THE EFFECTS OF UNIVERSITY TECHNOLOGY COMMERCIALIZATION PRACTICES ON LICENSING INCOME - A COMPARATIVE STUDY

By

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DEDICATION

To my family: Mammy, Daya, Misty, Rachel, Khadisha and my darling Christelle.
And to all my friends who were there for me through it all.

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CHAPTER I

INTRODUCTION

It has been almost 25 years since the introduction of the Bayh-Dole Act of 1980 gave universities authority to commercialize discoveries made using federal funds (Powers, 2000). Since then, university technology transfer has been perceived to be an important factor in both economic development and the generation of useful innovations that are critical in maintaining the competitive position of U.S firms (Siegel, 2002). Research on how university technology transfer offices transform their invention disclosures into revenue generating technologies is however, still in its embryonic phases (Thursby, 2001). Because of this, there is a need for information that will increase the efficiency and effectiveness of the process of bringing new university-developed technologies to the market (Bozeman, 2000). In this thesis, we add to the literature on university commercialization processes by employing a two-step process for selecting and examining the universities in the sample. We found that while some universities seem to have the ability to generate more licensing income from fewer invention disclosures, fewer startups and fewer licenses (High Outcome Universities), others seem to be involved in considerably more licensing activities which result in lower levels of licensing income (High Activity Universities). This thesis (1) uses quantitative methods to identify the "above average" universities in the area of technology transfer; (2) segments these universities into high output and high activity institutions; (3) uses qualitative methods to investigate if there are differences in organizational practices between these two groups of university TTOs; (4) if there are differences, to determine what they are.

The quantitative part of the study gathered and analyzed preliminary data on the top 52 research universities in the United States and, based on this analysis selected four "high outcome" and four "high activity" universities for participation in the study. Based on open-ended interviews conducted with TTO directors at these eight universities, I will identify what appear to be critical factors in determining the impact of technology transfer processes on licensing income. Specifically, I show that faculty involvement in technology marketing is the major differentiator between high output and high activity universities. The results of this study will not only add to the literature on university technology commercialization processes, but will shed light on the organizational processes that will allow university technology transfer directors to increase the licensing income of their offices.

This thesis is organized as follows. The next chapter provides a review of the recent research that has been conducted on university technology transfer. It will consider the organizational factors that have been identified as possible differentiators of university technology transfer efficiency. Chapter 3 outlines the theoretical background that was employed in this study, and develops a research model. Chapter 4 goes into the methodology of the research, looking at the roles of both quantitative and qualitative data and the variables that are utilized in this analysis. Chapter 5 presents the finding of the study and Chapter 6 goes into a discussion of the findings and proposes areas for future research.

CHAPTER II

LITERATURE REVIEW

Issues in Technology Transfer

Technology transfer is the movement of know-how, technical knowledge, or technology from one organizational setting to another (Bozeman, 2000). In terms of university technology transfer, the Bayh-Dole Act of 1980 provided universities with the right to own and commercialize technologies developed with the use of federal funds (Powers, 2000). There are varying opinions on the role of the Bayh-Dole Act in stimulating an increase in technology transfer. On the one hand, this Act is often seen as creating an environment in which universities could evolve into entrepreneurial institutions (Etzkowitz, 1998). It is also credited for an increase in the formation of university technology transfer offices (UTTOs) from approximately 20 in 1980, to almost every major university having a UTTO in 2000 (Colyvas, 2002), thus increasing the quantity of patenting and licensing conducted by universities (Powers, 2000). Furthermore, the passing of Public Law 98-620 increased the array of inventions from which universities could gain revenue, resulting in an increase in patenting activity (Shane, 2002).

Conversely, there is the belief that the apparent increase in technology transfer activity in the last twenty years would have happened irrespective of the Bayh-Dole Act – in fact, this increase should be attributed to the increase in maturity of certain technological fields (Nelson, 2000). According to Nelson, many of the nation's research universities were already well on their way to significantly increasing their patenting and licensing efforts before Bayh-Dole, so this Act only sped up the process.

Whatever the role of the Bayh-Dole Act in promoting university technology transfer, one thing is interesting – the growth in technology transfer activities in the past two decades has increasingly caused universities to be looked upon as a potential component in economic development and financial gains to firms (Siegel, 2003) and a driver of technological change in industry (Mansfield, 1996).

Technology commercialization provides an avenue for universities to leverage their intellectual property. Successful technology commercialization involves the set of skills that include matching the products to the customer needs (Shane, 2002). It would follow that the universities that are the most efficient at technology commercialization would best possess those skills. As a result, there is a noticeable shift in the focus of the research from the quantity of patents and licenses, to the efficiency of the technology transfer offices (Bercovitz, 2001). This study intends to investigate the impact of the TTOs' organizational practices on their commercialization efficiency and effectiveness as measured by their licensing income compared to their inputs into the process.

The University Technology Transfer Process

According to research, the most comprehensive theoretical version of university technology transfer process is seen as more or less a linear process (see Fig 1) (Siegel, 2003). It begins with scientific discovery, followed by the decision on the part of the inventor as to whether or not the discovery should be reported to the TTO. If there is an invention disclosure, then the invention goes through a formal review process through the TTO, at which point the TTO staff decides if they should pursue patent protection, and if so, if they should patent the technology both internationally and domestically. These decisions are contingent on the financial resources that are available to the TTO. The next step in the process is to seek commercialization for the technology. This involves marketing the technology, and in the event that there is an interested licensee, it also involves negotiating a licensing arrangement.

As pointed out by Siegel (2003), this linear process as described by theory, may present an oversimplification of the university-industry technology transfer process since additional factors may play a critical role in the process. The primary goal of my thesis is to illuminate the intricacies of the organizational practices of some of the top research universities in the United States, in an attempt to identify factors that are unique to high outcome universities and high activity universities.

Licensing income was chosen as the appropriate measure of university technology transfer output because of the general consensus among university TTO that their most important objective is the level of royalties and fees generated (Thursby, 2001). Granted, university TTO often see technology transfer as a support service function of the university to faculty members, but there is still an awareness of the need for a profitable program (Trune, 1998).

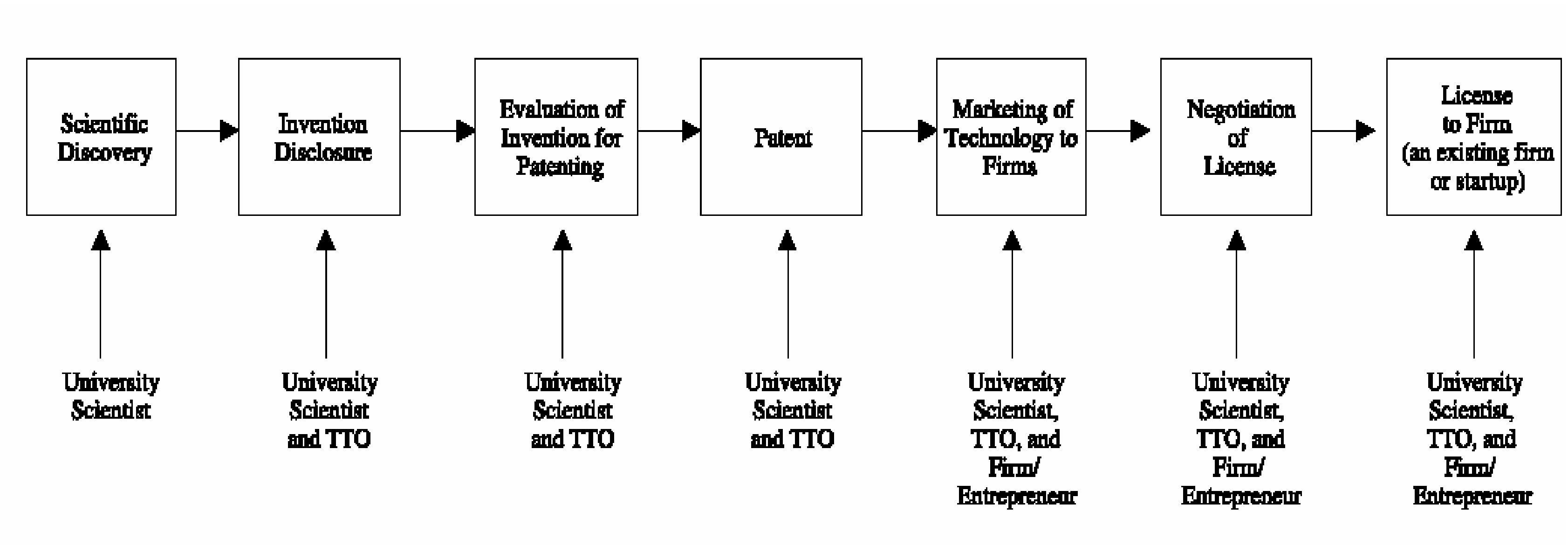


Fig. 1 – Siegel's depiction of the technology transfer process as is suggested by theory (Siegel, Waldman, Atwater et al., 2003).

Previous Studies on University Technology Transfer

While organizational practices are seen as critical to the success of technology transfer in universities (Siegel, 2003), very little research has been conducted in this area. Thursby, Jensen and Thursby (2001), Thursby and Thursby (2002), Bercovitz et al. (2001) and Siegel et al. (2003) are notable exceptions. Thursby, Jensen and Thursby (2001) surveyed TTOs of 62 major U.S. universities and focused on "policies related to ownership of inventions, the nature of the university inventions, license policies and strategies, as well as university objective in licensing". They suggested that the embryonic nature of many university inventions necessitates the faculty inventor's expertise for further development of the technology. Furthermore, faculty contacts were also seen as pivotal to successful marketing of the invention. The Thursby study also disclosed a list of marketing procedures for the sample universities. Following is a table that summarizes the findings of this study as they pertain to marketing procedures. The TTO directors in this study cited many of the factors identified below as methods they use for technology marketing:

Table 1 – Taken from (Thursby, 2001), showing results for TTO marketing strategies	
What procedure (s) does your office follow in marketing technologies which are available for licensing?	
	Percentage of respondents
Personal Contacts	75.0
Inventor Contacts	58.3
Direct mailing/fax	52.5
Website	37.5
Meetings	20.8
Trade Shows	18.8

Thursby and Thursby (2002) used quantitative data from the annual survey conducted by the Association for University Technology Managers (AUTM) to study the productivity of university technology transfer offices (TTOs). They were able to use this analysis to relate productivity to particular university characteristics in the 57 universities that responded to all the AUTM surveys for the period 1991-1996. Their results suggested that the total number of licenses executed would have the greatest impact on the efficiency of the technology transfer office, with such an outcome stemming from the importance that licensing plays in the commercialization process.

Unlike the Thursby and Thursby (2002) study that used quantitative data, Bercovitz et al. (2001) utilized case studies at three different universities. They combined qualitative and quantitative data to examine the relationships between organizational structure and technology transfer performance at three major universities and found that to a certain extent, factors such as coordination capabilities, information processing capacity and incentive alignment can be predicted based on the organizational structure of the university technology transfer office. That is to say, TTOs with a more decentralized operating units (H-Form) tend to be better at unit-level information sharing, while offices where one person or sub-unit is responsible for multidimensional functions (MX-Form) tend to have greater across unit coordination and incentive alignment. On the other hand, offices with centralized administrative offices and decentralized units (M-Form) offer greater across unit coordination.

Finally, Siegel (2003) used a combination of quantitative and qualitative data to study the relative productivity of university TTOs. Using a convenience sample of five universities, these researchers conducted interviews with administrators, entrepreneurs and scientists at five different universities to produce a list of organizational factors that were determined to have an effect on the efficiency of technology transfer offices. All of the individuals who were interviewed are stakeholders in the university industry technology transfer (UITT) process. The quantitative data was used to determine the factors that might be important in the technology transfer process.

There were other studies on university technology transfer that did not specifically look at factors affecting the efficiency of the process, but they did make useful contributions to the field. One study provides a framework for determining which technologies will be licensed based on the level of intellectual property (IP) protection (Shane, 2002), while another looks at the importance of patents in measuring knowledge spillover from universities (Agrawal & Henderson, 2002). Another study looks at the effects institutional practices on the faculty decision to disclose their inventions (Owen-Smith, 2001). Unfortunately, none of these studies, nor the previous ones, looked specifically at organizational practices in university technology transfer, have looked at possible differentiating factors between universities that are at the extremes with respect to a comparison of their levels of inputs vs. their levels of outputs in the technology transfer process. This thesis seeks to fill the void that currently exists in this area, since we will look at those extremes, as opposed to the average university. If there are differences between the organizational practices between the HA and HO universities, then this information would be interesting to know since these two groups of universities can benefit from the practices of each other. Conversely, if there are no significant differences between organizational factors of the HA and HO universities, researchers will be aware that the factors being measure in this study do not differentiate these groups from each other, and possibly conduct further studies to determine which factors do.

CHAPTER III

THEORETICAL BACKGROUND & RESEARCH MODEL

Alternative Theoretical Backgrounds

This paper uses the real-options theory to explain the effects of university commercialization practices on the success of technology transfer efforts as measured by licensing income. Arguably, there are other theories (for example, the dynamic capabilities theory (Teece, 1997), the resource-based view (Barney, 1991) and the resource-dependence theory (Pfeffer, 1978) that could have been applied to the university technology transfer research, but the options theory was determined to be the best suited for gaining an understanding of all the activities that go into the university commercialization process. This section begins by looking at some of the different theories that may have been applicable to this study. It then goes into a justification of the selected theoretical basis.

Dynamic capabilities theory

The dynamic capabilities model evaluates the methods of wealth creation of organizations operating in rapidly changing technological environments (Teece, 1997). Dynamic capabilities are further defined as the processes of the firm that use resources to create market change through integration, reconfiguration, and acquisition and release of resources (Eisenhardt, 2000). The managerial and organizational processes, along with the assets of the firm, contribute to the competencies and capabilities of the firm. The institution's history, as determined by its path dependencies, greatly impacts the options that are available in terms of product development strategies (Teece, 1997). These path dependencies are a factor of the amount of investments made by the institution in its current processes and knowledge base (Deeds, 2000). There are however, two types of path dependencies - static and transformational. With static path dependencies, the more a firm gains experience selling to one type of customer, the less likely it would be to enter a new market. Conversely, the more a firm gains experience reorganizing or redirecting its effort to new markets, the more likely it would be to continuing doing so, leading to transformational path dependencies. Transformational path dependencies mobilize organizations by allowing them to create processes that support change (King, 2002). Dynamic capabilities would have been a more suitable theoretical background for this study if university TTOs behaved more like corporations in terms of targeting their new product development efforts towards market needs. On the contrary, the very nature of university research, allows inventors to work on whatever is of interest to them at the moment, after which, the TTO tries to determine if the invention has commercial potential. As a result, although this is an interesting theory when looking at targeting new product development efforts to market needs, it does not provide the most appropriate framework for looking at the organizational practices affecting technology commercialization in university TTOs.

Resource-based view

The resource-based approach (Penrose, 1959; Wernerfelt, 1984) uses philosophies from three major areas of research: strategy, organizational economics and industrial organization analysis (Mahoney, 1992). This view pays particular attention to the specific attributes of value, substitutability, imitability and rareness as characteristics of a technology that might affect a firm's ability to extract profits from its innovations (Barney, 1991). This theory would provide a very strong framework for analyzing the strengths of the innovations emerging from the university setting. However, it does not account for the processes that the TTOs would use to commercialize these innovations.

Resource-dependence Theory

The resource-dependence theory (Pfeffer, 1978) pays particular attention to the impact of external resource dependencies on the performance of the firm. This theory has been used in the study of academic entrepreneurship because of (1) its view of organizations as dependent on the external environment, (2) the levels of uncertainty about the actions of these external organizations and (3) a shift in the direction of the dependence, as organizations will of seek to reduce their dependence. These factors were all seen as being applicable to the university setting (Powers, 2000). This theory would work very well for universities that are looking towards technology transfer as a method of reducing their dependency on outside sources of research funding (Powers, 2000). However, given that for the sample of universities in this study, their average total research and development funding is well over $400 million dollars, these universities do not consider “inadequate funding” to be a major issue.

Real Options Theory

The real options theory provides a framework for decision making which involves an initial investment decision (option creation) followed by a subsequent investment decision (option exercise), with the second investment usually being considerably larger than the first (Rosenberger, 2003). This allows the investor to mitigate the cost of failure by controlling the rate at which resources are funneled into the investments (Bowman, 1993; McGrath, 1997; McGrath, 1999; Trigeorgis, 1993). According to Rosenberger, here are some of the variables that affect option creation and exercise:

(1) uncertainty – causes managers to be more conservative in their investments. By making smaller initial investments, managers are able to observe their environments before exercising their options.

(2) asset value – there seems to be no relationship between the value of the asset and option creation, because for very valuable assets, both creating an option or outright ownership creates value for the manager.

(3) irreversibility – describes the level of difficulty in undoing previous investments. So in situations were investments are irreversible, managers will have a tendency to decrease their option exercise, as this course of action may result in the loss of very large investments.

(4) exercise costs – is the cost to exercise the option. As the cost of the option exercise increases, managers are less likely to both create options and exercise options. They are more likely to wait for the exercise cost to decrease before making any decisions.

(5) competition – in situations where there is more competition for an option, managers will be less likely to both create options and exercise options, because it is more likely that other firms will stand in the way of the manager exercising the option.

In summary, in constantly changing environments, firms will gravitate towards option creation and as these ambiguities decrease, option exercise will increase (Hackett, 2004; Rosenberger, 2003).

Real Options the best option

Given a review of the above theories with respect to investigating the organizational practices of the TTOs, the real options theory was seen as the most appropriate for this study. Real options is a philosophy that gives the right but not the obligation to exercise options. Since university TTOs are constantly faced with decisions about options, it makes sense to use the real options perspective as the lens through which to study the TTO technology commercialization process.

Options theory would view the decision of the technology transfer office to “elect” a technology as creating an option (see Fig. 1). Election of a technology involves investing TTO finances and human capital into the evaluation and the subsequent decision of the TTO to assume ownership of the technology. The steps that follow the decision to attempt commercialization, which include pursuing intellectual property protection, marketing the technology and negotiating a licensing contract would all be seen as option exercises. The primary tenet of the real options perspective is that options creation will increase in situations of high uncertainty, and when that uncertainty decreases, option exercise will increase (Rosenberger, 2003). Universities can be considered to exist in uncertain and competitive environments; there is competition for finances as well as for top students (Powers, 2000). TTOs also face uncertainty in terms of being aware of the value and commercial potential of their technologies. In general, university inventions are embryonic in nature, with the manufacturing feasibility being known for only about 15% of the inventions, and with only 12% of the inventions being ready for commercial/practical use (Thursby, 2001). Additionally, patenting is an expensive and irreversible process. It would thus make sense for TTOs to use option creation to ensure that their technologies are further along developmentally, before seeking patent protection. In fact, the patent office may chose to deny the patent (choose not to exercise the option) on the invention if its utility cannot be proven (Thursby, 2001). As postulated by the options theory, in such uncertain environments, organizations using option creation will face less risk and outperform those organizations that do not use options (Rosenberger, 2003). From these propositions, it would follow that universities who actually use real options as a mechanism for gauging the value of the technology and reducing uncertainty in the commercialization process will outperform those who do not.

Although the real options perspective has not previously been used to study the university technology commercialization process, it has been used in research that can be characterized as being similar in nature to this study, and we believe that it may provide a useful framework for this problem. For instance, Hackett and Dilts (2004) do an impressive job of explaining why the real options theory would be the most appropriate for explaining the process of incubating new ventures. Hackett and Dilts (2004) describe the incubation process as incubatee selection, monitoring and assistance and resource munificence (Hackett, 2004). Similarly, it appears that the university commercialization practices can be segmented into three main areas: technology selection, technology marketing and managerial practices (which will be described in the following section). Thus, in many ways the incubation process is similar to the technology transfer process in the university setting. As a result, my thesis will use the Hackett and Dilts model and their use of options theory as a guide for building the framework for this study.

Research Model

The following model (fig. 1) was developed in order to be able to provide more clarity to this thesis. The three main areas of technology transfer which this thesis intends to explore are: (1) Technology Selection Processes, (2) Technology Marketing Processes and (3) Managerial Practices. All of these factors constitute university technology transfer practices, and they are all combined in different ways and accordingly will impact the technology transfer outcome of licensing income. As mentioned earlier, based on real options, technology selection would the creation of the option, while the technology marketing and managerial practices constitute exercising the option.

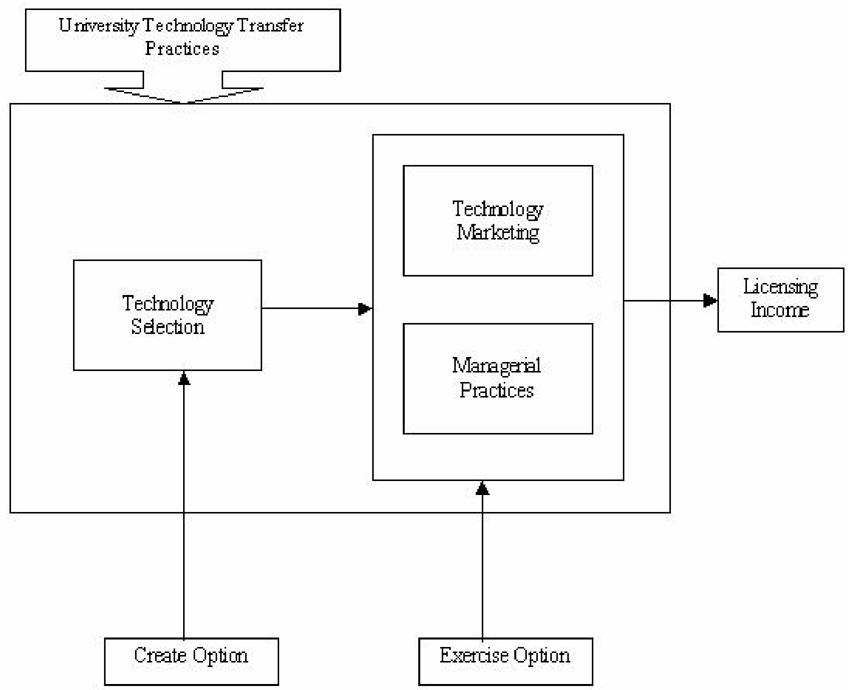


Fig. 2 – University Technology Commercialization Model

Technology Selection

The intent of this section is to explore the process that takes place prior to making a decision about commercializing one of the technologies from the university's portfolio. According to theory, after receiving an invention technology disclosure, the TTO would make a decision about whether or not to pursue patent protection, and this decision may be influenced by the presence of industry interest. In some instances, the TTO may decide to pursue patent protection prior to any expression of interest by industry (Siegel, 2003). Although this tells what is done in the TTO office, it makes no mention of the attributes that would make a technology attractive for pursuing patent protection in the absence of an expressed interest by industry.

Technology Marketing

This involves the process of creating awareness in the marketplace of the existence of one of the technologies within the university's portfolio. The majority of technologies emerging from universities are generally in their embryonic stages and will require the cooperation of the faculty inventor and relationships with industry contacts for successful marketing of technology

(Thursby, 2001). Additionally, the life-cycle stage of the technology may determine the kind of company that the technology is licensed to, with early stage technologies having a tendency to be licensed to start-up companies and late-staged technologies being licensed to larger companies (Thursby, 2001). It will be interesting to see if these same attributes of technology marketing apply to the top research universities.

Managerial Practices

The main purpose of this section is to explore the managerial practices and philosophies within the university technology transfer office. Some of the issues that have been identified as managerial hindrances to successful technology transfer are incompetent technology transfer officers, inflexibility of the TTO, and insufficient rewards for inventors (Siegel, 2003). Inventor cooperation is critical to university technology transfer efforts, primarily because they provide the inventions as well as industry contacts for marketing the inventions (Siegel, 2003). However, the decision of the inventor to work with the TTO will often depend on their perception of the resulting benefits (Owen-Smith, 2001). These perceptions can often be influenced by the TTO making a concerted effort to educate inventors on technology transfer.

Summary

Chapter III has presented the theoretical background and a model for exploring the technology commercialization process in the university TTO. After careful consideration of a number of theories, it was determined that the real options perspective would be the most appropriate for looking at the research described in this thesis. Accordingly, university TTOs that use the real options approach should have a higher financial outcome than university TTOs that do not. Finally, using the real options perspective and the model developed by Hackett and Dilts (2004), a university technology commercialization model was developed to look at how technology selection, technology marketing and TTO managerial practices could affect technology transfer performance, as measured by licensing income.

CHAPTER IV

METHODOLOGY

As previously mentioned, there have been no studies that compare universities that exist at the extremes in technology transfer efficiency. In order to accomplish this task, the 2-staged methodology was employed. The first stage involves the use of quantitative data in order to determine which universities would be included in the study. The second stage then used these universities as the target of open-ended qualitative research. The interviews were conducted via telephone, and the conversations were recorded so as to better allow the interviewer to focus on the conversations with the TTO directors. Following is a description of the steps that were taken to carry out this study.

First of all, this thesis seeks to show differences between high outcome and high output universities, but before this can be done, there is a need to obtain data that may show differences in universities, and this data will be used to determine if there were even universities occupying the extremities of technology transfer that were mentioned earlier. This data was quantitative in nature, and was compiled from a number of published sources. A list of the top fifty-two American research universities was obtained from the Lombardi Program on Measuring University Performance. This list is determined by the rankings of the universities on nine different measures (see Table 2) (Lombardi, 2002). For the purposes of this study, the following data were taken directly from the Lombardi Report: Number of Measures in Top 25 Nationally, Number of Measures in Top 26-50 Nationally, Total Research, Total Research National Rank, Federal Research and Federal Research National Rank. For the majority of the schools in the sample, information on the number of full-time and number of part-time faculty was taken from The College Blue Book, 30th Edition (Quick, 2004). For the schools for which this information could not be found in the College Blue Book, the information was obtained from the Peterson's web publication at www.petersons.com and from the websites of the schools.

Table 2 - Lombardi Measures for Ranking Research Universities

Measures	Total Research
	Federal Research
	Endowment Assets
	Annual Giving
	National Academy Members
	Faculty Awards
	Doctorates Granted
	Postdoctoral Appointees
	Median SAT scores

Data on university technology transfer was taken from the 2000 annual report from the Association of University Managers (AUTM, 2000). The 2000 data was used because it was the most recent data available at the time of data collection (see Table 3).

Table 3 – List of AUTM Variables

Variables Taken from AUTM	Medical School
	2000 Total U.S. Patents
	2000 Licensing Income
	Start-Up Companies Formed
	Number of Licensing FTE's in Technology Transfer Office
	Other FTE
	Invention Disclosures Received
	Number of Licensing Agreements
	Start Year of TTO

Some of the schools included in the top U.S research universities were not participants in the AUTM survey, so those schools were contacted directly for information concerning technology transfer. Certain universities like the University of California system reported their data to AUTM in aggregate. For the University of California system, much of the necessary information for the individual schools was taken from their 2000 annual report (*Annual Report: University of California Technology Transfer Program*, 2000) while additional information was obtained from the individual TTOs.

Statistical analysis was performed to determine which of the measures would be the most relevant to this study. A correlation matrix was generated for the variables in the sample, and for the most part, the relationships came out as expected[1]. However, in certain instances non-significant relationships appeared where significant relationships were projected and significant relationships disappeared after controlling for university size. This observation of positive and significant relationships disappearing when controlling for size was present in the relationship between federal research dollars and patents per faculty (.677** versus .235) and total research dollars and patents per faculty (.635** versus .105). This relationship was also observed between the number of licensing FTE's and the number of patents per faculty (.568** versus .166)[2].

Another significant relationship appeared between the number of startup companies and the number of licensing agreements of the TTO. Conversely, it was found that there were non-significant relationships between the total faculty at the institution and the outputs of the technology licensing process (i.e. licensing income, start-up companies formed, licensing agreements and total patents). This observation could be explained in terms of the quality of the faculty at the various institutions. Having a large faculty does not necessarily mean that they are contributing to the pool of available technologies that would impact the commercialization process (Powers, 2000).

The age of the TTO did not show a significant relationship with licensing income or licensing income per faculty or licensing income per FTE or patents per faculty. Although older universities may be more efficient at forming start-up companies and negotiating licensing agreements, they may not necessarily be gaining the most from their intellectual properties.

An interesting discovery was made from the correlation matrix: neither the number of start-up companies formed (correlation of .239), nor the number of licensing agreements (correlation of .153) had a significant relationship with licensing income. Additionally, although there was a significant relationship between invention disclosures and licensing income, it was not very large and controlling for the size of both the university (number of faculty) and the TTO (licensing FTE's), the relationship disappears. What this seems to translate into, is that factors such as number of licensing agreements, number of start-up companies and number of invention disclosures do not necessarily translate into higher licensing income. This was an interesting discovery and somewhat counterintuitive. Given that licensing income is generated from

[1]Based on prior research that was conducted in this area e.g. (Powers 2000), (Siegel, 2003) and (Thursby, 2002).
[2] ** Relationship significant at the .01 level

licensing activities, either to existing companies or to start-up, it would seem that the more of these licensing arrangements that exist, the more licensing income would be generated. For this reason, the above three factors were plotted against licensing income to determine the type of relationship that existed among the variables (see Fig. 2 and Fig. 3). In one scatter plot, number of licensing agreements and number of start-up companies were combined and plotted against licensing income. Additionally, the number of invention disclosures was plotted against licensing income.

As expected, in both graphs, there were universities that existed in the extremes. Those were the ones that are of special interest to this study – universities in the top left quadrant, which translates to mean low input, high output universities, and the universities in the bottom right quadrants, which translate to mean high input, low output universities.

Four universities were selected from each category, and these eight sites became the focus of this study. It was felt that this would be an appropriate number for each group so as to predict similar results within groups and contrasting results between groups (Yin, 1994). Two of the universities in the upper left quadrants were not a part of the sample because in one case, the university TTO director did not respond to the request for participation even after a number of attempts on the part of the researcher to enroll them in the study. In the second case, the university TTO only occupied that position in the upper left quadrant in 2000, but fell off the chart in 2002.

Variables Pertinent to University Commercialization Practices

Below is an explanation of all the variables that were included in the initial quantitative exploration. All the variables were populated into a correlation matrix, as mentioned earlier in this section, in order to determine the relationships among variables. These relationships were used as the basis for determining the critical variables in the study.

Dependent Variables

- **Start-up companies formed (STARTUP)** - The decision to undergo university technology transfer through start-up companies is one that is carefully considered due to the extensive time and resource commitment (Powers, 2000). However, forming a start-up company as a vehicle for commercializing a particular technology may prove to be a preferred method for generating the most benefit from an emerging technology (Powers, 2000), since the value of a technology increases as it gets closer to being an end product. That is to say, there is significant commercial potential in transferring university technologies through new ventures (Okada, 1999). As a result, the number of start-up companies formed would serve as an output from the technology transfer process.

- **Licensing Income Received (INCOME) –** This is the primary method of measuring university licensing endeavors. In many situations this licensing income is used to judge the success of technology transfer offices in realizing rents from their licensed technologies. They provide objective and visible measures of the financial profits that are realized from the commercialization process. These measures of university performance attempts to capture the financial returns to the university (Powers, 2000). Both Thursby (2002) and Siegel (2003) support using licensing income as a measure of technology transfer output.
- **Number of Licensing Agreements (LICAGR) –** This variable is considered to be central to the commercialization process (Thursby, 2002). This type of licensing activity is seen as being one of the most crucial outputs of technology licensing (Siegel, Waldman, & Link, 2003) as it ultimately impacts the level of licensing income. Thursby and Kemp (2002) also support this viewpoint.
- **Total Patents (PATENT) -** Upon receiving and evaluating invention disclosures from researchers and scientists within the university, the TTO will then seek to patent those technologies which appear to have commercial potential (Thursby, 2002). As a result, the total number of patents obtained by a university can be viewed as one of its outputs of technology transfer.
- **Licensing Income per Faculty (INCFAC) -** This measure estimates the licensing income as a function of the size of the institution as measured by the total faculty at that institution.
- **Licensing Income per FTE (INCFTE) -** This measure estimates the licensing as a function of the size of the technology transfer office as measured by the total licensing FTEs in the technology transfer office.

- **Patents per Faculty (PATFAC)** - This measure estimates the number of patents as a function of the size of the institution as measured by the total faculty at that institution.

Independent Variables

- **Federal Research Dollars (FEDERAL)** - This value represents the average annual federal research dollars received by universities. Federal dollars actually make it possible to produce some of the technologies that are subsequently available for licensing through university technology transfer offices (Thursby, 2002). Although the federal research dollars was found to be positively significant in predicting the number of start-up companies formed, it was not predictive for the institution's licensing income (Powers, 2000).
- **Total Research Dollars (TOTRES)** - As with federal research dollars, the total amount of money available within an institution for research would be likely to influence the number and quality of the technologies available for licensing and could possibly have an impact on the outputs on university technology transfer.
- **Total Licensing FTEs (LICFTE)** - An increase in the number of individuals employed in the TTO office would likely increase the number of licensing agreements generated by the TTO although it was not found to result in additional revenue (Siegel, 2003).
- **Invention Disclosures (INVDIS)** - These provide the pool of technologies that are available for licensing and are a key input into the technology licensing process (Siegel, 2003).
- **Presence of Medical School (MEDSCH)** - Thursby and Kemp found that the presence of a medical school may actually decrease the efficiency of the technology transfer process of the school in which it is located (Thursby, 2002). The presence of a medical school was not significant in predicting the licensing income, but it was found that institutions with medical schools did have fewer start-ups than those without (Powers, 2000).
- **Public/Private University (PUBPRI)** - Private schools should be more efficient at technology transfer because of their ability to specialize more so than public universities would be able to (Thursby, 2002). In this same study by Thursby and Kemp, this variable was indeed found to be a significant determinant of university technology

transfer efficiency (Thursby, 2002).

Control Variables

- **Number of Faculty (FACULTY) -** This variable measures the size of the university in which the TTO office operates.
- **Age of TTO (AGE) -** Older TTOs tend to be more efficient in their licensing of university intellectual property, suggesting that there is a learning effect involved in this activity (Siegel, 2003).

As observed in the statistical analysis, an increase in the number of start-up companies, number of licensing agreements and invention disclosures does not automatically mean more income for the UTTOs. In fact, after plotting these variables against the outcome variable of income, it was observed that there are actually two distinct groups – high outcome institutions and high activity institutions. In order to determine which universities would be a part of the sample, two different graphs were plotted, and the outliers were selected.

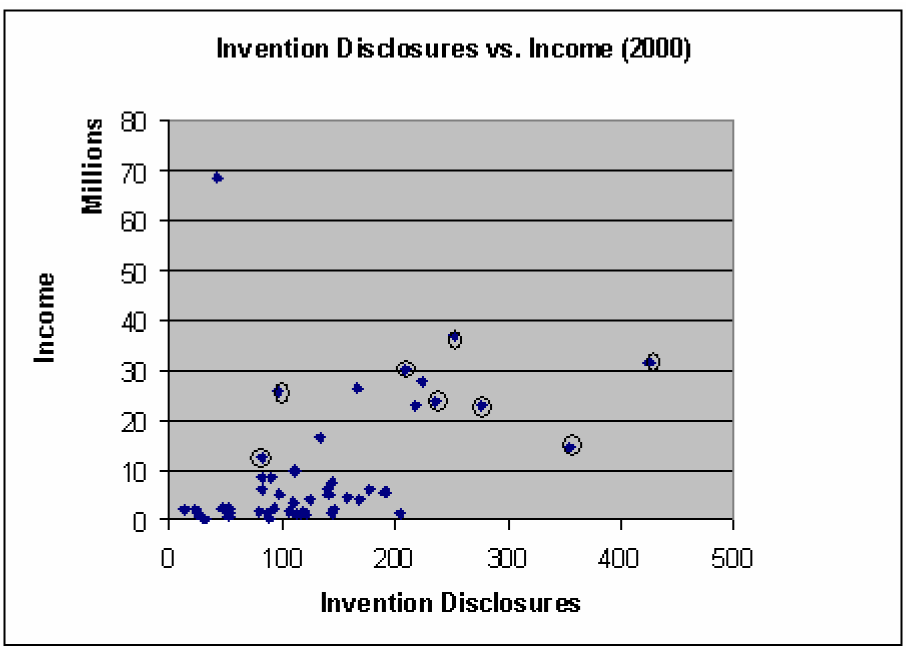


Fig. 3 – 2000 Data showing Invention Disclosures vs. Licensing Income

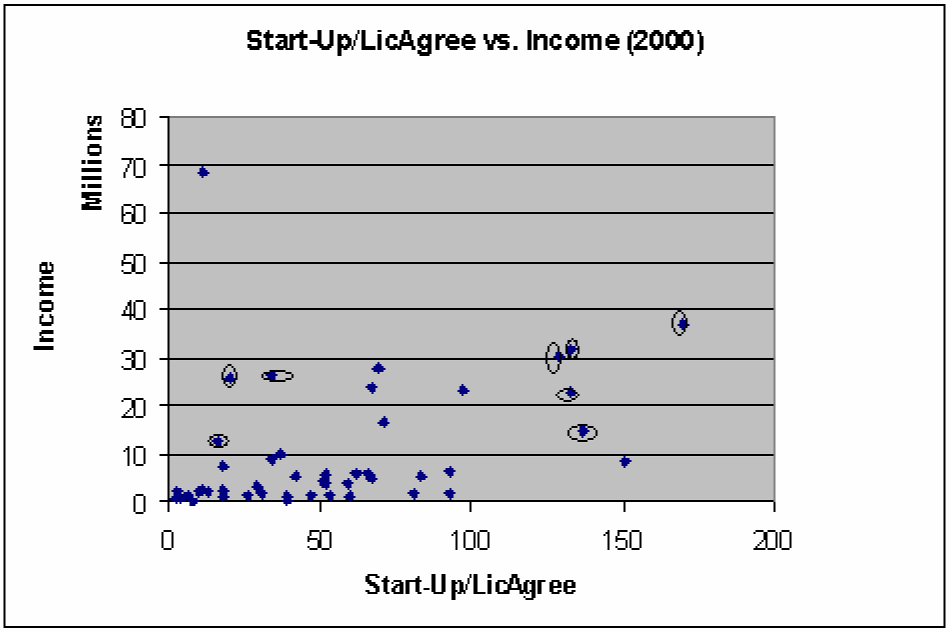


Fig. 4 – 2000 Data showing Start-up Companies formed and Licensing Agreements vs. Licensing Income

In the above graphs, the circled points represent the universities that were selected to be in the study. The circled cases to the left of the graphs have fewer inputs into the technology commercialization process than the cases to the right of the graphs, while both groups share similar levels of licensing income. For this reason, the cases to the left are classified as HO universities, while those to the right are classified as HA universities. The two outliers were not a part of the study because in one case, the TTO director did not respond to the request for participation even after constant requests, while in the other case that TTO only appeared in that position for one year, and fell off from the chart in the subsequent year.

Being aware that the universities that occupy certain positions may vary from one year to the next, I also collected data for 2002 and compared the two sets of graphs from those years. As expected, there was a slight variation in the universities that fell into each category, but in general, the results remained constant. That is to say, the universities that were high outcome in 2000 were also high performers in 2002, and likewise for high activity universities.

Qualitative Approach to Data Collection

The research sample consisted of eight universities selected from among the top 52 research universities in the United States. Four of these universities will from this point on be referred to as "high outcome" (HO) universities, while the other four will be referred to as "high activity" (HA) universities.

Definitions of HO and HA universities

HO universities - are located primarily in the top left quadrants of the graphs. They have fewer invention disclosures, less start-up companies and fewer licensing agreements, but they generate impressive levels of licensing income.

HA universities - are predominantly found in the bottom right quadrants of the graphs. They have higher levels of invention disclosures, start-up companies formed and licensing agreements than do HO universities, but they have approximately the same levels of licensing income as the HO universities. They begin the technology commercialization process with more research dollars at their disposal, but their licensing income does not increase accordingly.

2000 data was used for this study, but recognizing that there can be a lag effect in terms of the when the outcomes of licensing activities are observed, the 2000 data was cross-referenced against 2002 data. All of the universities in the sample were consistently in the same position across both time periods. The case study methodology was appropriate in this situation, since I sought to compare the processes of university technology commercialization, as it exists in its real-life context (Yin, 1994). The process of technology commercialization will serve as the **unit of analysis.** Following is a description of the universities in the sample.

Table 4 – Characteristics of the 8 universities in the case study

	High Outcome Universities				High Activity Universities			
	A	B	C	D	W	X	Y	Z
Institutional Control	Private	Public	Public	Private	Private	Public	Private	Private
Number of Disclosures	<100	151-200	201-250	101-150	351-400	251-300	251-300	401-450
Number of Start-Ups formed	0-5	6-10	6-10	0-5	6-10	6-10	6-10	>10
Number of Licenses/Options Executed	11-20	21-30	121-130	69-70	121-130	121-130	161-170	101-110
Gross Licensing Income (millions)	11-20	21-30	21-30	11-20	11-20	21-30	31-40	31-40
Issued Patents	26-50	51-75	51-75	51-75	99-125	76-100	76-100	151-175
Total Research Dollars (100 millions)	2.1	3.1	5.3	3.4	9.0	5.5	4.5	4.3
Total Federal Research Dollars (100 millions)	1.5	1.2	3.9	2.8	7.9	2.8	3.7	3.1
Number of Faculty (thousands)	2.3	1.6	3.3	2.4	1.1	2.2	1.7	1.8
Medical School	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Licensing FTE's	6-10	11-15	26-30	16-20	21-25	21-25	21-25	26-30
Age of TTO	11-20	21-30	21-30	21-30	31-40	61-80	31-40	61-70

As seen from the above table, the HO and HA universities vary in a number of ways. The HA universities have significantly higher levels of invention disclosures, more start-up companies formed and more licenses executed. Additionally, their total research dollars is considerably higher than that of the high outcome universities. These higher levels of licensing inputs do not however, seem to give them an edge over the HO universities in terms of licensing income. Table 4 shows that the licensing incomes of both groups are approximately at the same levels.

IRB Approval

This study involved the use of human subjects, and as such, could not be administered without prior approval from the Vanderbilt University Institutional Review Board (IRB). The IRB is responsible for reviewing all research activities that involve human subjects, to ensure that "ethical considerations, scientific merit, adherence to regulations and IRB policies and procedures" are met.

Information on the study was submitted to the IRB for review and on January 29th 2004, I received notification that the study had been accepted for Exempt Review by the IRB (IRB# 040070).

Selecting Survey Participants

After the focus universities were selected, I visited their respective websites to determine the appropriate individuals to direct correspondences to. The survey questions were directed at individuals within the organization who were at the director level, since these would be the people who would have the most intimate knowledge of the issues being tested in the survey instrument.

Development of the Survey Instrument

It was determined that the best method of testing the research model was to survey TTO directors. The questions for the survey instrument fell into three major categories identified from theory. These categories, as mentioned above, were technology selection, technology marketing and managerial practices. The questions were open-ended, semi-structured questions (Miles, 1994) were developed in order to allow the respondents to fully open-ended in nature to allow participants to provide their insights on the areas being study.

As mentioned before, there were a few studies that looked particularly at factors that could impact the efficiency of the university technology transfer process. In particular, the Siegel study (Siegel, 2003) identified a number of factors that could be barriers to university industry technology transfer. A number of these were incorporated into the survey instrument for the purpose of testing their significance in influencing efficiency in high output and high activity universities (See Appendix C). Once the critical factors for the purposes of this study were identified, they were presented in the form of open-ended questions for review by a fellow researcher in the Management of Technology program. Certain terminologies in the survey were then modified based on his feedback. At this point, the survey consisted of three sections and thirteen questions.

The next step was to present the survey to an actual director of a TTO. His feedback was incorporated into the survey in a number of ways as described below:

- Certain terminology was changed so as to reflect terms that are used in the technology transfer field.
- The title of one of the sections was renamed to more accurately reflect the areas that were being tested.

- Additional questions were added to each section in order to gain a more comprehensive understanding of the processes that were being evaluated in technology transfer offices. In section 1, the number of questions increased from five to seven. In section 2, the number of questions increased from four to five questions. Two of the questions in this section were reworded for the purpose of increasing clarity. And in section 3, the number of questions increased from four to five questions. One of the questions was broken up into two questions (see Appendix C for a copy of the survey).

Pre-Tests

The survey instrument was pre-tested at two different university technology transfer offices, and suggestions for improvement were incorporated before each successive pre-test. The pre-tests also assisted in ensuring that the surveys would take no longer than 30 minutes to complete. The first director suggested changes that should be made to the cover letter and responded to the questions in the survey. The second director also responded to the survey questions, and in both instances, it was determined that the survey should take no more than 25 minutes to complete (see Appendix C for a copy of the survey instrument).

CHAPTER V

RESULTS

This section will demonstrate that the HO universities (see Table 5) have two major things in common, as opposed to HA universities – (1) they consider their faculty members to be an integral part of their technology commercialization process, and they have severe reservations about undertaking any project in which the faculty member is not totally committed and (2) in making the decision about whether or not to form a start-up or to license to a start-up, the high output universities seem to be much more concerned about the ability of the start-up to attract funding and ability of the technology to generate revenue. This section will look at all three areas that were investigated in the study, discussing the results accordingly.

Technology Selection Process

Following is a look at the results obtained from investigating the technology selection processes in both HA and HO universities. This section looks at the responses for each of the factors that were measured, followed by a discussion of some of the unique practices in technology selection, as well as a section summary.

1. Positive Factors Affecting Commercialization

For the first measure which tested the positive factors affecting technology commercialization, it was found that HA universities looked at more areas when considering these factors. More HA universities also look at having a corporative and enthusiastic inventor (3 HA universities versus 1 HO university). Additionally, the HA universities also consider a greater number of positive factors in the decision to commercialize a new technology. Specifically, HA universities also pay attention to whether or not the market is ready for the technology. Additionally, one of the four HA universities will consider whether or not the technology creates a benefit for society, if the TTO can patent the technology with a broad claim, and whether or not the technology disclosure comes with a licensee. These factors were not mentioned by any of the HO universities.

Both HO and HA universities tend to focus on the commercial potential and the patentability of the technology, for example:

> "We evaluate all of our technologies for commercial potential and for patentability. In some cases, we have outside consultants do a commercial assessment for us and external patent attorneys do patentability assessments for us."

2. Negative Factors Affecting Commercialization

In many respects, the responses given to this question were the opposite of the responses to the previous question. Both HO and HA universities cited low commercial potential and low patentability as factors negatively affecting technology commercialization.

A greater number of HA universities cited uninterested inventors (3 HA universities versus 1 HO university) and complicated ownership (2 HA universities versus 1 HO university) as additional factors negatively affecting technology commercialization.

HA universities also consider a greater number of factors as negatively affecting technology commercialization. The HA universities cited five factors that were not even mentioned by HO universities. These were, a lack of interest by industry, an undesirable proprietary position, an inadequate or non-existent market, a difficult industry to license into and a high cost to file the patent. This HO director stated:

> "[factors contributing negatively to my decision to commercialize are] the industry is difficult to license into. If it [patents] would be hard to enforce. If it [the technology] was just a tweak on existing technology without a whole lot of added benefit or advantage. If it [the patent] would cost a lot to file"

3. Necessity of Patent Protection

With respect to the necessity of patent protection on technologies, there appears to be no significant difference between HO and HA universities. Both groups saw this as important. This is in line with the universities' commitment to the provisions of the 1980 Bayh-Dole Act. As one director commented:

> "…if you are going to comply with the Bayh-Dole mandate, there are just many situations in which a patent is necessary and exclusive licensing is necessary in order to

incentivize the licensee to come in and license and develop."

Conversely, there were instances when patent protection may not be important. For example, one director stated that his university does a great deal of licensing of biological materials and software without patenting. Before making this decision, TTOs must determine if it would be cheaper for the customer to purchase the technology or make it. If it is cheaper for the customer to purchase the technology, then there is not really a need to seek patent protection. If however, it is cheaper for a company to manufacture the technology, then the TTO would need to seek patent protection in order to protect the appropriability of the technology. One TTO director explains this as follows:

> "with some technologies, it [patenting] isn't necessary. It isn't necessary if the potential licensee has to obtain some physical thing from you, for example, genetically engineered mice or other animals. It's often easier for the customer and cheaper to license the materials from an institution under a bailment agreement, essentially, purchase them, than it would be to make them themselves. If it ever comes out that making it is cheaper than buying it, then you have to seek patent protection."

4. Who Handles Patent Protection

There were also no observable differences between HO and HA universities in who handled the legal work involved in patent protection. The majority of university TTOs (3 TTOs from each group) showed a preference for using external counsel. The main justifications for this were the wider range of talent obtainable from external counsel, the lower cost involved as opposed to having in-house attorneys, and because external counsel has more knowledge in very specific areas, it takes a shorter period of time to have the technology evaluated and the patents filed.

> "We use external counsel for the sake of specialization. We could not afford to hire the breadth of patent attorneys internally with the subject specialty expertise to do all of the patenting that we need. An attorney must mot just be a specialist anymore in the technology field, but must also be a specialist in the technology."

One university from each group uses a combination of internal and external counsel.

> "We file provisional patents in the office, but ultimately if there is actually ongoing prosecution with those patents that get filed we always ultimately seek outside counsel. Our regular and foreign filings are done by outside counsels."

5. Is Most of Your Income from Patented Technologies?

In all of the universities, the majority of their income was from patented technologies. This could be because of unwillingness on the part of the licensees to invest in technologies to which they do not have exclusive rights.

6. Percentage of Patents Sought from Disclosures

Another interesting observation was that the HO universities sought patent protection on a much smaller percentage (10%-50%) of their technologies, than did HA universities (40%-90%) of their invention disclosures. This validates that there is indeed more patenting activity taking place among the HA universities than among the HO universities.

7. TTOs' Primary Customer

The final measure in this section looked who the university TTOs perceived to be their primary customer. There appeared to be no observable difference between the two groups. Interestingly enough, all of the directors mentioned the faculty. There were certain instances when a director chose not to be limited to just one "primary customer", but decided that both faculty and industry were just as important. After further probing, a number of reasons were uncovered to justify the faculty members as a critical customer:

> "…I have two primary customers – faculty and industry, but if I had to answer the question to who my primary customer is, then I would look at the fact that I get paid by the university, I work on the university facilities, so therefore I would give the edge to the university faculty."

> "Faculty [is the primary customer], because if they are not happy, they will not submit inventions to you, and that's the quickest way for a tech transfer director to lose his job."

> "The faculty [is the primary customer], because that's the way it is here. There are others we must satisfy, but for the most part, at least at this institution, the opinions of the faculty members seem to have the most weight – at least as far as technology transfer goes. Their opinions matter as far was selecting licensees and establishing licensing

terms. To some extent, as far as pursuing an invention for patents or not – their opinions matter maybe more than at other universities."

Unique Practices in Technology Selection

The TTO directors were asked if they felt that there was anything unique about their technology selection processes. Half of the sample (2 HO and 2 HA) do not believe that they have any unique technology licensing processes. However, the other four TTOs in the sample were willing to share their unique practices.

One university TTO director believes that their technology selection uniqueness lies in their method of evaluating new technologies:

"We use our alumni who's been successful in business to help us evaluate the potential of our patenting and licensing process."

One HA university TTO divides its intellectual property functions and business functions between two unique groups of personnel. They believe that by breaking up these functions, the TTO increases the efficiency of the process.

Another of the HA university TTOs admits that faculty opinions have the most weight as far as technology transfer goes. That is to say, if the faculty member wants his/her invention to be patented, it will be patented. This same TTO is attempting implement a program that will allow for more objectivity in the technology selection process:

"…the institution is considering putting together groups of faculty advisors to the tech transfer office, as well as external advisors to the dean's office to help us focus more on commercially viable inventions. So to some extent, that's going to take the decisions fro patenting and commercializing a bit away from a decision by a licensing associate who's interacting with a faculty member."

Finally, although one HO university TTO did not believe that they had any unique technology selection practices, they did have plans to implement a program that would set them apart. This TTO director says:

> "We are trying to find ways to pursue proof of principle. I believe that the rate-limiting step for most of the technologies that we have that get disclosed in the biomedical research institution, is the fact that they are too early stage. I would want to find a way to help the technologies look further along. We want to find ways to pursue proof of principle, so that we can get people to evaluate the invention based upon its merit because there is something there to evaluate other than a concept or an idea."

Summary

In the majority of instances there appeared to be no observable differences between HO and HA universities in the factors that were taken into consideration as part of the university TTOs' technology selection processes. A few factors did however stand out. HA universities seek patents on a greater number of their invention disclosures, and this would confirm why these universities are high activity in the first place. Additionally, HA universities consider a greater number of positive and negative factors affecting technology commercialization. This is an interesting observation since it suggests that HA universities may be spending too much of their time considering factors that do not necessarily affect their licensing income.

Technology Marketing Processes

Following is a look at the results obtained from investigating the technology marketing processes in both HA and HO universities. This section looks at the responses for each of the factors that were measured, followed by a discussion of some of the unique practices in technology marketing, as well as a section summary.

1. Methods of Marketing

When it comes to the methods of marketing new technologies to the marketplace, there appears to be no significant difference between the HO and HA universities in terms of the way this is done. Both groups of university TTOs try to use faculty members (3 TTOs of each group) and websites (4 HO universities and 3 HA universities) as methods of marketing new technologies. One point which stood out, is that more of the HO universities seemed to rely on mailing campaigns, than do the HA universities (3 HO universities versus 1 HA university). It could be that this approach allows for a more targeted effort at matching technologies to the interest areas of prospective licensees.

The other methods of marketing new technologies seemed to be fairly constant between

HO and HO universities. Both groups attempt to use a variety of methods to market their technologies. Those include commercial databases, email alerts and TTO networking. TTO directors state about their marketing processes:

> "We market to our existing licensees that we already have. We have a website that is keyword searchable and an email verification list on that site. We work with the university communications office to get stories out on technologies that we have available."

> "One of our most effective marketing source is our mailing campaigns to potential companies with a marketing piece that describes the technology."

> "On a more general front, we do the things that everyone else does. We put summaries on our website. We list summaries with TechEx – one of the internet companies that take subscriptions from commercial entities, and based on keywords, match and push out summaries. We also enlisted in the last year and email alerting service patterned after how the NIH does theirs."

2. Factor favoring Start-up Formation/Licensing

For the factors favoring start-up formation or licensing to a start-up, there seems to be a consensus among the majority of the universities that faculty buy-in is a critical factor. However, in the HO universities, licensing to a start-up occurs if there is no interest on the part of established companies. If this is the case, then the HO universities tend to focus a bit more on the ability of the start-up to attract funding, and on the commercial potential of the technology that is being licensed. The following quotes best express the views of these HO universities:

> "We rarely have a choice (in the decision to form a start-up). We would probably always first try to license to an existing company, and if we're not successful, we would form a start-up when necessary."

Yet another HO university TTO director tells of the factors that would persuade him to form a start-up company instead of licensing to an existing company:

> "A lack of interest by industry. A commitment by the faculty member to pursue product development in spite of the lack of industry interest, and a technology that lends itself well to investment opportunity. Another big factor is outside interest by a venture capitalist or an entrepreneur."

Conversely, in the HA universities, half of the sample pointed out that they would give preference to a faculty start-up company if they could present a "reasonable" plan:

> "We (TTO) give preference to faculty start-ups if they have a reasonable plan."
>
> "We consider any opportunity to form a start-up company, whether it comes from a venture capital group that we meet with. Quite frequently, different groups will want to come and find out what we have going on. If they're interested in starting a company around a particular technology that we have in our portfolio, we're certainly willing to listen to them. If it sounds like they have a reasonable plan, we'd ask them to submit a business plan. Again, we'd need our faculty inventors' buy-in. Faculty members around here have quite a bit of weight as far as what happens with their technologies.

The HO universities pay additional attention to the management team of the start-up, as well as commercial utility and it's ability to attract funding prior to engaging in licensing to a start-up company. HO university TTO directors state about the factors that would persuade them to license to a start-up company:

> "A lack of interest by industry. A commitment by the faculty member to pursue product development in spite of the lack of industry interest, and a technology that lends itself well to investment opportunity. Another big factor is outside interest by a venture capitalist or an entrepreneur."
>
> "We rarely have a choice. We would probably always first try to license to an existing company and if we're not successful, we would form a start-up when necessary. Generally speaking, the inventor would have to be interested in participating in forming the start-up."
>
> "…if the start-up is credible, meaning that there is a business concept or plan document that looks like it could raise money. If there are already credible professional investors interested, or if there is a management team and an entrepreneur with a (good) track record. The short summary is that we would go whatever route we need to honor our allegiance to the technology and its commercialization."

3. Importance of Industry Networks

When it comes to the importance of industry networks in technology transfer, all of the universities in the sample seem to agree – networks are definitely important, and they will do whatever it takes to strengthen and extend these networks. Even when the responses varied from “critical” to “very important” to “important”, these responses seem to allude to the same underlying meaning expressed through different wording. In this respect, there seems to be no significant difference between HO and HA universities. One TTO director best captured the general feeling about the importance of industry among TTOs in this statement:

> “I think it’s very critical. I still believe that there is an art to this business and that it’s a people game or profession, and without those contacts or without developing those contacts and having excellent personal interactions with those people, then you’re not going to be successful in this business.”

One HA university did mention that industry networks were important but not critical, but stated:

> “It’s important, but not crucial. If you don’t have it you can develop it over time.”

In this case, the TTO director seems to acknowledge that these networks are important.

4. Methods of Cultivating Networks

There appears to be no significant differences between HO and HA universities with respect to their methods of cultivating the networks necessary for technology transfer. Those methods seem to be standard to the industry, and they include attending conferences/meetings, using faculty networks and hosting potential licensees on campus.

> “We write the people that we already know and try to keep them informed about new inventions and things like that. We’re always trying to increase the network, so we go to meetings and we meet people, or people come to visit us, so we’re always increasing the network.”

> “We attend professional meetings. We invite these people into the university. We get invited by these people to visit with them and what they’re doing. There is a constant stream of people that want to just come in and meet with the tech transfer office for a number of reasons. We [also] attend trade shows and market ourselves.”

There were a few other methods of cultivating industry networks that were mentioned by isolated university TTOs, but they did not seem to provide differentiation between HO and HA universities.

5. Faculty Involvement in Marketing

This question seems to bring out one of the major differentiating factors between HO and HA universities. As mentioned in question 1, all TTOs try to use faculty members in marketing new technologies. However, with HO universities, faculty involvement in the process is more of a requirement than a desire, as seems to be the case with many HA universities (4 HO universities require faculty involvement in marketing, versus 1 HA university). Some of the HO universities TTO directors' responses were:

> "They [inventors] have a big involvement because most licensees find us. And the reason most licensee find us is because many of our licensees, again particularly in the biomedical research area, attend the same scientific meetings as our faculty members do and they know what our faculty is doing, so they express our interest to us as opposed to us finding them."
>
> "[Inventors are] very involved. They are asked on the disclosure form to give us suggestions and we go sit and meet with them to try to figure it out. It's rare that they can't help us."
>
> On the other hand, HA universities responded as follows:
>
> "Well, we ask the inventors to help us write the abstract of the invention and if there are interested parties, we ask them [inventors] to meet with the interested parties. They may also do consulting if they want to."
>
> "They're [inventors] very important, but it's hard to get them involved."

From the remarks made by TTO directors, it seems apparent that both groups recognize the importance of having faculty participation in technology marketing. HO university TTO directors make this participation a required component of technology marketing, while HA university TTO directors will continue with commercialization efforts whether or not the faculty inventor will assist in the process.

Unique Practices in Technology Marketing

Just as was done with technology selection, the TTO directors were asked about unique features of their technology marketing processes. Two directors (1 HO and 1 HA) felt that having a prestigious school name assisted them in commercializing their inventions, since prospective licensees come to them as a source of new technologies.

One HO director states:

> "…another avenue we use is that we're constantly marketing our program to serial entrepreneurs trying to find experienced executives to start our companies. If we find an experienced executive, we will try to find them technologies that they like."

Another HA university TTO director feels that the uniqueness of their technology transfer office lies in the amount of time that is spent networking in an effort to generate company leads, while an HO director expressed frustration for the inadequacies of their marketing efforts:

> "Marketing is one of those things I don't think we do very well. We're like a lot of big companies that are under-staffed and under resourced – marketing is the first thing to go, and you come back and focus on the task at hand and getting your products developed."

This statement comes from an HO university.

Summary

HO and HA university TTOs do not differ in a majority of the factors that were measured by the survey. They have similar methods of marketing their technologies, they all recognize the importance of industry networks, and use more or less the same methods of cultivating those networks. With respect to the factors favoring start-up formation or licensing to a start-up company, the majority of the TTOs agree that faculty buy-in is important (4 HO and 3 HA). HO university TTO however, seem to pursue start-up formation only as a last resort, after a demonstrated lack of interest by industry (3 HO versus 1 HA). In this event, the HO university TTOs place more emphasis on evaluating the market potential of the technology and the ability start-up to attract funding (7 count of HO university TTOs versus 4 count of HA university TTOs).

HO and HA university TTOs vary most significantly in their ability to engage faculty inventors in marketing new technologies. Although, the majority of TTOs (3 HO and 3 HA) will admit that faculty inventors are vital to the technology marketing process, only in HO universities (all 4 HO universities) were faculty inventors “very involved” in marketing the new technologies, as opposed to the inventors being “somewhat involved” in HA universities (3 HO universities).

Managerial Practices

This section discusses the results obtained from investigating the managerial practices in both HA and HO universities. It includes the responses for each of the factors that were measured, followed by a discussion of some of the unique practices in technology selection, as well as a summary of the section.

1. Qualifications for Licensing Officers

There appears to be no significant differences in the qualifications that TTO directors look for when hiring new technology licensing officers. The majority of the TTOs (3 HO and 2 HA) look for some kind of advanced degree. They seem to have a preference for a Ph.D. or M.D. if the licensing officer is going to be focused on the life sciences. In addition to academic qualifications, TTO directors will look for a combination of other skills, including business experience, licensing experience, legal and technical knowledge and communications skills. As one TTO director states:

> “I look for somebody with legal, business and technical expertise. You can’t always find all three of those, particularly not at an entry-level position, so I look for a strong background in one of those three, preferably business or technical. I look for somebody who is well spoken, who can articulate difficult technical issues effectively and I look for somebody who has good people skills, because I believe that is critical to being a good dealmaker.”

One interesting observation is that HA university TTOs seem to have a tendency to look for licensing officers with qualifications in patenting (2 HA versus 0 HO).

> “Most of our intellectual property managers would have a Master’s degree or Ph.D. and some knowledge of intellectual property law. They all come with being a patent agent, or they go through the training to become a patent agent.”

> “We look for a familiarity with patents and the patenting process although we feel pretty comfortable that we can teach that.”

This observation may be as a result of the high level of patenting that takes place at HA universities, as mentioned in previous sections.

2. Qualifications in Senior Staff

HO and HA university TTOs seem to look for similar qualifications in senior staff. Of central importance seems to be academic licensing experience (2 HO and 3 HA).

> “In senior staff, we look for specific experience. I’ve found it very difficult to take someone from another industry and retrain that person. Ours is a very unique profession.”

> “Our senior staff have either a Ph.D. or a J.D. Also, they either have had extensive patenting experience or extensive business or contract negotiation experience or prior academic technology transfer experience.”

Senior staff is also expected to have such skills as business, legal and technical experience and the appropriate advanced degree. One interesting qualification sought by one of the HA universities, is that their executive staff comes with industry contacts.

3. Incentive Compensation

Incentive compensation for TTO staff was suggested as one of the methods of increasing TTO productivity (Siegel, Waldman, & Link, 2003). However, there appeared to be no major differences in the incentive compensation offered to licensing staff in the HO and HA universities. The majority of TTOs do not offer any kind of incentive compensation (3 HO and 3 HA). For the most part, the general sentiment seemed to be that the most critical thing was to offer competitive wages to licensing staff. Of all the universities in the sample, only two had a bonus system in place (one HO and one HA university).

4. Flexibility in Negotiating Licensing Agreements

All TTOs believe that they are flexible in negotiating licensing agreements, but they will admit that there are certain areas of a licensing agreement that are non-negotiable. Those areas include warranty and indemnity, preserving the right to publish, freedom to use and distribute research and the use of the university name. HO universities seem to have a greater tendency to be inflexible on reserving the right to distribute the technology for non-profit research. As stated by HO university TTO directors:

> "We work hard to try to get the deal done. We don't get credit for not doing deals in the tech transfer office. Our success at t end of the year is measured by the number of deals we do, so not getting deals done and being inflexible is not in our best interest. On the other hand, doing deals that don't generate revenue for the institution, protect our freedom to publish, and protect our freedom to distribute biological materials are not in our best interest."

> "Financially, we can be very flexible, as can most universities. The term we have trouble with, and yet we will still try to be as flexible as we can with is: retaining the right to use the licensed technology, not only for our own investigators, but the right to grant licenses to other non-profit institutions for use of the technology in their basic academic research."

5. Efforts to Educate Industry Contacts

There seems to be a consensus among all university TTOs that educating industry contacts is not a priority. This is because industry contacts are usually well versed in the particulars of university technology transfer. If however, they are not, the university TTO will take whatever the necessary steps are, to ensure that the industry contacts understand the commercialization process. University TTO directors say about their education of industry contacts:

> "Well, it's unfortunate if they don't already have it [education]. You like to work with people who understand working with universities. But if in fact some one doesn't, and we need to do a deal with them, we will spend a lot of time educating them."

> "As much [education] as is necessary to close the deal. Industry contacts are fully competent on all licensing issues. They just have to be educated in some instances on the peculiar needs of academic institutions"

> "Some of them [industry contacts] are pretty savvy about it and they've been through the process and they've done a lot of university licensing. And some of them [industry contacts] are new to the process and we have to do a lot more education on it. For the ones who are not as savvy, we give them a background of our operations; the policies and procedures that we have in doing licensing. The federal statues that we have to comply with and any other policies that we might run into. We just kind of walk through our agreements and point out why those things are there from a licensing standpoint."

> "…with much of our efforts being focused in the biomedical area, we've got a more sophisticated audience out there then I believe would exist in a number of other areas."

Often, when TTOs are pressed for resources, functions such as industry contact education are neglected:

> "There is not a lot of outreach right now by our office to the industry. Right now, we are a very resource limited office. So we're spending basically 100% of our time trying to manage reports of inventions and evaluating and licensing them."

6. Efforts to Educated Faculty Inventors

On the other hand, university TTO directors of both HO and HA universities seem to hold education of faculty and inventors in higher importance than education of industry contacts. The majority of the TTO directors stated that they placed a great deal of emphasis on inventor education, accomplishing this end through a number of methods such as frequent seminars, education during the course of the invention disclosure process and publications. A common comment made by respondents:

> "…you can never say that they're [faculty/inventors] are educated – there are new faculty coming in, people forgetting it – you've always got to be re-educating faculty."

Unfortunately, not all TTOs can place the kind of emphasis that they would like on faculty education:

> "It's too small of an effort, and again, we're reactive in the office instead of being proactive. And one of the biggest areas of criticism we get is that we don't spend enough time educating faculty."

Unique Features in Managerial Practices

Unique features about managerial practices that were revealed ranged from implementing a client service orientation in an effort to make the process interactive and realistic with faculty and licensees, to creating an office environment where the employees actually enjoyed their jobs. Another director felt their TTOs uniqueness was in their philosophy. This HA TTO director states:

> "Our objective is to get as many technologies invented as possible instead of making the most money. We often under-price a technology to make a deal reasonable. We do not have the "cherry picking" policy to select the best technologies. Our goal is to license 100 technologies per year."

> Other TTO directors state about the uniqueness of their management philosophy:

> "I insist that we have a good time, and I will fire anybody who doesn't have a positive attitude." (HO TTO director)

> "I'm not suggesting that we put a product on the market here at the university, but I am suggesting that there's additional value that we can create in our own technologies that goes above and beyond what the faculty member would walk in the door and disclose to us, and filing the patents and negotiating a license if a licensee can be found. There are additional things that can be done to create value." (HO TTO director)

Summary

For the most part, there appeared to be no significant differences between the HO and HA universities with respect to their managerial practices. They all look for more or less the same kinds of qualifications when hiring TTO licensing staff and executive staff. With respect to flexibility in negotiating licensing agreements, all of the universities felt that they could be very flexible on the financial terms of the contracts, but that there were certain areas that were not negotiable. These included areas such as warranty and indemnity, preserving publishing rights and preserving the freedom to use and distribute the technology for research.

On the measure of the TTOs effort to educate industry contacts, this area does not seem to be a very high priority. University TTO directors seem to believe that industry contacts are in general already educated, but if they are not, then the TTO will do whatever education it takes to get the deal done. The university TTOs do place greater emphasis on educating faculty inventors.

Summary of Results

HO and HA university TTOs are similar in most respects when it comes to their technology commercialization practices. Their differences lie primarily in their level of use of faculty inventors in the technology marketing process and in the amount of consideration placed in evaluating a start-up's potential before deciding to invest in such a venture. To be specific, HO universities require faculty inventors' cooperation in technology marketing while HA universities would like to have faculty participation, but do not make it a requirement. Additionally, HO universities spend a lot more time evaluating prospective start-ups, while HA universities will license to a start-up if they can present a "reasonable plan".

Table 5 – Summary results of the qualitative research

SUMMARY OF RESEARCH FINDINGS

TECHNOLOGY SELECTION

	High Output (HO)	High Activity (HA)	Explanation of Difference
1. Positive Factors affecting Commercialization			
High Commercial Potential	A, B, C, D	W, X, Y	HA universities focus on more factors when looking at positive factors affecting commercialization. They also have a greater concern about the readiness of the market for their technology
High Patentability	A, C	W, Z	
Cooperative/enthusiastic inventor	A	W, X, Y	
Fulfilling Bayh-Dole Obligations	D		
Disclosure comes with Licensee		X	
Great Benefit to Society		X	
Market ready for Technology		X, Y	
Can Patent with Broad Claim		Z	
2. Negative Factors affecting Commercialization			
Low Commercial Potential	A, B, D	W, X, Z	Same as above, HA universities consider a lot more negative factors affecting commercialization
Low Patentability	A, B	W, Z	
Uninterested Inventor	A	W, X, Z	
Complicated Ownership	A	W, X	
Need for unrestricted technology	C		
Industry not Interested		Z	
Undesirable Proprietary Position		X, Y	
No/Inadequate Market		X	
Industry difficult to license into		Y	
High Cost to File		Y	

	High Output (HO)	High Activity (HA)	Explanation of Difference
3. Necessity of Patent Protection			
Very Important	B, C	Z	No Difference
Relatively Important		Y	
Not Important			
It Depends	A, D	W, X	
4. Who handles Patent Protection			
Internal Counsel			
External Counsel	B, C, D	X, Y, Z	No Difference
Combination	A	W	
5. Is most of income from patented technologies			
Yes	A, B, C, D	W, X, Y, Z	No Difference
No			
6. Percentage of Patents Sought from Disclosures			
0-25	C		These results validate that MIT, Stanford, JHU and WARF are indeed high activity universities
25-50	A, B	Y, Z	
50-75		W	
75-100		X	
7. TTO's Primary Customer			
Faculty	A, B, C, D	W, X, Y, Z	No Difference
Industry	A	Y, Z	
Administration			

	High Output (HO)	High Activity (HA)	Explanation of Difference
TECHNOLOGY MARKETING			
1. Methods of Marketing			
Faculty	B, C, D	W, X, Z	No Difference
Website	A, B, C, D	W, X, Z	
Mailing Campaigns	A, B, C	Y	
Commercial Databases	C, D	W	
Press Releases		X	
TTO Networking	A, B, C	W, X	
They come to us	D	Z	
TTO Email Alert	D	X	
Regional Representatives		X	
Newsletter		Y	
2. Factors favoring start-up Formation/Licensing			
Faculty/Inventor Interest	A, B, C, D	W, X, Z	There is a consensus among all universities that faculty buy-in is necessary to forming a start-up. However, there is a greater tendency among HO universities to also consider funding for the start-up and its commercial potential
Lack of Industry(big company) Interest	A, B, C	Y	
Viable Return on Investment	A, D	Z	
VC/investor interest	A, D		
Credible Management Team	D		
Platform Technology	D	W, Z	
Commercially Useful	C		
Technology will not fit into "Big Company		X	

	High Output (HO)	High Activity (HA)	Explanation of Difference
3. Importance of extensive industry networks			
Critical	C, D	X	No Difference - Even the universities who said that it was not critical, mentioned that if they did not already exist, they could be built up
Very Important		Y, Z	
Important	A		
Important but not critical	B		
I don't Know		Y	
4. Methods for cultivating networks			
Attending conferences/meetings	A, B, C	Y, Z	No Difference
Using faculty networks	A, D	W, Z	
Hosting on campus	A, C	Y, Z	
Trade Shows	A		
Press Releases	A		
TTO Staff Personal Networks	D	X	
Face-to-Face Meetings with Companies		X	
5. Faculty Involvement in Marketing			
Very involved - Faculty brings most licensees	A, B, C, D	Z	Difference - For the HA universities, they would like to see faculty members involved, but they do not pressure them. For the HO universities, faculty members are expected to be involved
Somewhat Involved		W, X, Z	
Not involved			

	High Output (HO)	High Activity (HA)	Explanation of Difference
MANAGERIAL PRACTICES			
1. Qualifications for Licensing Officers			
Ph.D.	B(life sciences), C, D	W, X (or M.S.)	No Difference
MD	D		
Marketing Experience			
Business Experience	A, B(engineering, physical science), C	W, Y, Z	
Licensing Experience	C		
Patenting Experience		W, X	
Legal Experience/Knowledge	C,D	X	
Technical Skills	A, D	X, Z	
Communication Skills	A	Y	
Team Player	A		
Research Experience			
2. In Senior Staff			
PhD		W (or J.D.)	
Business Experience		X	
Legal, Business and Technical	A	W	
PhD, Legal, Business, Research	C		
Know Role of Technology Transfer	A		
Academic Licensing Experience	B, D	W, Y, Z	
Industry Contacts		Z	
3. Incentive Compensation			
Yes	A	X	No Difference

No	B, C, D	W, Y, Z	
	High Output (HO)	High Activity (HA)	Explanation of Difference
4(a). Flexibility in Negotiating Licensing Agreements			
Very Flexible on Business Terms	A, B, C, D	W, X, Y, Z	No Difference
4(b). Not Flexible on:			
Warranty and Indemnity	C, D	W	Difference - The HO feel very strongly about reserving the right to distribute technology for non-profit research
Preserving Publishing Right	A	W	
Freedom to use/distribute for research	A, D		
Use of University Name		W	
5. Efforts to Educate Industry Contacts			
Education through deal negotiation	B, C	W, X	No Difference - There seems to be a consensus among all universities that this is not really a high priority area. Industry contacts are already educated, but if they are not, the TTO will do whatever is necessary during deal negotiation to fix this
Formal Education/Seminars	C		
Industry Contacts are already Educated	D		
Enough to close the deal	D		
Give Talks		Y, Z	
Not a lot of effort		W	
6. Efforts to Educate Faculty/Inventors			
Publications			No Difference
Seminars	B, C, D	W, X, Y, Z	
Education through disclosure	A	W, Y	
Education through their involvement in process	C		
Not a lot of effort	A		

CHAPTER VI

CONCLUSIONS AND FUTURE RESEARCH

This chapter provides interpretations of the findings from the qualitative research with reference to the existing literature and the theoretical foundation of this study as described in Chapters II and III. The chapter is organized as follows: it begins with a discussion of the implications of the research findings, followed by a discussion of the limitations of the study, suggestion for future research within the area of university technology transfer and a thesis summary.

The main goal of this thesis was to uncover the differences in the technology transfer processes that differentiate high outcome universities from high activity universities. The thesis utilized quantitative data to first select the variables of interest in university technology transfer, then to explore whether or not there were actual institutions that would fall into the categories of high outcome and high activity universities, and to identify those for the target of further study. Once the four universities in each category were identified, qualitative methods were employed to illuminate the intricacies of the technology transfer process in those university TTOs.

The real options perspective was employed to study the technology commercialization practices of these two groups. Based on the theory, university TTOs that follow a real options model of technology commercialization would realize higher levels of licensing income.

After surveying the two groups of universities, it was found that the HO universities place a much higher emphasis on faculty involvement in marketing new technologies (see Table 5). This seems to be the most significant organizational factor affecting university technology transfer effectiveness. This finding is consistent with the findings of Thursby, Jensen and Thursby (2001). This factor may very well be a major differentiator between “high outcome” and “high activity” universities.

Faculty involvement in technology marketing serving as a differentiator between HO and HA universities also makes sense from the real options perspective. The real options theory suggests that options exercise will increase as the level of uncertainty decreases. Faculty inventors would have a more intimate knowledge of the technology, thus allowing them to assist in decreasing the uncertainty about the value of the technology, prior to continued investments by the TTO into the commercialization process.

Another interesting discovery was that all of the universities in the sample seemed to have a tendency to market new inventions to established companies. However, as was pointed out by previous researchers (Thursby, 2001), due to the embryonic nature of many university inventions, these inventions are more likely to be commercialized by small and start-up companies. The major difference between the HO and HA universities is that the HO universities seemed to have a greater tendency to evaluate the commercial viability of the technology, as well the potential of the start-up to attract funding (see Table 5). Once again, this practice would have the effect of reducing uncertainty and increasing the TTOs' likelihood to further invest in the technology. From this standpoint, the HO universities seem to use real options in their decision to invest in start-up companies, thus outperforming the HA universities who do not go through these uncertainty reduction practices.

Both of the above-mentioned factors, may impact the licensing income of the universities. For instance, if HA universities are starting companies, or licensing to start-ups, without thoroughly analyzing the feasibility of the start-up, this practice could be costly, both in terms of financial and human resources, that are not being converted into licensing income. Likewise, the lack of faculty participation in many of the HA universities could be stunting their abilities to effectively market emerging technologies.

This thesis also uncovered some information that is seemingly incompatible with the finding of the Thursby and Thursby (2002) results. These researchers found that the total number of licenses executed would have the greatest impact on the efficiency of the technology transfer office. This finding may not hold true for the universities in this sample. We found that the number of licenses executed had no relationship to the efficiency of the TTO, if efficiency is measured with respect to licensing income. In this sample, HO and HA universities had roughly the same licensing income, although HA universities licensed considerably more technologies (an average of 129.5 licenses executed for HA universities, as opposed to 59.25 licenses executed for HO universities). It could be that HO universities are more focused on licensing technologies that will provide the greatest return on their investments. This area is fertile ground for additional research.

Based on the result of the qualitative study, HO and HA university TTOs seem be similar in most respects. For instance, both groups place similar levels of importance on patent protection, and gain most of their income from patented technologies. They both show a preference for external counsel when applying for patents. Both groups use the same standard methods of cultivating their networks and marketing their technologies, and they both look for the similar qualifications in their TTO staff. As a university technology transfer practitioner this information is useful, because it suggests that alterations to these general areas would not be sufficient to bring about significant changes in licensing income. On the other hand, if it is the goal of the TTO to transform its operations in such a way as to increase its output, it might be useful to focus on certain key issues, and these include an almost mandatory involvement of faculty inventors in the evaluation and marketing of the technology, as well as thorough evaluation of the technology and start-up potential before engaging in forming a start-up company.

As with most studies, this one has its limitations. For one, the data was primarily collected for one year (although it was cross-referenced with another year). In technology transfer, there is often a lag effect, in that the revenue for technologies licensed in a particular year may not be realized for several years. One extension of this study could be to replicate the study using aggregated data for a number of years. Additionally, the target sample consisted of eight universities. Another extension could be to conduct the study on a much larger sample in an effort to increase generalizability of this thesis.

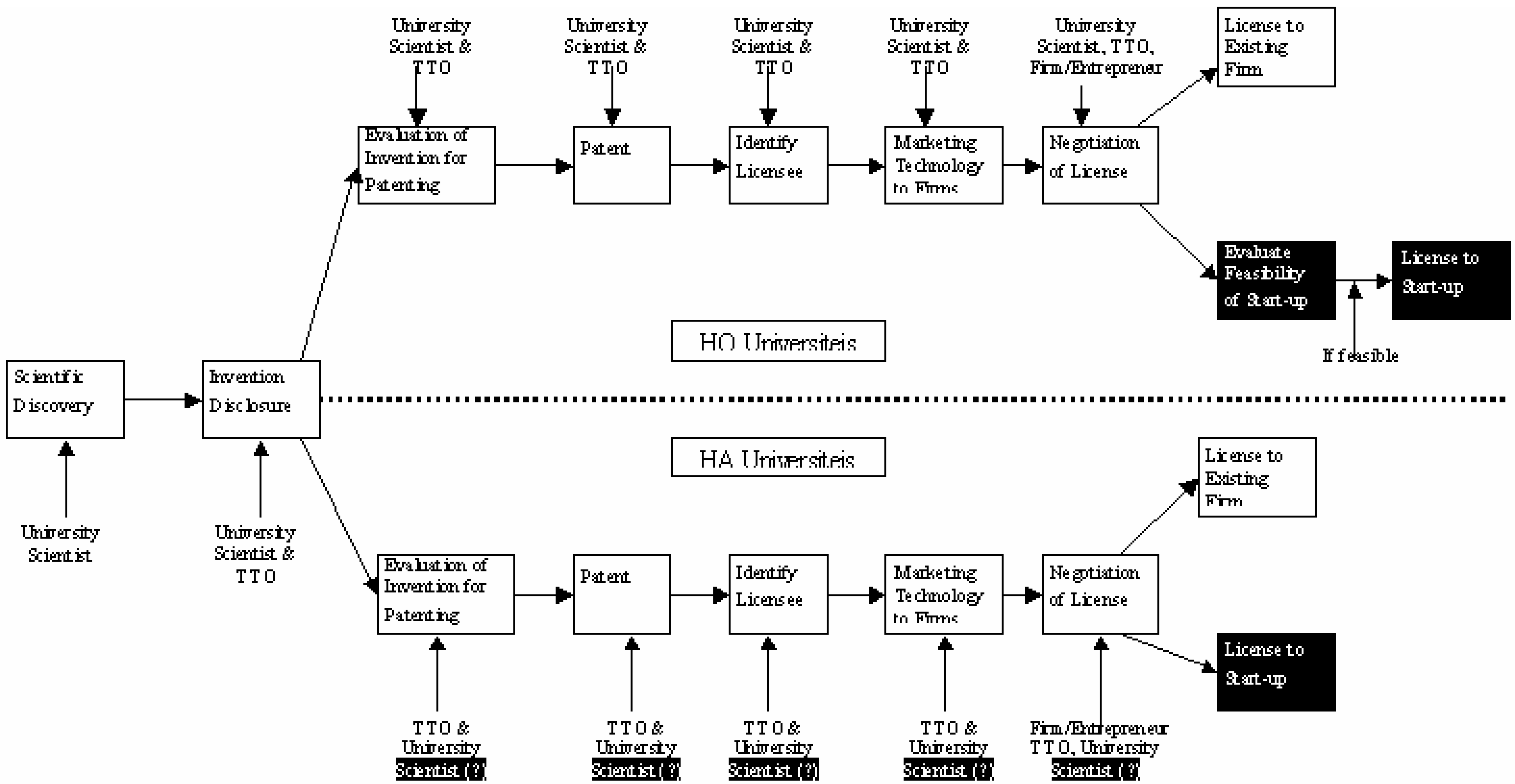


Fig. 5 – Differences in technology transfer processes for HO and HA

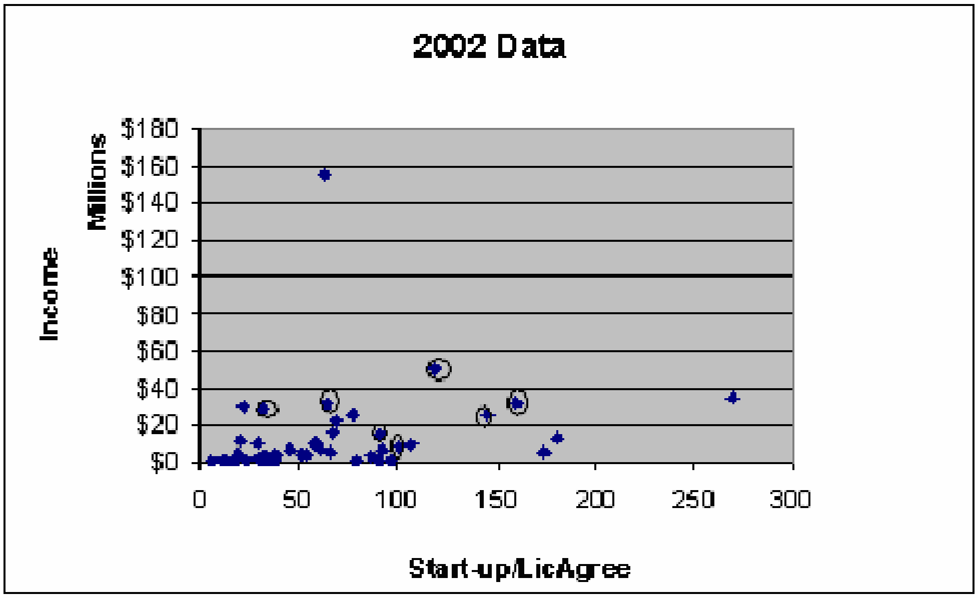
APPENDIX A

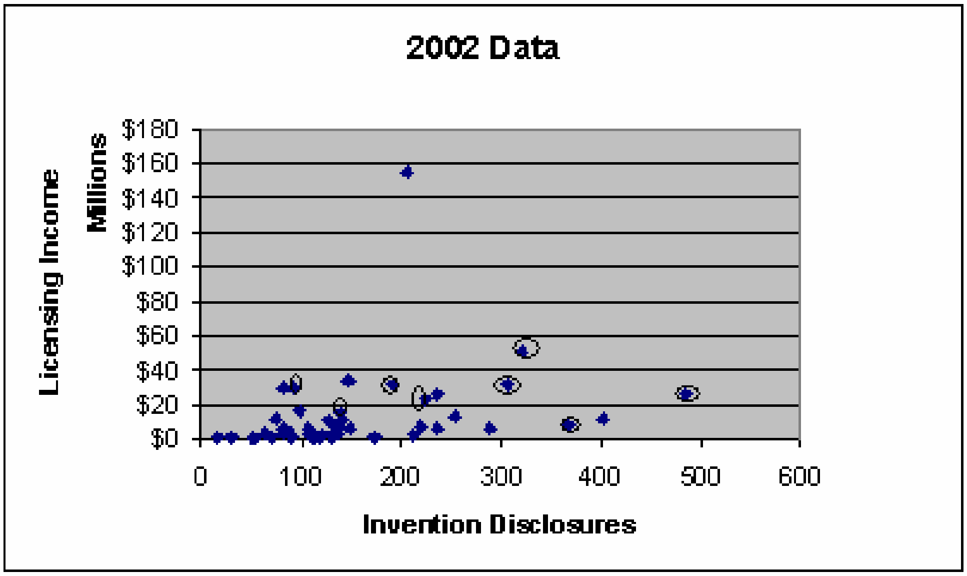
Expected Outcome of Correlation Matrix

		Expected Outcome of Correlation Matrix						
		Dependent Variables						
		Licensing Income	Start-up Companies Formed	Licensing Agreements	Licensing income/ faculty	Licensing income/ Licensing FTE	Total Patents	Patents/ faculty
Independent Variables	Public University	-	-	-	-	-	-	-
	Private University	N/A	+	+	+	+	+	+
	Medical school present	-	-	-	-	-	-	-
	Total Faculty	+	+	+	+	+	+	+
	Federal Research dollars	N/A	+	+	N/A	N/A	+	+
	Total Research dollars	N/A	+	+	N/A	N/A	+	+
	Research dollars/ Faculty	+	+	+	+	+	+	+
	Total Licensing FTEs	N/A	+	+	N/A	N/A	+	+
	Invention Disclosures	+	+	+	+	+	+	+
	Age of TTO	+	+	+	+	+	+	+

APPENDIX B

2002 Data Graphs





APPENDIX C

IRB Request for Exemption Packet

Vanderbilt University Institutional Review Board

Request for Exemption

Principal Investigator Information

First Name: Kisha	Middle Initial:	Last Name: Lashley	
Degree(s): ☐ Ed.D. ☐ J.D. ☐ M.D. ☐ Ph.D. ☐ R.N. ☐ Other, specify:			
Job Title: Graduate Student		Affiliation: ☐ VU ☐ Stallworth ☐VA-TN Valley HS ☐ Other, specify:	
Department/Division: Management of Technology		School/College: Engineering	
Campus Address:		Zip+4:	
Campus Phone: 322-7769	Fax:	Pager:	Email:
Complete if PI does not have campus address:			
Address: 261 White Bridge Pike, Apt. 157		City: Nashville	
State: TN	Zip: 37209	Phone: 615-594-4994	

1. **Faculty Advisor** **(complete if PI is a student, resident, or fellow)** ☐ **NA**

Faculty Advisor's name: Dr. David Dilts		Title: Prof. Mgmt. Of Technology	
Department/Division: EECS		School/College: Engineering	
Campus Address: 338 Featheringill Hall		Zip+4:	
Campus Phone: 322-2259	Fax:	Pager:	Email: david.dilts@vanderbilt.edu

2. **Study Contact Information** **(complete if primary contact is different from PI)** ☐ **NA**

First Name:	Middle Initial:	Last Name:	
Degree(s): ☐ Ed.D. ☐ J.D. ☐ M.D. ☐ Ph.D. ☐ R.N. ☐ Other, specify:			
Job Title:		Affiliation: ☐ VU ☐ Stallworth ☐VA-TN Valley HS ☐ Other, specify:	
Department/Division:		School/College:	
Campus Address:		Zip+4:	
Campus Phone:	Fax:	Pager:	Email:
Complete if contact does not have campus address:			
Address:		City:	
State:	Zip:	Phone:	

3. Study Information:

A. Give a brief synopsis of the research, including background information and rationale.

University-Industry technology transfer has shown significant increase since the institution of the Bayh-Dole Act of 1980. However, there is still very little understanding of the processes that are used for in commercializing new technologies (Siegel, 2003). Studies such as those done by Siegel et al. (2003) and Thursby et al. (2002) have both illuminated this area. My intention is to extend these studies to pay particular attention to the universities that demonstrate exceptional performance in technology transfer. This study will seek to distinguish between the processes of the universities that show differences in terms of their inputs to technology transfer relative to their outputs.

B. Describe the subject population/ type of data/specimens to be studied. Note: Research involving prisoners, fetuses, pregnant women, non-viable neonates, or human in vitro fertilization are not eligible for exemption from IRB review.

The sample consists of multiple respondents at eight (9) technology transfer sites at universities around the country. This would result in an approximate range of about 18-27 participants in the study. The data will be qualitative in nature, and untraceable to its source.

C. Describe the source of data/specimens and if these are publicly available. If not publicly available, describe how prior approval will be obtained before accessing this information (attach approval letter if available).

Much of the data used in this study is publicly available from publications made by the Association of University Technology Managers (AUTM) and from the Annual Report from The Lombardi Program on Measuring University Performance – The Top American Research Universities.

D. Does this study involve the collection of existing records or data often referred to as "on-the-shelf" data -see 45 CFR 46.101 (b)(4)? Describe how this data is collected, stored and de-identified.

As described above, the data used in this study is available from publications made by the Association of University Technology Managers (AUTM) and from the Annual Report from The Lombardi Program on Measuring University Performance – The Top American Research Universities. The data was collected directly from these sources and transferred into an Excel file.

E. Describe the recruitment process, including any advertisements, to be used for this study.

The participants in this study were identified from the available data described above. Their contact information will be retrieved from the Internet, and they will be contacted via email.

F. Describe any procedures to be used during this study.

The participants will be contacted via email, requesting their permission to participate in the study. This email will be in the form of a letter that will describe the study and guarantee their confidentiality. The subjects will then be asked to contact the researcher if they are interesting in participating in the study. If participation consent is obtained, a time will be established for a telephone interview.

I will also ask the subjects for their permission to audiotape the interview. I will only audiotape the interviews if I am given written consent via email. If I am allowed to audiotape the interviews, I will transcribe the tapes and store those files confidentially. The only people who will have access to those tapes and files are my academic advisor (Dr. David Dilts) and I. The tapes will be kept for 2 years after completion of the study, at which point they will be destroyed. Please see attached letter and interview guide.

G. Is this study affiliated with any other IRB-approved studies?
No

H. Is this proposal associated with a grant or contract?
No

CATEGORIES OF EXEMPTION

Involvement of human subject research in the following categories may be declared exempt from IRB Review by the IRB. Only the IRB may determine which activities qualify for an exempt review. From the six categories presented below, check "**Yes"** for the categories that you believe describe your proposed research and "**No"** for all others. If none of the categories apply, complete an application for expedited or standard IRB review or contact the IRB staff for instructions.

YOU MUST CHECK "YES" OR "NO" FOR ALL OF THE FOLLOWING:

45 CFR 46.101(b)(1):

☐ Yes ☒ No **EVALUATION/COMPARISON OF INSTRUCTIONAL STRATEGIES/CURRICULA**

Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

If "Yes", describe the educational setting in which the research *will be conducted and the type of normal educational practices involved.*

45 CFR 46.101(b)(2):

☒ Yes ☐ No **EDUCATIONAL TESTS, SURVEYS, INTERVIEWS, OR OBSERVATIONS**

Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Note: This exemption is not available for research involving children unless the research is limited to observation of public behavior when the investigators do not participate in the activities being observed.

45 CFR 46.101(b)(3):

☐ Yes ☒ No **PUBLIC OFFICIALS OR CANDIDATES FOR PUBLIC OFFICE**

Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior that is not exempt under the previous paragraph if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) Federal statute(s) require(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

Describe how subjects may be identified or are at risk, or state the federal statute that allows the confidentiality of the subject to be maintained throughout the research and thereafter.

45 CFR 46.101(b)(4):

☐ Yes ☒ No **COLLECTION OR STUDY OF EXISTING DATA**

Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Note: To qualify for this exemption, the data, documents, records, or specimens must be in existence before the project begins. Additionally, under this exemption, an investigator (with proper authorization) may inspect identifiable records, but may only record information in a non-identifiable manner. See IRB Policy III.D for additional information and examples regarding this exemption.

45 CFR 46.101(b)(5):

☐ Yes ☒ No **RESEARCH & DEMONSTRATION PROJECTS**

Research and demonstration projects which are conducted by or subject to approval of federal Departmental or Agency heads (such as the Secretary of HHS), and which are designed to study, evaluate, or otherwise examine: (i) Public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; (iv) possible changes in methods or levels of payment for benefits or services under those programs.

Proof of approval by Department/Agency Head is attached. ☐Yes ☐No

Note: This exemption applies to federally funded projects only and is most appropriately invoked with authorization or concurrence from the funding agency. Additionally, specific criteria must be satisfied to invoke this exemption (see IRB Policy III.D). Also, this exemption category does not apply if there is a statutory requirement that this project be reviewed by an IRB or if the research involves physical invasion or intrusion upon the privacy of subjects.

45 CFR 46.101(b)(6):

☐Yes ☒ No **FOOD QUALITY EVALUATION & CONSUMER ACCEPTANCE STUDIES**

Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome food, without additives are consumed or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA or approved by the EPA or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

5. Will Protected Health Information (PHI)[1] be accessed (used within VUMC) in the course of preparing for this research?

No

If "No", skip to the Conflict of Interest statement on the next page.

STATEMENT OF AFFIRMATION

If Protected Health Information (PHI)[1] is accessed (used) in the course of preparing for this research the following 3 conditions must be met:

1. The use or disclosure of the PHI is sought solely for the purpose of preparing this research protocol.
2. The PHI will not be removed from the covered entity.
3. This PHI is necessary for the purpose of this research study.

The above 3 conditions must be met to allow for the access (use) of PHI as "preparatory to research."

A. Will a de-identified data set be created *(all 18 HIPAA identifiers must be removed, see list attached)*?

☐ No ☐ Yes

B. Will a limited data set be created?

☐ No ☐ Yes *If "Yes", complete the VUMC "Data Use Agreement" below.*

The data use agreement below sets forth the terms and conditions in which the Covered Entity (VUMC) will allow the use and disclosure of a limited data set [2] to the Data Recipient (Principal Investigator). The limited data set must have direct identifiers removed, but may include town, city, and/or 5-digit ZIP codes as well as date elements (e.g., dates of birth, admission, discharge, etc.).

VUMC DATA USE AGREEMENT ☐ **NOT APPLICABLE**

In addition to the Principal Investigator, identify all individuals who will be requesting authorization to access the limited data set:

Name of Institution and/or Individual	Non-VUMC Data Use Agreement Required?*
	☐ Yes ☐ No
	☐ Yes ☐ No
	☐ Yes ☐ No
	☐ Yes ☐ No
	☐ Yes ☐ No
	☐ Yes ☐ No

A Non-VUMC data use agreement is required to disclose the limited data set to an Individual or an Institution outside of VUMC. A template is available at:

http://www.mc.vanderbilt.edu/irb/Forms/Form1109DataUseAgreement.doc.

As the Principal Investigator of this study I agree:

Not to use or disclose the limited data set for any purpose other than the research project or as required by law.

To use appropriate safeguards to prevent use or disclosure of the limited data set other than as provided for by this Agreement.

To report to the Covered Entity (Vanderbilt University Medical Center) any use or disclosure of the limited data set not provided for by this agreement, of which I become aware, including without limitation, any disclosure of PHI to an unauthorized subcontractor.

To ensure that any agent, including a subcontractor, to whom I provide the limited data set, agrees to the same restrictions and conditions that applies through this agreement to the Data Recipient with respect to such information.

Not to identify the information contained in the limited data set or contact the individual.

Conflict of Interest Statement

Do you or any other person responsible for the design, conduct, or reporting of the research have an economic interest in, or act as an officer or a director of any outside entity whose financial interests would reasonably appear to be affected by the research? ☒ No ☐ Yes

Investigator Assurance and Compliance Statement

As the PI of this study I agree:

☒ To accept responsibility for the scientific and ethical conduct of this project;

☒ To ensure all investigators and key study personnel have completed the VU human subjects training program;

☒ To submit for approval any additions, corrections or modifications to the protocol or informed consent document to the IRB prior to the implementation of any changes; and

☒ This project will not be started until final approval has been granted from the IRB.

____________________________________ ____________________

Principal Investigator's Signature Date

____________________________________ ____________________

Faculty Advisor (if PI is non-faculty) Date

[1] **Protected Health Information (PHI):** Protected health information (PHI) is individually identifiable health information that is or has been collected or maintained by Vanderbilt University Medical Center, including information that is collected for research purposes only, and can be linked back to the individual participant. Use or disclosure of such information must follow HIPAA guidelines.

Individually identifiable health information is defined as any information collected from an individual (including demographics) that is created or received by a health care provider, health plan, employer, and/or health care clearinghouse that relates to the past, present or future physical or mental health or condition of an individual, or the provision of health care to an individual or the past, present or future payment for the provision of health care to an individual and identifies the individual and/or to which there is reasonable basis to believe that the information can be used to identify the individual **(45 CFR 160.103).**

A covered entity (VUMC) may determine that health information is not individually identifiable (**De-identified**) health information only if all of the following identifiers of the individual or of relatives, employers, or household members of the individual are removed:
1. Names;
2. Any geographic subdivisions smaller than a State, including street address, city, county, precinct, zip code, and their equivalent geocodes, except for the initial three digits of a zip code;
3. All elements of dates (except year) for dates directly related to an individual (e.g., date of birth, admission);
4. Telephone numbers;
5. Fax numbers;
6. Electronic mail addresses;
7. Social security numbers;
8. Medical record numbers;
9. Health plan beneficiary numbers;
10. Account numbers;
11. Certificate/license numbers;
12. Vehicle identifiers and serial numbers, including license plate numbers;
13. Device identifiers and serial numbers;
14. Web Universal Resource Locators (URLs);
15. Internet Protocol (IP) address numbers;
16. Biometric identifiers, including finger and voiceprints;
17. Full-face photographic images and any comparable images; and
18. Any other unique identifying number, characteristic, or code.

[2] **Limited data set:** The limited data set is protected health information that **excludes** all above data elements with the exception of elements of dates, geographic information (not as specific as street address), and any other unique identifying element not explicitly excluded in the list above.

Vanderbilt University Institutional Review Board

Request for Waiver or Alteration of Consent, Authorization, and/or Documentation of Consent

Please check the appropriate category and answer the corresponding questions.

☒ **Request for Waiver of Documentation of Informed Consent and/or *Authorization.**
The IRB may waive the requirement to obtain a signed informed consent document for some or all of the participants if the study meets one of the following conditions:
The only record linking the participant to the research is the consent document and the principal risk would be potential harm resulting from a breach of confidentiality. Under this condition, each participant must be asked whether he/she wants to sign a consent document. The IRB must review and approve the consent document.

Does this study involve procedures that would be minimal risk except for the linking of the consent document to private information? ☒ Yes ☐ No
If "*Yes*", describe the potential harm to the subject that could result from a breach of confidentiality? If there is a breach of confidentiality, individuals who are not a part of the study may be able to link the identity of respondents to their responses. The respondents may not necessarily wish for this to happen.

The research is minimal risk and involves no procedures for which written consent is normally required outside of the research context.

Does this study involve procedures that, outside of the research context, would require written consent?
☐ Yes ☒ No
If "Y*es*", waiver of documentation is not appropriate.

☐ **Request for Waiver or Alteration of the Informed Consent Process and/or *Authorization.**
The IRB may approve a consent procedure which does not include, or which alters, some or all of the elements of informed consent, or may waive the requirements to obtain informed consent provided that the following conditions are met:

1. Check which is appropriate:
   ☐ Requesting Waiver of Informed Consent Process
   ☐ Requesting Alteration of the Informed Consent
   If requesting alteration, which elements of consent will be altered, or omitted, and provide justification for the alteration.

2. Describe how the waiver or alteration of consent and/or authorization involves no more than minimal risk and will not adversely affect the rights and the welfare of the individual (Also, discuss how the waiver will not adversely affect the privacy rights of an individual).

3. Explain why the research could not practicably be conducted without the waiver or alteration.

4. Define the plan, where appropriate, to provide individuals with additional pertinent information after participation.

☐ ***Request for Waiver of Authorization.** **Note: Authorization only applies when protected health information (PHI) will be created, used, or disclosed in the course of the research.**

The IRB may approve a waiver or alteration in the Authorization procedure provided that the following conditions are met:

1. Explain why the research could not practicably be conducted without access to the protected health information.

2. Describe how the privacy risks to individuals whose protected health information is to be used are reasonable in relation to the anticipated benefits (if any) and the importance of the knowledge expected from the research.

3. Describe the plan to protect the identifiers from improper use and disclosure.

4. Describe the plan to destroy the identifiers at the earliest opportunity consistent with the conduct of the research, unless there is a health or research justification for retaining the identifiers or such retention is otherwise required by law.

5. Verify that the protected health information will not be reused or disclosed to any other person or entity, except as required by law, for authorized oversight of the research project, or for other research.

Please be aware, if a protocol is granted a "Waiver of Consent and/or Authorization" by the VU IRB, the PI must be prepared to provide the Vanderbilt Privacy Office the following information for any PHI disclosed outside VUMC:

1. *The date of the disclosure;*
2. *The name, title, and contact number of the VUMC workforce member making the disclosure;*
3. *The name of the entity or person who received the protected patient information, and, if known, the address of such entity or person;*
4. *A brief description of the protected patient information disclosed; and*
5. *A brief statement of the purpose of the disclosure that reasonably describes the basis for the disclosure.*

This mandate is pursuant to 45 CFR 164.528, which states that an individual has the right to request and receive an accounting from the covered entity (VUMC) of all possible disclosures of his/her protected health information that was permitted without the individual's authorization.

January 13th, 2004

Dear (TTO Director),

My name is Kisha Lashley and I am a graduate student in Management of Technology at Vanderbilt University. My research concerns the impact of internal processes on the process of university technology transfer. Specifically, I am investigating the impact of technology selection processes, marketing processes and management practices on technology transfer at top research universities in the United States. This research project is being conducted in partial fulfillment of my Master's thesis in Management of Technology.

I would like to ask for your help in completing a telephone interview that should take no more than 30 minutes. Attached is a copy of the survey for your familiarity. All individual responses will be treated as confidential. Data will be aggregated, and the information will not be reported in a way that enables others to identify the respondent or the respondent's institution. Additionally, you will be provided with a copy of the results to this study.

With your permission, I would like to audiotape the interview, as it would help me better focus on our conversation. Please respond to this email to indicate whether or not you are willing to participate in this study, and if it I may audiotape the interview. At such time, I will contact you to verify your willingness to participate in this study and to establish a mutually convenient time to conduct the telephone interview. If I receive audiotape the interviews, the tapes will be kept for 2 years after completion of the study, at which point they will be destroyed.

If you have any questions or comments, I can be reached at kisha.lashley@vanderbilt.edu or 615-594-4994, or you may contact my academic advisor at david.dilts@vanderbilt.edu or 615-322-2259. For additional information about giving consent or your rights as a participant in this study, please feel free to contact the Vanderbilt University Institutional Review Board Office at 615-322-2918 or toll free at 866-224-8273.

Thanks in advance for your assistance,

Kisha Lashley

APPENDIX D

Interview Guide

University-Industry Technology Transfer

I am interested in studying the impact of three (3) main factors (Technology Selection Processes, Technology Marketing Processes and Managerial Practices) on the technology transfer process within major research universities. Following is an outline of the questions that I intend to ask:[3]

1. Technology Selection Processes – This section is aimed at exploring the processes that accompany the decision to pursue commercialization of one of your available technologies.

i. What factors would contribute positively to your decision to commercialize one of the technologies developed at your university?
ii. What factors would contribute negatively to your decision to commercialize one of the technologies developed at your university?
iii. How necessary does your university feel patent protection is in licensing a technology?
iv. When your university seeks to patent a technology, do you handle it internally or do you seek external counsel?
v. Is most of your income from patented technologies?
vi. On approximately what percentage of your invention disclosures do you pursue patent protection?
vii. Who do you view as your primary customer?

2. Technology Marketing Processes - this section is aimed at exploring the process of creating awareness of the existence of your technology in the marketplace.

i. How do you market new technologies to industry?
ii. What factors would persuade you to form a start-up company instead of licensing to an existing company?
iii. In your opinion, how critical is possessing extensive industry networks to successful technology transfer? How do you cultivate those networks?

[3] The questions in this survey were modified from:

1. Siegel, Donald S. et al. (2003). Commercial knowledge transfer from university to firms: improving the effectiveness of university-industry collaboration. *The Journal of Technology Management Research*, Volume 14, pp 111-133 and
2. Siegel, Donald S., David Waldman and Albert Link (January 2003). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study. *Research Policy*, Volume 32, Issue 1, pp 27-48.

Since my study is an extension of the study documented in the above two articles, I basically measured the same things, but took the study to a different setting.
Additionally, the following article was used for its theoretical background:

3. Hackett, S. M., & Dilts, D. M. (2004). A real options-driven theory of business incubation. Journal of Technology Transfer, 29(1), 41-54.

iv. What involvement, if any, do inventors at your university have in technology marketing?

3. Managerial Practices - this section will explore your management philosophy within your technology transfer office.

i. When hiring new technology licensing officers, what kinds of qualifications do you look for?
ii. What kinds of incentive compensation do you give to technology licensing officers?
iii. How flexible is your university in negotiating licensing contracts?
iv. How much effort do you place in educating industry contacts technology transfer?
v. How much effort do you place in educating inventors on technology transfer?

Kisha Lashley

Telephone Script – 1/14/04

Hello, My name is Kisha Lashley and I am a graduate student in Management of Technology at Vanderbilt University. You are being asked to participate in this study so that I may fulfill my M.S. thesis requirements. Your university was selected because you have exhibited extraordinary performance in university-industry technology transfer. Your participation in this study is voluntary. All individual responses will be treated as confidential. Data will be aggregated, and the information will not be reported in a way that enables others to identify the respondent or the respondent's institution, except with the permission of the respondent. The interview should take no more than 30 minutes to complete. Is this a convenient time to conduct this interview? _________

(If answer is no…) Could I schedule a time that is more convenient for you? _______

If yes, continue…

With your permission, I'd like to record our interview as it would help me better focus on our conversation (pause for response; if subject says no, then do not record interview. If yes, begin recording.)

(If yes…) I will proceed to ask the questions that were submitted to you at a previous date. If there are any questions that you do not wish to respond to, feel free not to. You may stop me at any point during this interview if you need to ask a question or make clarifications. Are there any questions before we begin?

Ok, my first questions are about your Technology Selection Processes – This section is aimed at exploring the processes that accompany the decision to pursue commercialization of one of your available technologies.

viii. What factors would contribute positively to your decision to commercialize one of the technologies developed at your university?
ix. What factors would contribute negatively to your decision to commercialize one of the technologies developed at your university?
x. How necessary does your university feel patent protection is in licensing a technology?
xi. When your university seeks to patent a technology, do you handle it internally or do you seek external counsel?
xii. Is most of your income from patented technologies?
xiii. On approximately what percentage of your invention disclosures do you pursue patent protection?
xiv. Who do you view as your primary customer?

Is there anything else that you believe is unique to your technology selection process?

Next, I want to ask questions about your Technology Marketing Processes – this section is aimed at exploring the process of creating awareness of the existence of your technology in the marketplace.

v. How do you market new technologies to industry?
vi. What factors would persuade you to form a start-up company instead of licensing to an existing company?
vii. In your opinion, how critical is possessing extensive industry networks to successful technology transfer? How do you cultivate those networks?
viii. What involvement, if any, do inventors at your university have in technology marketing?

Is there anything else that you believe is unique to your technology marketing process?

I will now ask questions relating to Managerial Practices. This section will explore your management philosophy within your technology transfer office.

vi. When hiring new technology licensing officers, what kinds of qualifications do you look for?
vii. What kinds of incentive compensation do you give to technology licensing officers?
viii. How flexible is your university in negotiating licensing contracts?
ix. How much effort do you place in educating industry contacts technology transfer?
x. How much effort do you place in educating inventors on technology transfer?

Is there anything else that you believe is unique to your managerial practices?

That is all the questions I have. Thank you for taking the time to talk to me about your technology transfer processes. If you have any further questions about this study, feel free to contact me at 615-322-7769 or at kisha.lashley@vanderbilt.edu.

REFERENCES

Agrawal, A., & Henderson, R. (2002). Putting patents in context: Exploring knowledge transfer from MIT. *Management Science, 48*(1), 44-60.

Annual Report: University of California Technology Transfer Program (2000). Oakland: University of California.

Association of University Technology Managers (2000). *AUTM Licensing Survey: FY 2000*. Norwalk: Association of University Technology Managers.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management Review, 17*, 99-120.

Bercovitz, J., Felman, M., Feller, I., & Burton, R. (2001). Organizational structure as a determinant of academic patent and licensing behavior: an exploratory study of Duke, Johns Hopkins and Pennsylvania State University. *Journal of Technology Transfer, 26*(1/2), 21-35.

Bowman, E. H., & Hurry, D. (1993). Strategy through the options lens: An integrated view of resource investments and the incremental choice process. *Academy of Management Review, 18*(4), 740-782.

Bozeman, B. (2000). Technology transfer and public policy: a review of the research and theory. *Research Policy, 29*(4-5), 627-655.

Colyvas, J., Crow, M., Gelijns, A., Mazzoleni, R., Nelson, R. R., Rosenberg, N., & Sampat, B. N. (2002). How do university inventions get into practice? *Management Science, 48*(1), 61-72.

Deeds, D. L., Decarolis, D., & Coombs, J. (2000). Dynamic capabilities and new product development in high technology ventures: An empirical analysis of new biotechnology firms. *Journal of Business Venturing, 15*(3), 211-229.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: what are they? *Strategic Management Journal, 21*(10-11), 1105-1121.

Etzkowitz, H. (1998). The norms of entrepreneurial science: cognitive effects of the new university-industry linkages. *Research Policy, 27*(8), 823-833.

Hackett, S. M., & Dilts, D. M. (2004). A real options-driven theory of business incubation. *Journal of Technology Transfer, 29*(1), 41-54.

King, A. A., & Tucci, C. L. (2002). Incumbent entry into new market niches: the role of experience and managerial choice in the creation of dynamic capabilities. *Management Science, 48*(2), 171-187.

Lombardi, J. V., Craig, D. D., Capaldi, E. D., & Gater, D. S. (2002). *The Center - The Top American Research Universities*. Gainesville: University of Florida.

Mahoney, J. T., & Pandian, J. R. (1992). The resource-based view with the conversation of strategic management. *Strategic Management Journal, 13*(5), 363-380.

Mansfield, E., & Lee, J.-Y. (1996). The modern university: contributor to industrial innovation and recipient of industrial R&D support. *Research Policy, 25*(7), 1047-1058.

McGrath, R. G. (1997). A Real Options Logic for Initiating Technology Positioning Investments. *Academy of Management Review, 22*(4), 974-996.

McGrath, R. G. (1999). Falling forward: Real options reasoning and entrepreneurial failure. *Academy of Management Review, 24*(1), 13-30.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data Analysis* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Nelson, R., R. (2000). Observations on the Post-Bayh-Dole Rise of patenting at American Universities. *Journal of Technology Transfer, 26*(1/2), 13-19.

Owen-Smith, J., & Powell, W. W. (2001). To Patent or Not: Faculty Decisions and Institutional Success at Technology Transfer. *Journal of Technology Transfer, 26*(1/2), 99-114.

Penrose, E. T. (1959). *The theory of the growth of the firm*. New York, N.Y.: Wiley.

Pfeffer, J., & Salancik, G. R. (1978). *The external control of organizations: A resource dependence perspective*. New York, N.Y: Harper and Row.

Powers, J. B. (2000). *Academic Entrepreneurship in Higher Education: Institutional Effects on Performance of University Technology Transfer.* Unpublished Doctoral Dissertation, Indiana University, Indiana.

Quick, A. C. (Ed.). (2004). *The College Blue Book* (31 ed. Vol. 2). New York: MacMillan Reference.

Rosenberger, J. (2003). *What are real options: A review of empirical research.* Paper presented at the Academy of Management, Seattle.

Shane, S. (2002). Selling university technology: Patterns from MIT. *Management Science, 48*(1), 122-137.

Siegel, D. S., Waldman, D., Atwater, L. E., & Link, A. (2003). Commercial knowledge transfers from universities to firms: improving the effectiveness of university-industry collaboration. *The Journal of High Technology Management Research, 14*(Spring), 111-133.

Siegel, D. S., Waldman, D., & Link, A. (2003). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study. *Research Policy, 32*(1), 27-48.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal, 18*(7), 509-533.

Thursby, J. G., Jensen, R., & Thurby, M. C. (2001). Objectives, characteristics and outcomes of university licensing: A survey of major U.S. universities. *Journal of Technology Transfer, 26*(1/2), 59-72.

Thursby, J. G., & Kemp, S. (2002). Growth and productive efficiency of university intellectual property licensing. *Research Policy, 31*(1), 109-124.

Trigeorgis, L. (1993). The nature of option interactions and the valuation of investments with multiple real options. *Journal of Financial and Quantitative Analysis, 28*(1), 1-20.

Trune, D. R., & Goslin, L. N. (1998). University Technology Transfer Programs: A profit/loss analysis. *Technology Forecasting and Social Change, 57*, 197-204.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal*, *5*(2), 171-180.

Yin, R. K. (1994). *Case Study Research: Design and Methods* (2nd ed.). Newbury Park, California: Sage Publications.