief executive to lead the startup. He wrote a business plan. Ursula said that they then went to the same angel investors and venture capitalists and within a few weeks had raised $1 million. “Because [the TTO] had a structured process and because we had credibility in the community, we raised the capital. And [the total capital raised] is up to $5 million right now.” Ursula said that only three months passed between the first conversation and the close of the initial round of capital. The startup had won approval from the US Food and Drug Administration and planned to begin selling products soon.

“[The invention] wasn’t even university originated,” said Ursula. “But we see the value of getting the right people, the right systems, the right services, the right instruction, and the right process.” Ursula said that the inventors needed intensive support from the TTO, but the TTO provided all of the support and services that the inventors required. “[The TTO] offers everything you need to start a business,” she said, “including formation, the board, all corporate governance, logo design, webhosting...everything. And [the inventors] needed every one of these services.”

“We found that we have to offer all the services a startup could need,” said Ursula. “We’re not MIT. But in the past few years we’ve done as many startups as MIT.”
Ursula said that, with the success of that startup, inventors from outside the university are increasingly coming to the university for assistance with startups.

The TTO is “more than happy” to help startups from outside the university “because we want to be good stewards of the community,” Ursula said.

**Ursula’s comments on the successful incident**

“We set up [the TTO] as a service business, so we engage everybody in the process. If you are really going to be in the service business, serve everybody” Ursula said. “We hear sometimes criticism that we’re not doing things we should be for the university. In fact, what we do for people outside the university brings goodwill and resources to the university.”

Ursula explained that helping startups from outside the university created publicity that led to venture capital firms investing in university startups and companies sponsoring research at the university,

Ursula said that publicity about the TTO has caught the attention of some chief executives and venture capitalists who visit Salt Lake City. “We have to play to our strengths, and one of them is that we have unbelievable ski resorts. We spend a lot of time up at Park City and Deer Valley to see the people who fly in from California. A lot of people split their winter between here and California,” she said.

Ursula said the TTO faced many restrictive university policies. The TTO’s strategy was that, when the objective was consistent with the TTO’s
mission, then the TTO would work with university lawyers to get through or around the restrictions. “We weren’t [allowed] to start wholly-owned companies, but we spent about nine months figuring out with legal counsel how to actually start a company and control it within the university until we found the right funding and the right CEOs to get it out. It took a lot of time, but we knew it was the right thing to do, and when you work from that position from the starting point, you can get anything done.”

Many university rules addressed conflict of interest, Ursula said, but conflict of interest was inherent in university startups. For example, a university researcher thought his invention had value, so he wanted to form a startup, own an equity interest in the startup, and control his own research. In a strict legal interpretation, that situation violated many government rules, yet TTOs have put procedures in place to comply with the law and to allow the inventor to form a startup. With government rules multiplying, TTOs just had to address these situations all the time to make sure that the TTO could fulfill its mission, Ursula said.

Ursula noted, “We really try to build that culture that we embrace opportunities. We always figure out what the solution is – even though somebody tells us we can’t do it. That just makes us more persistent. Many times we were up against roadblocks – why we can’t do things – but if it’s important enough, we will figure it out.”

“This is as much about innovation as technology transfer,” said Ursula, “How do you transfer ideas? How do you translate knowledge? It’s a fascinating process.”

“But the challenges are constant,” said Ursula. “We did a survey of TTOs across the country on the challenges in commercialization. The
three biggest challenges are finding proper funding for early-stage companies, finding the right executive to manage those companies, and reducing high legal costs.” Ursula said that legal costs consumed 50 percent to 75 percent of a university TTO budget (in the US). Nearly all of the legal costs paid for patent prosecution and maintenance, and at least half of that [amount] was wasted, she said. If the wasted money were saved, she said, “You could put it toward innovation, create new funding programs and entrepreneurship training. You could transform commercialization.”

**Researcher’s comments on Ursula’s successful incident**

The TTO in this incident showed evidence of adapting to the environment. With the absence of the entrepreneurial community and infrastructure of the Silicon Valley area or the Boston area, the TTO endeavored to build a community, or an ecosystem, of startups both internal and external to the university. The TTO has worked to cut the red tape of bureaucracy in university policies when such policies limit the TTO’s efficacy. The TTO built processes and networks to teach, learn, share knowledge, broker information, and coach entrepreneurs.

**Ursula’s unsuccessful incident**

The intellectual property involved a diagnostic microchip. University researchers made a series of disclosures, and the TTO filed patent applications.

Ursula was new to the TTO, and she became the project manager two months before the startup filed for bankruptcy. To prepare for the bankruptcy process, she investigated the history of the startup at the TTO.
She said the management and the culture of the TTO were completely different at that time. “Everyone [in the TTO] felt overworked. The attitude was to just get things done no matter how they turned out,” she said. The TTO had processes, but no one seemed to follow them.

The TTO made mistakes in the search for an entrepreneur to lead the startup, she said. “We were looking for someone [as CEO] who could follow our process. The first CEO had serious problems. So did the next two. [The startup] went through three CEOs before the first round of funding,” she said.

Negotiations for the license agreement took 18 months because technology transfer officers felt they had too little time to focus on this startup, the chief executives seemed to have no knowledge of license agreements, and, said Ursula, “The IP portfolio was massive.”

The startup filed for bankruptcy. The TTO went to court to recover the intellectual property. The legal proceedings were complex, said Ursula. “We had to settle disputes, and the negotiations were really long. It got extremely expensive,” she said.

Ursula said that, after regaining the intellectual property, the TTO found a competent CEO, and the next startup succeeded. She said she was the project manager for that launch, and she followed the TTO process.

**Ursula’s comments on the unsuccessful incident**

Ursula said that she thought of this incident as a learning experience, and, from that perspective, the incident was a successful learning experience.
She said that she learned the importance of: (1) identifying the key people who the TTO needs for a successful startup, (2) getting all of them involved early in the process, (3) making sure that everyone in the process shares the same alignment with goals, and (4) working only with people you trust.

She said that a new university president transformed the TTO. He aligned the TTO with the university’s business school in strategy, structure, and systems. “That’s made the biggest difference,” she said. “Now we really focus on our stakeholders, and we serve them better.”

Reseacher’s comments on Ursula’s unsuccessful incident

Ursula’s incident revealed how a TTO could waste resources with poor execution. The lessons she learned emphasized the actions of learning, aligning goals, and establishing trust as a foundation for collaboration.

22. Varney

Varney’s successful incident

The technology involved a device for measurement in human physiology. The disclosure had been made approximately 15 years earlier and the patent issued approximately 11 years earlier.

Varney was reviewing his portfolio of patents and noticed that a maintenance payment was due on a US patent. In deciding whether the TTO should continue making maintenance payments, he began investigating the patent landscape. “I noticed that there’s a company in
South Korea that's selling a similar product. It turned out that one of the inventors on our patent was South Korean, and [he] went to South Korea and started a company and they were selling the product,” Varney said. “I brought it to our director’s attention, and we looked into it more. We realized that this might be an infringement issue.”

The TTO decided to pursue the matter. Varney said, “It took about a couple of years to put the resources together and do the actual due diligence on the company and on our patent to realize it was indeed an infringement issue. Typically it's really hard to hire experts and attorneys to be able to make a thorough analysis of this type of situation and move forward with the process. It's a lengthy process, and also it requires some dedicated time and effort.”

“From a scientific perspective,” Varney said, “I realized that there were similarities in the product and our patent. So conceptually I started looking at the claims on one of their patents and the claims on one of our patents, and the description of their patent, and I noticed similarities in our patents. Our patent was filed before their patent was filed. We engaged an outside council, that they were able to do a thorough claim-by-claim analysis. Then we knew that we actually had a strong case to move forward with. Also we had to get help from a litigator.”

“We only had a US patent,” said Varney, “and the company went forward and filed patents in the US and all over the world, but we were only able to get damages in the US.” The award of damages was approximately $400,000, and the TTO’s expenses were approximately $150,000, Varney said.
Varney’s comments on the successful incident

“This was a success because we were able to put resources behind it. Putting the right resources behind a process drives the process to success. You have a higher chance of achieving success with the right resources,” said Varney.

Varney emphasized the risk in this incident. “I think being able to take some risks is important. You have failures and successes. Of course, we are bounded by and limited by our resources, but we also have a certain level of freedom, and we can challenge ourselves and take the risk.”

“This by no means was a huge revenue generator for us, but it became something that we learned from,” Varney said. “Now, when other managers come across similar situations, we’re not afraid to look into it deeper and pursue it. They know the resources are available.”

Researcher’s comments on Varney’s successful incident

Varney noted the importance of resources to facilitate the TTO process. Enforcement of patent rights is often important to signal to university inventors that the TTO works to protect their intellectual property and the opportunity for reward. If a TTO failed to pursue infringements, then university inventors could justifiably conclude that there is no reason to make disclosure or grant access because the TTO may forfeit the reward to an infringer.
Actions of collaborating, learning, and sharing knowledge with other TTO staff are evident.

**Varney’s unsuccessful incident**

The intellectual property involved an engineered material. A professor made the disclosure four years earlier, and the TTO filed a patent application two years earlier.

The professor and an entrepreneur now wanted to form a startup, Varney said, and they asked for a license. Varney said that he considered the license negotiation an unsuccessful incident.

“*We are very far apart,*” said Varney, “*and we have been negotiating for 18 months.*” He said that a few times the negotiations have reached an impasse for several weeks, with neither side talking to the other for that period of time. “*Your motivation goes down...but some negotiations take longer than others,*” he said.

**Varney’s comments on the unsuccessful incident**

Varney said he has asked himself many times what he should have done differently. “*Perhaps we could have been more stringent. Perhaps we should have had a take-it-or-leave-it approach. Perhaps we should have set a deadline. But ultimately we want to develop a relationship, especially if you’re working with people in your community. It is a small business community after all, and you want to develop a relationship. Despite our differences we can still work together, still get along. So you*
have to accept each other and somehow work together. I've found I can often turn a setback into a success.”

“But you also have to know when you're just wasting time and when to cut your losses,” Varney said. “We talk about that in the office [among technology transfer officers] a lot.”

Varney observed that every negotiation is different. What is important, he said, is that he makes an effort to adapt to the situation and use creativity and flexibility to work toward a mutually beneficial deal.

**Researcher’s comments on Varney’s unsuccessful incident**

Varney clearly expressed frustration in discussing this incident, yet he also showed perseverance. He seemed to understand that often university technology transfer requires patience and persistence. He collaborated with colleagues in the office as they shared ideas and strategies.

23. Whitney

**Whitney’s successful incident**

The intellectual property involved renewable energy technology, and the inventor was a professor and researcher at the university. He made the disclosures six years earlier. “[The disclosures] didn't languish,” said Whitney, “but we were trying to be creative with how we approached this. But we couldn't get [a licensee]. That’s when we decided to form
[the startup] with the researcher. He started working on it but ran out of
time.”

Whitney said, “I think that our [TTO] is trying to take the lead in being very
creative, very forward thinking...really looking at [technology transfer] as kind of a partnership... So what we did recently is we've partnered with a local venture capital group and worked at starting a couple of different seed funds that are focused not only on getting some bridge funding to get [a startup] to the next stage but really focused on university technologies that [the venture capital group] can provide the management for.”

Whitney said that the TTO formed a joint venture with the venture capital group to commercialize university technologies with applications in energy industries and markets. “What really made [this joint venture] different from the standard procedure is that we're able to get this technology into the hands of this business group, and they were able to actually add the money and expertise in moving this forward,” she said.

Several large companies were looking at the startup as an acquisition, Whitney said. Once the venture capital group became involved with the startup, progress had been swift. “Why it’s a success to me is that we were able to get everything organized from the very first, from funding to buy-in from the researchers, to having the management team to having this [startup] formed that is solely focused on moving university technologies along. We really have this strong partnership for [inventors]... Getting that outside support at early stages has really helped them,” she said.

Whitney explained that the relationship with the venture capital group evolved over a few years. “We actually went to them and said,
‘Look we don’t have access to this seed money in the venture community like we really want to have, and we really want a stronger partnership.’ So they said, ‘What do you want to do?’ I said, ‘Well, we want to start a venture capital group with you, certainly taking into consideration some of the restrictions that the university has on being involved in those agreements. But we really want you to take a look at early stage technologies. Although we can’t have some formal agreements that we’re going to pass everything on to you, we can certainly provide you a steady flow of technologies that are coming out of the university for you to look at, and we’d like you to review those. At the end of the day, if you like a few of them, then it’ll be an easy transition for you to take some type of a license or other arrangement to it.’ So it’s really beneficial to try to bring in a commercial perspective at the very earliest stages to make sure that they get a look at this and are able to provide their opinion.”

Whitney said the relationship with the venture capital group started when the group asked the TTO to facilitate a research grant between the university and one of the companies in which the group had invested. “They were an investor in a large coal mining operation in Australia. That Australian company was looking for some research to take place and the [venture capital group] actually came to us. The only reason why I bring this up is this was our initial interaction with them. They came to us looking for some research basically just on coal mining and conversion of coal. We had a lot of conversations and came up with some creative approaches on how we [could] work together, and they were impressed, so that kind of sparked a relationship, and it just kept growing.”

Whitney said that the TTO had completed seven deals with the venture capital group in approximately two years. She said in those seven transactions, the progress or the outcomes were good, though some much
better than others. She commented that, thanks to the repetition of working with the same group of people, the process of transferring and marketing technologies and products had become highly productive between the group and the TTO.

**Whitney’s comments on the successful incident**

Whitney observed that the venture capital group felt some trepidation in forming a joint venture with the university. “They had worked with tech transfer offices before, and they had a bit of a negative, well, a bad taste in their mouth from dealing with universities. So when they originally came into this deal, I think they thought that we’re going to just have some standard agreements in place but they couldn’t get creative with those agreements, they couldn’t get outside the box. So we really tried to help them understand that we are working within the context of a university, and there are some things we can and can’t do, but we can try to be creative and make it easy... We’re really trying to come up with creative approaches on how those technologies flow easily through our office. Then we also support their investment by finding them other technologies that we could wrap up in the deal to make it more beneficial for them. So it’s really focused on a partnership. We understand their needs, and we’re going to do the diligence on our end to help them.”

To assist the venture capital group, Whitney said that the TTO looked at technologies not only within the TTO but also at other universities’ TTOs. “One of the projects that we’re working on right now is the Western Innovation Network, and we’re trying to get some grant money in place that would really centralize [information on] what each university has to offer, not only technologies that are available for
licensing, but specialized equipment, specialized researchers, and trying to pull that into one [database] so that, for example, if [a venture capital firm] came to us, we could say, yeah, we’ve got this technology, but look at what [the University of] Southern California has, look at what [the University of] Oregon has, look what [the University of] Montana has, look what [the University of] Colorado has, and having those relationships in place so that we can quickly respond. Now, the Western Innovation Network isn’t put together yet but at the end of the day everybody’s looking for the collaboration and looking to pull those technologies and resources,” Whitney said.

Whitney said that she learned from this incident that, when a technology arrives at the TTO, it is important to quickly get an internal assessment (from the TTO staff) and, just as quickly, an external assessment from people with relevant commercial experience, such as the venture capital group. They can identify the steps to commercialization, help the university inventor, and make available both funds and management expertise.

**Researcher’s comments on Whitney’s successful incident**

Whitney’s comments underscored the conditions of disclosure (i.e., a technology arriving at the TTO), access (i.e., quickly getting an internal assessment and an external assessment), and reward (i.e., helping the researcher, the technology transfer officer, and the venture capitalist). Also evident were actions of networking, collaborating, teaching, learning, and sharing knowledge.
Whitney's unsuccessful incident

The intellectual property involved technologies for renewable energy. The inventors were two university professors. They made the first disclosure 10 years earlier and the fourth and final disclosure five years earlier. Four patents were issued.

“This [technology] looked really exciting,” said Whitney, “but nothing happened for a long time.” A company expressed interest in the technology three years earlier, and the TTO began talking with company executives about licensing the technology. Several months later the company and the TTO executed a license agreement, and the company sponsored research with a grant of approximately $300,000 for the laboratories of the two professors.

The relationship between company executives and the professors quickly deteriorated, said Whitney. She thought that the professors failed to fully understand, first, the commitment they had made to the company in both the license agreement and the sponsored research agreement and, second, the direction the company planned to take their research and eventual commercial products. The researchers realized too late, said Whitney, that they wanted to proceed along a different path from the company. She felt she had clearly and fully explained the situation to the professors.

She said that she felt the TTO gave the company an unusually advantageous deal because previously no one had expressed an interest in the technology. The biggest problem, however, was that much of the language in the agreements was ambiguous, and the ambiguity favored the company. One practical effect was that the researchers were contractually obliged to inform the company of their research and
inventions for an unspecified, and unlimited, period of time. This became a major issue after the two professors decided they would no longer communicate with the company. Moreover, the company had made representations to the TTO, said Whitney, that the company itself would engage in manufacturing products based on the technology; the agreements, however, failed to incorporate those representations, which constituted one of the main reasons the TTO decided to give such favorable terms to the company. Whitney suspected that the company’s goal was to simply broker the technology rather than manufacture a product. Had the TTO known during license negotiations that brokering rather than manufacturing was the company’s intent, Whitney said, the TTO would have terminated negotiations.

Making the situation even worse, Whitney said, was that several months later “two major petroleum companies showed up at the researchers’ doors...trying to get access to this technology. It was tied up [in the license and research agreements] in such a way that we couldn't give them access.”

The company has become dissatisfied, as its commercial process for this technology has stopped, Whitney said. The professors are also dissatisfied.

**Whitney’s comments on the unsuccessful incident**

“It’s still an ongoing nightmare,” Whitney said, “but it has been a learning experience.”

In retrospect, she said that she did rationalize the deal. “You’re dealing with a technology that’s great, and the opportunity came along [to
license the technology], and you just jump on it to get that [technology] out there. The researchers were certainly on board with it, and so we're just excited to have it move along at all. So when you're looking at any deal at all that possibly could move it forward, just saying no and having [the technology] sit around for a while – that's hard. I think the idea was. let's try and get something done. Let's try and move it forward. Let's see if we can make something out of this technology even if there are terms [in the agreements] that we're not at all that happy with, but we think everybody's on the same page, so let's move it forward. So some of the normal protections that we'd have in [the agreements] just were absent.”

Whitney said that, as a result of this incident, she took extra care to make sure that faculty truly understand what they are getting and what they are giving up in an agreement. Just as important, she said, she made sure that faculty felt their goals were aligned with the company’s objectives. In this deal, Whitney said, goal alignment (or misalignment) was a big problem. “All the parties just weren’t aligned,” she said.

Whitney also observed that it’s important to understand whether a company is a strategic investor or a financial investor, and what the intent of the company is. “When you get into deals, especially with startups or companies that don’t have a history of manufacturing, you run the risk of having a broker on your hands.”

“Sometimes in your optimism and support in wanting to have something happen, those dreams get smashed, and this was one of those situations where that happened,” Whitney said.
Researcher’s comments on Whitney’s unsuccessful incident

In the absence of trust, the two professors lost interest in making disclosure or granting access to the company. The innovation process terminated when collaborating, sharing knowledge, and exchanging ideas stopped.

24. Xian

Xian’s successful incident

The intellectual property involved water treatment technology. A professor filed a disclosure seven years earlier, and the TTO received a patent four years after the disclosure was filed.

Xian said that the TTO had made attempts to find a licensee ever since the disclosure was filed. Little effort seemed to go into the attempts, and nothing came of them.

Xian found a marketing firm that commercialized technologies. The firm became interested in the water treatment technology and began conducting a marketing research project. The technology has numerous applications, Xian said, and the TTO’s marketing attempts presented a long and vague list of potential products. Unlike the TTO, the marketing firm focused on determining the best application for the technology. After identifying the best application, the firm turned to identifying the companies that would benefit the most from that application. “The marketing firm developed a list of companies, and then we started to identify who had contacts at those companies,” said Xian. “I had some contacts at those companies, the firm had some contacts, the researcher
had some contacts, [others in the TTO] had some contacts, and we had a long list. It was amazing. We had covered every company on this list.”

Xian said that he worked with the marketing firm to develop a presentation, and they started calling people on the contact list. “We did not actually try to go and sell the technology. We wanted to get some market feedback to see if the technology met their needs. As we started making these presentations, it became pretty evident relatively quickly that what we had was what they needed.”

“We were able to license the technology nonexclusively to [several companies], and were also able to get them to help pay for some of the further research and development,” said Xian. The TTO raised approximately $500,000 from the companies for research, he said.

**Xian’s comments on the successful incident**

Xian said he had wondered whether the technology even worked before he met the people at the marketing firm. “They had successes with energy technologies, and I had this [water treatment] IP on that list, so they started asking me about it when we first met. I told them what we had done, and that it had not really gone well, and they basically said that it’s because we had done it all wrong. So we stepped back and said, okay, if we’ve done it all wrong, how do we do it right? And they told us, so we hired them.”

Xian said this incident showed him that “you can’t just rely on one person’s network. When you have access to multiple networks, you really start to see a network effect working in your favor.”
Xian said that this experience impressed on him the importance of improving processes, building networks, and sharing knowledge.

**Researcher’s comments on Xian’s successful incident**

This incident revealed Xian openly admitting a failure in marketing a technology and welcoming assistance. He eagerly collaborated and learned without fear of embarrassment. From one perspective, Xian contributed little – perhaps the names of several industry contacts – to the success. From another perspective, he contributed greatly in concatenating the people who made the collaboration successful. Conditions of disclosure, access, and reward are evident, as are actions of analyzing, brokering, and sharing knowledge.

**Xian’s unsuccessful incident**

The technology involved was carbon sequestration. The inventor was a university professor. He made a disclosure. The intellectual property was know-how; there was no patent.

Xian said that an engineering company with an interest in working with the professor approached the TTO. The TTO proposed a joint venture rather than a license, as licensing know-how seemed especially difficult in this situation. The company agreed and formed a joint venture with the TTO; the company owned 51 percent of the joint venture, and the TTO owned 49 percent. The professor served on the board of directors. He also received research funds for his university laboratory. The business model for the joint venture was a consultancy.
“It became evident quickly that the professor would not fit with the company’s culture,” Xian said. The company operated with military precision, and the professor was relaxed and absentminded. “So the problem was just our ability to deliver the things that we said we were going to deliver. We had a problem with getting those deliverables to [the company] in a timely fashion.”

“So ultimately, after a year and a half, we ended up having to terminate the joint venture,” Xian said. The relationships remained friendly, and there was still collaboration, but a joint venture was the wrong vehicle, he said.

**Xian’s comments on the unsuccessful incident**

“We really failed at aligning and managing expectations. I think we thought we could figure that out later. Or we just assumed it wouldn’t be a problem,” Xian said.

Xian said he should have been more aware of the absence of any cultural fit. Had the cultural fit been strong, or even close, the professor and the engineers could have worked through the issues and succeeded in the joint venture.

**Researcher’s comments on Xian’s unsuccessful incident**

Collaboration is not only cognitive but also behavioral. Xian failed to anticipate how the engineers and the professor would work together as a team. In startups, and even joint ventures such as this one, teamwork is often important.