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A Comparison of Faculty Perceptions of University Technology Transfer by Level of Institutional Success in the Technology Transfer Process.

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A COMPARISON OF FACULTY PERCEPTIONS OF
UNIVERSITY TECHNOLOGY TRANSFER
BY LEVEL OF INSTITUTIONAL SUCCESS
IN THE
TECHNOLOGY TRANSFER PROCESS

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Educational Leadership, Research and Counseling

by
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May 2001

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ABSTRACT

A growing awareness that faculty cooperation and support are necessary to the success of university technology transfer has raised a number of questions about the perceptions of faculty participants regarding aspects of university technology transfer. The purpose of this study was to gather information concerning faculty perceptions of university technology transfer and to compare the perceptions of faculty towards university involvement in technology transfer activities by the relative success of the institutions in technology transfer. The objectives were to describe selected faculty at two southern land grant universities based on certain personal, professional, and demographic characteristics, and to compare faculty at an institution defined as successful in technology transfer and an institution that is relatively unsuccessful on certain selected measures. Participants were asked to complete a researcher designed survey consisting of 33 items and comprised of two parts: (1) a section requesting background information, and (2) a section requesting faculty perceptions on various aspects of and issues related to university technology transfer.

The faculty responses indicated that there were many similarities across the institutions, both in faculty demographics and in faculty perception of their university's policies and practices in the area of technology transfer. In fact, only one significant demographic difference between the respondents of the two universities was noted. Respondents from the more successful institution in the area of technology transfer had a significantly higher likelihood of having received competitive grant funding within

the last three years. All other demographic factors were found to be independent of the institutional affiliation of the faculty member.

When reviewing the findings regarding faculty perceptions and institutional affiliation, no significant difference was found between universities on the mean rankings of the importance of technology transfer office functions. However, the universities' respondents differed significantly in their responses to the question of institutional success at technology transfer. Faculty in the more successful institution responded more favorably to the survey items regarding institutional success in technology transfer and faculty in the less successful institution responded less favorably to the same items.

CHAPTER 1: INTRODUCTION

“As a result of a number of significant recent changes in the global political and economic scene, a new policy paradigm is emerging” (Lee, 1994, p. 260).

The statement above was published in the 1994 Summer issue of *Policies Studies Journal*. Its author, Dr. Yong Lee, was discussing the challenges facing the United States in an era of global interaction beyond anything contemplated by former generations. He continues, focusing on problems that must be overcome:

generating more public benefits from research and development (R&D), converting massive military technologies into industrial use, shifting R&D spending priorities, reinvesting in education and training, and forging new public-private partnerships for scientific and technological cooperation. To shift, to reinvent, and to revitalize the nation’s scientific and technological resources, as well as its financial resources, the old status quo may have to be unfrozen, the old habits and assumptions unlearned, and a new institutional partnership forged among the key sectors: government laboratories, research universities, and industry. This is no small task (Lee, 1994, p.260).

Lee’s point is valid. Forging this kind of partnership is a huge task and many people are beginning to question whether the United States, its business entities, and its research institutions are up to meeting the challenges of this new global economy. Dr. Louis Tornatzky, former director of the Southern Technology Council (STC), has written about our need to recognize that economic success in the future will depend on an entity’s ability to “quickly commercialize leading-edge technologies into new products and processes and sell them in worldwide markets As far as we can foresee the future, economic vitality will be owned by those who can master technology (Tornatzky, 1996, p. 4).”

Innovation and technology are believed to be the basis for financial stability and growth in this “information age,” and universities are being increasingly viewed as “engines of economic development” (Feller, 1990).

There are a number of ways in which one can “master technology,” but Tornatzky was referring specifically to the ability of an entity to develop and transfer new technology to the marketplace. His message concerned one of the most rapidly growing fields today, the area of technology transfer. “Technology transfer” is a phrase gaining popularity in certain academic and business circles, but is still comparatively unfamiliar to the general public. Hauksson, borrowing from Robert Clyatt, defines technology transfer in his work on the commercialization of university research discoveries as “the process by which science and technology are diffused throughout human activity.” He goes on to say:

Wherever systematic rational knowledge developed by one group or institution is embodied in a way of doing things by other institutions or groups we have technology transfer. This can be either transfer from more basic scientific knowledge into technology, or adaptation of an existing technology to a new use. Technology transfer differs from ordinary scientific information transfer in the fact that to be really transferred it must be embodied in an actual operation of some kind (Hauksson, 1997, p.9).

In universities, the usual manner in which technology is moved from the research laboratory to the marketplace is through the negotiation of a license with an industrial partner. The licensing partner thereby obtains the right to commercialize the technology, and the university receives revenue from the license in the form of a royalty based on sales or other commercial use of the technology. There are a number of variations of this process, but the purpose is to move the technology into practical use and generate a return to the university.

The primary focus of much of the research generated within the nation's research universities has historically been basic research. But there are a few institutions that have engaged in the transfer of technology since the early part of this century. And there are sectors in universities that have long focused on the more practical applications of their research. These include engineering departments, computer science departments, and, often, departments of chemistry and the biological sciences. The state agricultural experiment stations within the land grant institutions have always focused more strongly on the direct application of scientific theory to problems related to agriculture, the environment, and the improvement of the quality of life in rural and urban environments. Many people are not aware that this focus emphasizes economics and agribusiness, community services, food safety issues, population pressures, protection of natural resources, climate change, energy, and new developments in biotechnology, as well as production agriculture (Meyer, 1995). The diverse nature of the research often leads to a variety of patentable technologies, many of which can be extremely valuable to the institutions and to society.

In any serious discussion of university technology transfer, one is likely to hear a debate over concerns that strike at the heart of academic philosophy. What are the role, scope, and mission of universities today? Should the role, scope and mission be expanded as the needs of society change? If so, are we headed in the right direction? Are we being true to our ultimate goal of finding ways to improve the quality of life for all, or have we become too mercenary in our quest for new ways of providing funding for institutions with bigger bottom lines?

These questions are raised by those who revere traditional university roles and values, and by those who believe we should forge new ground and accept a new leading role in developing and strengthening America's position in the new global economy. From the results of a survey conducted by the Association of University Technology Managers, it appears that many in academia are beginning to agree that the path appears to lie somewhere between these two extremes (AUTM Licensing Survey: FY 1997 Survey Summary, 1998).

If the traditional role of public land grant universities was to provide a practical and liberal education designed to benefit the masses, then the universities may not be so far off that path in providing practical benefits to industry and in helping to foster economic development in our local communities. If the citizens paying the bills are interested in seeing their universities become more accountable, they will want the results of education and research efforts reported in terms that are meaningful to them.

What then is the focus of university research? How is it relevant to our society? What are the people getting from their investment? Have our universities forgotten the service aspect of the land grant mission? William Tierney reminds us in his 1998 book, The Responsive University, "Serving people requires two essential ingredients: a service, and someone who wants or needs it. Our [universities'] orientation has been that we provide certain services and anyone who wants or needs them is welcome to come and get it (p.23)."

If our land grant universities are to improve the quality of life for people and prove their relevance to the public who funds them, then those universities undoubtedly will have to become more responsive to the needs and wants of that public. There are

many political and business leaders in this country who believe that one way to be more responsive is to engage in university-industry partnerships to foster the development of new technology and its progress to the marketplace. Tierney is among those who believe that universities are receiving strong indications that they should expand their horizons: “State legislators, employees, professional associations, and federal government agencies are all asking the academy to link work and school and to become more active partners in addressing and solving our social ills and be more competitive internationally (p.63).”

While most individuals in this country incorporate into their everyday lives technological and scientific advances undreamed of by their grandparents, few people are aware of the origins of this technology from which they benefit daily. Even fewer are aware that institutions of higher education play a vital role in this drama. Yet, because the United States now functions as part of the global community and thus is susceptible to international economic market fluctuations and competition, the need to effectively move research findings from the academy to the private sector has never been more pressing.

In 1993, the Association of University Technology Managers (AUTM) conducted a national study which indicated that more than \$45 billion in product sales resulted from nonprofit technology transfer programs in 1993, more than \$9 billion in tax revenue to the state, local, and federal governments was generated, and more than 300,000 industrial jobs were created or retained by nonprofit research institutions (AUTM Manual, 1998). Because technology transfer has grown dramatically in the last

few years, those figures have increased at a steady and significant pace (AUTM Licensing 5-Year Survey Summary Report, 1996).

The mission of state universities, particularly the land grant universities in our country, is directed toward the primary objective of serving the public which supports the institution. In line with that overall mission, university technology transfer offices must protect academic freedom, transfer technology to the commercial sector for public benefit, and generate sources of unrestricted income for institutional purposes. Because universities are generally not equipped to make the results of their research available to the public without the cooperation and assistance of commercial entities, protecting relations with private sponsors is another priority.

To meet the growing needs and demands of the public, universities have recently begun using their technology transfer offices to facilitate the establishment of research parks, incubator programs, and new company start-ups. They have established foundations, sought to secure venture capital, fostered partnerships with scientists from other universities and with corporate scientists, all in the hope of facilitating their ability to do a better job in this domain. In all transactions involving transfer of rights in university intellectual property, the mission and goals of the institution must be of foremost consideration. However, the importance of being able to accomplish the task of technology transfer in a timely and cost-effective manner cannot be overemphasized if the university hopes to reap the greatest benefits for the institution and the state.

The Role of Faculty in University Technology Transfer

A major part of the process of protecting university intellectual property and stimulating faculty awareness of university policy involves education of university

personnel. Beyond education, the issue of faculty reward and the role it plays in the success of any university technology transfer program is being examined by many people in the higher education community.

It is significant that a number of national and regional organizations, including the National Association of State Universities and Land Grant Colleges (NASULGC), the Carnegie, Pew and Kettering Foundations, and the American Association of Higher Education, are in the process of reexamining the prevailing views about what constitutes “scholarship.” This analysis is taking place in response to demands from the public that universities become more responsive to their needs and more accountable and productive. The examination is concentrating not only on “extrinsic rewards (job standing, pay, etc.) but also on the intrinsic rewards that shape faculty priorities” (Rice, 1995, p. 7).

The public is calling for better and more responsible teaching and for research and professional efforts that will help improve the quality of life. Eugene Rice, writing for the 1995 ASHE Annual Meeting, declares that the “landscape of public expectations” has changed and higher education must do a better job of addressing the “needs of the local communities and the larger society” (Rice, 1995, p.3). Rice argues that universities and the scholarly community can no longer afford to be “one-dimensional” in their response to scholarship, but instead must recognize the diverse missions and goals of the institutions in the evaluation of and reward for scholarly activities, including teaching, service, and applied research. That will require a reassessment of prevailing views about what constitutes “real” scholarship and “what kinds of knowledge are most worth possessing” (Rice, 1995, p.13).

Statement of the Problem

Universities today are actively engaged in the process of technology transfer, yet faculty perception of the technology transfer process has not been assessed. If land grant universities are going to successfully engage in technology transfer, the administration at the universities must ensure that faculty are active participants in the process. A university can adequately protect its interests and the investment of the public only if faculty are aware of the potential importance of new technologies, believe that the technology transfer process is a legitimate function of the university and its employees, and are willing to participate in the institutional disclosure procedures so that patents or other legal protection can be obtained. To encourage faculty participation, many universities have incorporated educational strategies and rewards for faculty engaged in the creation of new technology, primarily in the form of royalty distributions designated by university policies. However, the impact of those strategies on faculty is unknown.

Because faculty participation is an essential ingredient for successful university technology transfer, the goal of this research is to gather information about faculty perception of the technology transfer process within the land grant university. Without faculty acceptance of and responsiveness to university technology transfer activities, the likelihood of success is greatly reduced. This research is designed to survey faculty at two land grant universities, one with a technology transfer program that meets certain criteria identified with successful institutions and one that does not yet meet those criteria. This study will help determine whether there exists a different perception of university technology transfer at the two institutions and whether faculty perception

correlates with institutional success. To accomplish this goal, the following question is addressed.

Research Question

Is there a significant positive correlation between the relative success of a university's technology transfer program and the perceptions of its faculty towards the appropriateness and importance of university involvement in these activities?

Objectives

The specific objectives of the study are as follows:

1. To describe the faculty at land grant universities based on the following personal, professional, and demographic characteristics:
 - a. Number of years they have had a doctorate
 - b. Number of years experience at their current institution
 - c. Academic rank
 - d. Attainment of competitive research grant funding within the past three years
 - e. Number of occasions whereupon contributions toward a university patent/license were made
2. To determine the perceptions of faculty at institutions regarding the appropriateness and importance of technology transfer activities.
3. To compare faculty at an institution defined as successful in technology transfer and an institution that is relatively unsuccessful on the following measures:
 - a. Number of years they have had a doctorate

- b. Number of years experience at their current institution
- c. Academic rank
- d. Attainment of competitive research grant funding within the past three years
- e. Number of occasions whereupon contributions toward a university patent/license were made
- f. Perceptions toward university technology transfer activities relating to the appropriateness of the activities and importance of the activities

Summary

State universities have a mission of service to the public. First and foremost is the mission to improve the quality of life for all people. Another aspect of that mission is the charge to foster economic development. In direct relation to that mission, universities have a vested interest in the formation of new business, the creation of jobs, and the generation of a stronger tax base. If universities do not make a move today to encourage the creation of new technology and facilitate its quick introduction in the marketplace, they will find themselves explaining to the public tomorrow why the United States cannot effectively compete in a new technology-driven economy. The research proposed here is designed to study the perceptions of faculty regarding the technology transfer policies and practices in land grant universities to discover faculty perceptions of the university's involvement in technology transfer and whether there is a correlation between success in tech transfer and the willingness of faculty to accept, support, and participate in the process.

CHAPTER 2: REVIEW OF RELATED LITERATURE

“Instead of worrying about the future, we should be laboring to create it.”
(Hubert Humphrey)

“The postindustrial technological revolution depends on universities.”
(Slaughter and Leslie, 1997, p. 27)

Introduction

Howard Bremer, a widely recognized authority on patent and technology transfer, describes the economic climate impacting universities today as “knowledge based . . . entrepreneurially based . . . involving world markets . . . continuous and radical technology changes . . . more decentralized . . . and increasingly competitive on a global scale . . .” (Bremer, p. 21- Council on Government Relations (COGR) Journal of Papers, 1998).

Despite skepticism and resistance from some sectors of academia in the early years of university involvement in technology transfer, university administrators and at least some university research faculty have become increasingly responsive to real-world problems. The emphasis on transferring university technology to the private sector is having a marked impact on the cultural climate within universities in this country. Many universities that have been slower to embrace this change are now attempting to “catch up” to their more aggressive peers and establish stronger ties with industry and government, while still maintaining integrity of purpose and academic excellence. As will be discussed below, the result is that technology generated by university research is having a direct impact on the competitiveness of the U.S. in today’s global market. Many view that competitiveness as the foundation for

continuing U.S. growth and leadership in this time of rapid technological change, and value the university's role in helping to maintain it.

. This literature review presents a discussion of research and writings generated during the last two decades concerning the history of the transfer of university technology from American land grant universities to the private sector. Technology transfer refers specifically to the process of transferring rights in inventions from one entity to another, usually conveyed through a license for commercialization. It also refers more generally to other aspects of managing a technology transfer office, which include evaluating, protecting, and marketing technology. For purposes of this review, the discussion will refer specifically to the process and practices related to *university* technology transfer.

Because the focus of this research is on the reward policies and practices to faculty in land grant institutions, it is appropriate to begin with a brief history of the land grant institution. This will provide a description of the federally designated mission of land grant institutions. From there, the focus will be on the literature that has been generated since 1980, when the Bayh-Dole Act was passed, changing the position of American land grant universities with respect to intellectual property created within the university. Recent writings which discuss the impact of various practices and policies of U.S. land grant universities as they relate to the generation of new technology and its transfer from the university to the private sector for production and marketing will be reviewed in some depth, with an emphasis on faculty motivation and reward.

A Brief History of the Land Grant Institution: How Did We Get Here and Why?

A considerable body of literature exists concerning the land grant institution. Originally, the Morrill Acts of 1862 and 1890, along with the Hatch Act of 1887, were passed in order to provide states with public land so that they could create a system which provided land and funding for colleges and universities focused on agricultural research and education. The goal was to present an opportunity for the working classes to receive an education in agriculture, military tactics, and the mechanical arts. The philosophy of the land grant institution has focused on teaching, research, public outreach, and service (Kerr, 1987).

Since the original passage of the Morrill Acts, funds have been appropriated annually by the federal government for land grant institutions through these and later legislative acts. Today, there is at least one land grant institution in every state and territory of the United States, and the District of Columbia, and more than \$550 million in annual federal appropriations are distributed to them. The United States Department of Agriculture acts as a primary administering and coordinating agency of federal land grant funds and activities, helping to set priorities and share information at a national level (NASULGC, 1995).

The practical role of land grant institutions was the emphasis of a 1997 presentation before the Council on Government Relations by Alvin L. Kwiram, Vice Provost for Research at the University of Washington. Referring to the “ivory tower mentality” as an aberration in the history of universities, he reminded his audience that the creation of the land grant universities was:

explicitly designed to provide training in the practical arts such as agriculture, mining, engineering, and the like. To be sure, the primary role is to train students to be productive members of society, but another purpose is to create the knowledge base on which a productive and competitive society can thrive (Kwiram, 1997, p.3).

Kwiram is quick to counter the old notion that academia is compromised by consorting with industry or appearing too entrepreneurial. He says that, if our focus is to improve the quality of life, then universities should be striving to enable this country to maintain its competitive status in the new global economy (Kwiram, 1997).

Technology Transfer Defined

Before discussing the management of technology transfer within the land grant institution, it is necessary to address the concept of intellectual property protection and transfer in a more general sense. The first step is to define the primary terms. The next is to describe the process of obtaining legal protection over new inventions.

Albert Muir, author of "The Technology Transfer System," provides clear definitions for the basic terms:

Technology transfer refers to the conveyance of inventions from one entity to another under license agreements, for the purpose of commercialization. *Inventions* are new technologies in general; ideas for new products and processes, including trade secret or patent protection (Muir, 1997).

The Association of University Technology Transfer Managers (AUTM), offers an even more thorough description of the technology transfer process:

Technology transfer is a term used to describe a formal transferring of new discoveries and innovations resulting from scientific research conducted at universities to the commercial sector. One way that universities transfer technology is through patenting and licensing new innovations. The major steps in this process include: 1) the disclosure of innovations; 2) patenting the innovation concurrent with publication of scientific research; and 3) licensing the rights to innovations to industry for commercial development. (Association of University Technology Managers, Inc. 1998. "Common questions & answers

about technology transfer”. AUTM Internet Site:
<http://www.crpc.rice.edu/autm/publications/survey/qa.html>).

The term “intellectual property” refers more generally to property of the mind; that is, property created and/or reduced to practice for the first time by an inventor. Inventions can include new products or new processes for development of products, or both. Patents are generally considered the most powerful form of protection for intellectual property, but they are also more difficult and costly to obtain than other forms of property protection. Trademark, trade secret law, and copyright law are other forms of protection that exist for certain kinds of intellectual property. Although patents may be more problematic, they are also the most commonly sought form of protection for university intellectual property because they afford the greatest protection against infringement.

Development of Intellectual Property Rights in the U. S.

Intellectual property rights were recognized in Europe as far back as 1421, when the first known patent was issued to an architect in Italy for a new kind of ship. In the United States, trade secret and patent law evolved from English Common law and, prior to the establishment of American independence, initially resided within the jurisdiction of the various colonies and, briefly, the states. While at least one patent was issued earlier in Massachusetts, South Carolina enacted the first patent statute in 1784 (Rosenberg, 1992).

After U.S. independence, patent law became the subject of federal jurisdiction and was incorporated into Article I, Section 8 of the United States Constitution and the Patent Act of 1790. Initially, that act established a seventeen-year period for patent

protection on a new invention. Over the years, various amendments were made and the life of a patent eventually was broadened to the current 20 year date from the filing of the application, with some possibility for extension under certain circumstances. U.S. Patent Law (Title 35 of the United States Code) defines patentable material, identifying three basic criteria. First, it must be novel and unknown to the public. If it has been made public, a U.S. patent application must be filed within one year of the publication. In foreign countries, the right to obtain patent protection is usually lost upon publication if no patent application has previously been filed. Second, it must have utility. This means that it must function, and it must serve some useful purpose. Finally, it must be non-obvious to someone skilled in the art (35 U.S.C. §§ 101-103).

Patents can be obtained for a new process, a machine, composition of matter, or manufacture. These broad categories include things as varied as new types of structures, tape recordings, and genetically engineered materials. As mentioned earlier, other forms of legal protection apply to various kinds creative works, know-how, and trade secrets. A person or entity that infringes on someone else's patent rights is liable for damages resulting therefrom. Owning a patent means that the holder has the right to file suit if third parties violate the patent by unauthorized manufacture, use, or sale of the patented invention (Rosenberg, 1992). The other most commonly used forms of protection over intellectual property are the following: trademark, trade secret, and copyright. Trademark, trade name, and/or service mark refer to words, names, symbols, devices, pictures, numbers, or any combination of the above. All of these can be registered at the state or federal level, and the legal protection remains in effect as long as the use of that name or mark is continuous. Trade secret generally refers to any

commercial formulas, patterns, processes, or other information that is secret, substantial, and/or valuable. Trade secret is legally protected for as long as the owner maintains that secrecy. Copyright protection in the U.S. is automatic and applies to works of the mind, such as writings (produced in a variety of forms of expression), paintings, movies, music, sculpture, or computer software. In order to effectively strengthen an owner's claim of infringement and ability to collect damages, the owner should register the work for federal copyright protection (Erbisch & Velazquez, 1998).

While all of these forms of protection for intellectual property constitute safeguards, the strength and the breadth of the protection vary widely with the form of protection, and, in the case of a patent, with the nature and scope of the claims contained in the application. The intellectual property protections described above allow the owners of intellectual property to attain direct financial benefits from that intellectual property. They also prevent others from infringing upon the rights of an owner who wishes to profit from the invention by producing and marketing it, or by selling or licensing the rights in that invention to another person or entity for manufacture and sale to the public (Erbisch & Velazquez, 1998).

Within the university setting, the rights to inventions are often licensed to a private entity which assumes the risk of manufacturing, marketing, and selling the product; or in the case of a patented process, the risk of using the process to achieve its ends. For assuming that burden, the private entity will retain the bulk of any profits generated by that technology. For release of the rights, the university may receive benefits in a variety of forms, including but not limited to, up front licensing fees, assumption by the licensee of patenting expenses, equity interest in the company, and

royalty payments based on sales once the product is launched. (Association. of University Technology Managers. 1998. "Common questions & answers about technology transfer". <http://www.crpc.rice.edu/autm/publications/survey/qa.html>).

Development of Technology Transfer in the Land Grant Institution

When and how did land grant universities become involved in the transfer of their discoveries to the private sector? The evolution of the process may more accurately be described as a *revolution* in the culture of the land grant university.

"Prior to 1980, fewer than 250 patents were issued to U.S. universities each year and discoveries were often not commercialized for the public's benefit. Today, U.S. universities participating in the Survey are issued an average of almost 1,500 patents per year. Moreover, there are now more than 200 universities engaged in technology transfer, eight times more than in 1980, as evidenced by the membership of AUTM Association of University Technology Managers, Inc. 1998." (referencing its annual survey of universities and research laboratories) <http://www.crpc.rice.edu/autm/publications/survey/qa.html>.

What factors led to this major change in university technology transfer activity? In order to answer that question, it is necessary to take a brief look at the history and status of technology within universities prior to 1980.

In the 20th century, universities performed most of the basic research conducted in the United States. However, until recently, inventions from universities that were the results of federally funded research were released to the public primarily on a nonexclusive basis. The belief was that, since the research was conducted with public funds, the results should belong to the public and be distributed without protection of any possible proprietary interests of the institution. This practice resulted in very little commercial development of university technology because businesses were reluctant to

invest in the production and marketing of inventions when their competitors had equal access to the technology (Muir, 1997).

Technology transfer occurred only very rarely in land grant institutions in the early part of the 20th century. It was a businesslike activity that was generally foreign to the service role and culture of most land grant institutions. Universities are by their nature traditional and slow to change. Yet, over the last 20 years, there has been a growing trend for universities worldwide to engage in technology transfer. In the United States, the trend began with the inception of the Bayh-Dole Act of 1980, which is discussed more thoroughly below, but which basically made it easier for universities to commercialize technology developed through federally sponsored research (Bayh-Dole Act of 1980. PL 96-517).

Prior to 1980, there was only a handful of universities with technology transfer offices. Today, there are nearly 300 and the Association of University Technology Transfer Managers has a membership of more than 1,800. The growth has been phenomenal, despite the fact that universities do not generally get rich from technology transfer activities. According to David Pramer, Executive Assistant for Research Policy and Professor Emeritus at Rutgers University, most university technology transfer offices are not even self-supporting. He estimates that only about one in 10,000 patentable disclosures result in “jackpot” returns (ASM News, p. 448, 1998).

So what’s the excitement all about? Why are universities so eager to enter an arena that is foreign to their culture and tradition? And universities aren’t doing this alone. They are partnering with business and industry, the sector that used to scorn academic institutions for the “ivory tower” mentality they sustained. In the same article

cited above, Pramer talks about the change in university- industrial partnerships: “By 1994, 90% of companies conducting research in the life sciences had working relationships with academic institutions, providing an estimated \$1.5 billion or about 12% of all research and development funding received by universities that year” (p. 446). What impelled this cultural revolution?

A primary catalyst was the fact that in recent years the government began to worry that the U.S. was losing its competitive edge in the world market. According to Albert Muir (1997), colleges and universities perform nearly half of today’s sponsored basic research. This is more than industry and federal agencies combined, yet most of the technology was not being fully developed or utilized prior to the early 1980’s. Besides the resistance of traditional university culture, there existed an additional obstacle to the licensing of university technology to private industry. The federal government sponsored much of the university research and declared itself the owner of most of the technology resulting from federally sponsored research. The difficult appeal process for universities requesting that the government assign the property to them reduced the likelihood of universities’ making the effort to gain control of that technology.

Discouraged at the lack of development and marketing of public technology, the federal government began to rethink its position concerning federally funded research and started looking to private industry for partnering opportunities. It recognized that, along with increased interaction between universities and industry, it should encourage improved cooperation and coordination between universities and federal research facilities. This change of attitude was reflected in the passage of the Stevenson-Wydler

Technology Innovation Act of 1980, and the University and Small Business Patent Procedures Act of 1980, more readily known today as the Bayh-Dole Act.

The first, the Stevenson-Wydler Act, encourages technology transfer from government labs to industry. It mandated that federal laboratories will actively seek cooperative research with state and local governments, academic institutions, nonprofit organizations, and private industry; it established the Center for the Utilization of Federal Technology at the National Technical Information Service to disseminate information and coordinate certain activities; and it established an Office of Research and Technology Applications at each federal laboratory with money set aside to fund technology transfer activities. (Stevenson-Wydler Technology Innovation Act of 1980. PL 96-480).

This Act was amended in 1986 by the Federal Technology Transfer Act which added specific requirements and processes for transferring technology from federal labs to the private sector, including evaluating and rewarding its scientists for the creation and transfer of innovative products and processes (emphasis added). (Federal Technology Transfer Act of 1986. PL 99-502).

The Bayh-Dole Act permitted universities and certain other entities conducting federally funded research to acquire rights to the inventions resulting from that research. This allows the university to grant exclusive licenses for these inventions to industry. The Act encouraged industry to make investments in research and motivated universities to market their inventions. (Bayh-Dole Act of 1980. PL 96-517). This legislation was amended in 1984 to specifically allow the following: contractors may receive royalties on patents, private companies may obtain exclusive licensing,

universities and nonprofit labs can retain invention titles, and the government always retains a worldwide, nonexclusive, irrevocable royalty-free right of use (Trademark Clarification Act of 1984. PL 98-620).

The enactment of these changes at the federal level marked the beginning of a new era for research conducted at land grant universities. The AUTM 1996 Survey of its members indicates that there was a 120% increase in U.S. patent applications by universities and a 68% increase in licenses involving university technology between fiscal years 1991 and 1995. Every indication is that the phenomenal growth will continue over the next decade (AUTM, 1996). The significance of this growth in university technology transfer activity is twofold: 1) the contribution to the scientific development of new products and processes that benefit society; and 2) the contribution to the economy.

Howard Bremer, writing for COGR's 50th Anniversary Journal of Papers, advises us that the transfer of new technology "to the private sector for further development into products and processes useful to mankind" is significantly more important than acquiring patents. He reminds us that, while the impact on the U.S. economy generated by university inventions is noteworthy, it pales in comparison to the issue of improved quality of life, for there the "contribution to society is immeasurable" (Bremer, p. 26).

According to AUTM's research, university technology transfer has had a phenomenal impact on the nation's economy and on quality of life:

University technology transfer --specifically the licensing of inventions -- adds more than \$21 billion to the economy and supports more than 180,000 jobs each year. It has helped spawn new businesses, create

industries and open new markets. Moreover, it has led to products and services that save lives, reduce suffering and improve the quality of life. From diagnostic tests for cancer to guardrails on our roadways to improved modems on the communications superhighway, technology transfer is enhancing the way we work and live.
(<http://www.crpc.rice.edu/autm/publications/survey/qa.html>, 1998).

University Technology Transfer Policies and Practices*

The policies and practices that have evolved within U.S. land grant universities have emerged in response to the concerns discussed above, and in response to the simple need for internal guidelines that facilitate university technology efforts. According to Trune (1998), “The considerable variation in universities that exists in this country makes comparisons difficult. There are vast differences in resources, infrastructure, size, local industry, teaching and research priorities, etc.” (p. 1).

Policies relating to intellectual property have been created and incorporated into the guidelines of most public research institutions in the country. The policies vary from one university to the next, but they tend to share some common themes and reflect common concerns. Universities use these policies in an attempt to clarify issues of ownership and transfer, as well as to define areas of potential conflict of interest and procedures for handling them. The primary policy issues addressed by universities engaged in this technology transfer generally focus on the following areas: ownership and disclosure, royalty distribution, areas of potential conflict of interest, and faculty reward (*See Footnote).

*Some sources of university policies in effect in 1999 include: Cornell University Conflicts Policy and Patents Policy; Michigan State University Faculty Handbook; Texas A & M System Policies; University of California, Guidelines on University-Industry Relations, University Patent Policies, and University Conflict of Interest Code; University of Florida, Intellectual Property Policy; University of Georgia, Research Policies and Practices Handbook; University of Illinois Policies; University of Minnesota, Board of Regents Policy.

The last category, faculty reward, will be discussed more thoroughly in the next section. (*See footnote.) While most universities engaged in technology transfer have begun to incorporate some form of policy that addresses the areas described above, there is no uniformity among the institutional policies. Many universities are still engaged in the

process of establishing or updating policies to adequately address the new concerns and conflicts of interest generated by these technology transfer activities (as evidenced by the number of university representatives attending AUTM conference sessions on policy creation and implementation during the last few years).

When creating and adopting new policy, each institution is guided by federal and state law, and the tradition, environment, and particular concerns of the institution. While one university may study the policies of others prior to creating or modifying its own policies, the uniqueness of each institution merits an approach, and usually produces a result, that is individual and distinctive. (*See footnote.)

In addition to the issues raised above, policies addressing university equity interest and employee ownership in commercial ventures are necessary to ensure full disclosure and adequate safeguards to the integrity of the institution. Without the creation of appropriate guidelines and the ability to articulate university policy to public and legislative constituents, the universities could find themselves hopelessly entangled in either red tape or bad publicity.

Actual practices related to the general process of technology transfer are generally more consistent among universities than are the intellectual property policies.

Functions of technology transfer offices at major land grant universities typically include the following:

1. Receiving and evaluating disclosures;
2. Preparing and submitting patent applications, securing patents on inventions and discoveries, and maintenance of those patents;
3. Marketing inventions to potential licensees;
4. Negotiation of new licenses;
5. Receipt and distribution of royalty income;
6. Monitoring of active licenses;
7. Maintenance of records of income and expenses associated with operating the office;
8. Negotiation of intellectual property rights with research sponsors;
9. Administering, interpreting, and recommending changes in the university's internal technology transfer policy;
10. Disseminating information to faculty and staff concerning university intellectual property policy and practices.

The majority of university technology transfer offices perform all these functions--each of which involves a number of steps and processes, the exact makeup of which may vary from one institution to the next (Johnson, 1984; see also Matkin, 1994; Slaughter and Leslie, 1997).

Evaluating new disclosures of inventions is a difficult process. While various factors are weighed, the validity of this early stage evaluation depends on the expertise of the decision makers, common sense, and a healthy dose of luck. One former

technology transfer manager, Kenneth Koonce (personal communication, Dec., 1998), who is now serving as Dean of the College of Agriculture at Louisiana State University, refers to the process as a “crap-shoot.” However, the factors considered in the initial evaluation process usually include: (1) the practical use and benefit of the technology; (2) the additional work, time, and expense that are necessary to get the technology ready for market; and (3) the presence of an interested investor (Steinbock and MacKenzie, Nov. 1995, p. 3-4).

This evaluation stage is particularly important because universities cannot afford to patent all the inventions disclosed to them. The patenting process may cost anywhere from three to ten thousand in the U.S. alone, and without the presence of an investor ready to pick up the tab, universities must carefully screen and select those technologies that appear to be most practical and profitable. Depending on the level of funding for patenting of inventions, universities may patent as little as two percent of the disclosed technologies or as much as thirty to forty percent. No institution is free of budget restraints and accountability to its constituents when making these decisions, and considerations include whether or not the invention represents a discovery that has broad protection and applicability, and may form the basis for a number of other inventions with patenting and licensing possibilities (Matkin, 1994).

The patenting process involves a number of stages and must be conducted by either a patent attorney or a patent agent. Prior to the initial application, a patent search is conducted to discover whether “prior art” (a patent office term referring to earlier similar technology) would prevent patenting of the invention. The application process is complex and, if biological material is involved, requires that a deposit be made in an

approved repository. In addition to the costs of filing the patent, there are processing fees, fees due upon issuance, and maintenance fees at certain intervals during the life of the patent. And of course, costs will increase significantly if foreign patents are also sought (Ersbisch and Velazquez, 1998).

Marketing the inventions of the university poses another problem for technology transfer officers. First, the marketing practices outlined in books and articles on the subject are the source of much debate. The effectiveness of one approach versus another has not been proven, except that there appears to be general agreement that non-targeted mass mailings do not usually generate positive responses. The second marketing-related problem actually appears to be the most prevalent. The economic situation at most universities results in university technology transfer offices that are understaffed, and little time is allotted to marketing the inventions. In fact, many technology licensing officers will be quick to say that the inventors themselves are often the best source of potential licensee companies, since they are often in a position of having been supported in their research by one or more entities interested in the results. Sometimes, the inventor is interested in starting his or her own company. If neither of those opportunities is present, the technology transfer officer will expose the invention to as many potential licensees as possible.

Although authors have proposed various models for assessing the value of a new technology, the accuracy of any such assessments is questionable and the issue is always a difficult one for licensing officers. One method for evaluating technology commonly used is to calculate royalty payments based upon a percentage of net sales. The percentage may be stable or based on an increasing or decreasing percentage upon

reaching certain milestones (Louisiana State University Licensing agreements, 1995-1999; AUTM Transfer Practice Manual, 1997 edition).

Up-front licensing fees are typically a part of the licensing agreement, as well as support for some or all patenting costs. Up-front fees may be waived or significantly reduced in the case of a start-up company where all available funds are needed for getting the product to market. In those cases, it is likely that the university will take an equity position in the company in lieu of up-front money (Louisiana State University Licensing agreements, 1995-1999; AUTM Transfer Practice Manual, 1997 edition).

After financial terms are agreed upon, the other terms of the licensing agreement typically include: an introduction, definitions, the grant of license, due diligence, reports and payment schedule, a termination clause, infringement restrictions, assignment, hold harmless clause, addresses for legal notices, miscellaneous terms, and signatures (Louisiana State University Licensing agreements, 1995-1999, AUTM Transfer Practice Manual, 1997 edition).

After licensing the invention, the technology transfer officer is responsible for monitoring licensee payments and distribution of those payments upon receipt. Most universities have a policy that describes the internal distribution of royalty income generated from licensed inventions. Although they vary, all provide for some share of royalty income to go to the inventor, a portion to pay for overhead and legal expenses, and a great deal to be reinvested in university research. (See footnote 1.)

While university policy may not spell out exact procedures for some of the other office activities, general business practices are used for assessing income and expenditures of technology transfer operations. The technology transfer office may take

an active role in monitoring research agreements with private sponsors to ensure that ownership of university generated technology is retained by the university.

In addition to policies governing internal procedures, a number of universities have established alliances with industry through their technology transfer activities. The Council on Governmental Relations 1996 Report, “A Review of University Industry Relationships”, identifies six major models of university-industry relationships:

- 1) Sponsored research--where industry provides funding for a delineated research effort, and rights to intellectual property and licensing rights are clearly defined;
- 2) Collaborative research--between universities and industry, and sometimes federal agencies which sponsor the research;
- 3) Consortia--participating institutions and businesses contribute resources to support research in an area of common interest to the group, typically with consortium members having first right to license resulting technology;
- 4) Technology licensing--standard university industry licensing agreements which generate royalty income;
- 5) Startup companies--established to further develop and commercialize specific university technology with the university often taking an equity position in lieu of up-front fees (high risk, but generally touted as a vehicle for local economic growth); and
- 6) Exchange of research materials--through material transfer agreements that encourage universities and industrial laboratories to share research materials for noncommercial research purposes only (Council on Governmental Relations, 1996, p 4).

Markers of Success in University Technology Transfer

Which technology transfer practices are best? Which policies facilitate a successful technology transfer program while adhering to the basic values and goals of the institution? These questions become questions of priorities. Each institution must select those policies and practices that best facilitate its technology transfer while adhering to the university's mission and goals. Even with this focus in mind, there are inherent difficulties related to the nature and newness of university technology transfer.

David Pramer (1998) believes that most research universities should view management of technology transfer "as a necessary administrative service and expense, and not as a university profit center" (p. 448). But some universities are making a profit, and that profit is contributing to the institution's research allocation. Additionally, their communities and states are reaping the benefits of increased local economic activity. How are they doing it?

No process for determining the factors that contribute to success in this arena has ever been clearly defined. Various studies have been conducted and certain factors have been associated with success, but even these can vary significantly from one "successful" program to the next. There is every indication that the bureaucracy of the typical research university is a barrier to the kinds of collaboration and cooperation that most universities hope to establish with industry today. Because universities keep trying to improve in this arena, a variety of policies and practices have evolved in university efforts to overcome obstacles to success. The huge variations in research funding, the types and sources of funding opportunities, and the mechanisms and diversity of state and private organizations through which technology transfer activities are conducted, all

indicate that there is no single successful approach to this process (Pressman, et al., 1995; Tornatzky, et al, 1995; Trune, 1996; and Kramer, et al., 1997).

In addition to the great diversity in the levels of funding and types of research conducted by the land grant universities, the individuals who constitute technology transfer professionals are a diverse group. While most of the advertisements for these professionals look for individuals with some science background, there are some which advertise for someone with business experience, others looking for legal experience, and still others that focus more on the ability to communicate well and handle a multitude of responsibilities under high pressure conditions. (Fliers advertising for tech transfer personnel are distributed among university licensing offices at a rate of 5 to 10 per month).

Before reviewing possible factors influencing success, one must attempt to define success. Generally, within the world of technology transfer, the term "success" is used to refer to those programs which are generating income for the university. However, there are a variety of important related issues that must be considered when dealing with an academic world. Administrators and faculty at most institutions do not discuss success of technology transfer in terms of economic impact alone. They do not discuss their programs without indicating what it means in terms of their overall missions.

How does technology transfer conform and contribute to the mission and goals of the institution? How does the faculty respond to technology transfer policies and activities? What is the effect of these activities on university/public relations? What real service to society is resulting from this addition to university responsibilities? And

what are the components that are most often assessed, evaluated, and referenced when measuring effectiveness of university technology transfer?

Economic development is a primary component. Nationally, the return on investment, according to the 1995 AUTM survey, seems to be about 3% if one considers national spending on university research and development (AUTM Licensing Survey, FY 1995). This doesn't appear to be very good, if all we're looking at is the financial bottom line. However, this is only one indicator of effectiveness and, for most supporters of higher education research, it is far from the most important indicator of success. The impact on the local economy and the service to the community and greater society is a greater concern for most who believe that the return on our investment in our universities cannot be measured in terms of dollars and cents alone. A far better approach is to consider the overall contribution to society (Matkin, 1993; Muir, 1997; Slaughter and Leslie, 1997).

This need to consider the bigger picture becomes even more apparent when one considers the testimony of Dr. Louis Tornatzky before the Louisiana House of Representatives Appropriations Committee in December of 1998. He stated that 86% of licenses and 95% of royalty income to American universities is generated by licenses with out of state companies, but the greater economic impact to the community and the state is likely to come from licenses to smaller, local entities and start-up companies. The small local companies are far more likely to directly contribute to the local and state economy through the creation of new jobs and an expanded tax base (Tornatzky, 1998).

A few studies have been conducted in recent years in an attempt to evaluate university technology transfer performance. Dennis Trune (1996) published a report of

his study of university licensing activities. He referred to the “vast differences in resources, infrastructure, size, local industry, teaching and research priorities . . .” among the universities included in the AUTM surveys, but made an attempt to identify some factors by which success could be measured. He performed a number of statistical analyses using multiple and simple regressions, and concluded that universities generally appear to be receiving approximately \$7.8 million in royalties per 100 licenses generating royalties. The licenses generating royalties were estimated to be about 37 of every 100 active licenses. His results also indicated that about 30 licenses were executed for every 100 disclosures received by universities, and that for every \$100 million in research dollars, approximately 42 disclosures resulted. Moreover, the national trend seemed to be that universities generate approximately \$88 million in research grants per 1,000 faculty members (Trune, 1996).

Two studies, one conducted at the Massachusetts Institute of Technology (MIT) in 1995, and a confirmatory study at Penn State in 1997, indicate the substantial impact of the Bayh-Dole Act in attaining its goals of encouraging the commercialization of federally sponsored technology, the participation of small business, and the use of university technology to generate economic growth (35 U.S.C., section 200). The results of both studies indicated that the income based on induced investments (investments of licensees prior to production and sales of the technology) can be estimated to be somewhere between 24 (at MIT) and 33 (at Penn State) times the amount of direct return to the university in the form of licensing income (Pressman, et al., 1995, and Kramer, et al., 1997) . In fact, researchers at Penn State found that their

“43 exclusive, active, patent licenses generated \$151 million in induced investments and created 242 full-time jobs.” (Kramer, et al., 1997, p. 1).

This is an important impact that is not revealed in the usual reports of university licensing income. The report of the MIT study examining the effectiveness of licensing activities at MIT carries a specific statement of MIT’s goals in technology licensing: “The primary goal of the MIT T.L.O. (technology licensing office) is to encourage, induce, and attract commercial investment to MIT inventions and to further product development and economic development. Revenue generation is only a secondary goal.” (Pressman, et. al., p. 54).

The fact that MIT invests in patents for about 40% of the disclosures it receives, versus the industry record of less than 10%, is indicative of the different goals of university licensing offices and commercial enterprises. Businesses invest in only those products and processes which are likely to produce large financial returns. Universities are concerned about getting their technological advancements to the public and generating economic development. Businesses are concerned first and foremost with generating revenues (Pressman, et.al., 1995).

This distinction becomes even more significant when one considers the nature of most university inventions:

University inventions are ‘embryonic.’ At the time a university is ready to hand its inventions off to industry, most have not even reached the prototype stage, much less demonstrated manufacturability and practicality in the market. These inventions will require substantial investment in product and market development, and many may never succeed. Thus, the task of the university in licensing these inventions is to find industrial licensees willing to make the high-risk investment (Pressman, et al., 1995, p. 50).

How does a university create that inducement? Other authors indicate that some of the success in generating both royalties for the university and economic development within a state is precipitated by innovative organizations formed by universities to promote and support research, licensing of technology, and establishment of start-up companies. Alvin Kwiram reported to the Council on Government Relations (COGR) at the Council's 1997 meeting in Seattle:

Most universities are engaged in at least patenting and licensing and seeking industry funding for collaborative research. The larger and more mature programs are also engaged in creating start-up companies, establishing incubators and research parks, and obtaining seed funds and venture capital funds (June, 1997).

Examples of some of the research parks and incubator programs include the University of Florida's Interdisciplinary Center for Biotechnology Research and the Sid Martin Biotechnology Development Institute (Biotech News, 1997), UMBC Research Park Corporation--a development venture owned and operated by the University of Maryland (Davis, 1998), Virginia's Center for Innovative Technology and the Kansas Technology Enterprise Corporation (Tornatzky, et al, 1995), and Clemson University's Genomics Institute, which has been awarded \$1.3 million from the National Science Foundation to purchase the equipment needed for the genetic work it proposes to conduct (Clemson University, May 1998).

David Hsu and Tim Bernstein, in the 1997 AUTM journal publication, discussed a number of ways in which university technology licensing offices could increase returns to the university. They emphasized the considerable advantage of strong industry relationships, networking, and pursuing industry-sponsored research projects. They also discussed the benefit of inviting venture capitalists and entrepreneurs to "open

houses” showcasing new university technology (January, 1997). Terrence McGuire, writing for the 1993 “Harvard Journal of Law & Technology”, indicates that over half the states have established some form of state--funded venture capital to encourage the growth of new technology. While he applauds their efforts, he also cautions that this can only benefit the state when these efforts are well coordinated to “add value to the private market, not simply compete with it.” (McGuire, p. 448).

Other factors leading to greater success that were discussed by Hsu and Bernstein included the use of students and interns with legal and business training, and improved measures of evaluating technology transfer performance. Throughout the article, the authors stressed the importance of effective marketing activities, discouraging marketing in the form of mass mailings, and focusing on the importance of targeted face-to-face contacts (Hsu and Bernstein, 1997).

These benefits sound enticing, but they do not come without significant cost to the university in terms of culture change and associated problems. The Council on Government Relations’ (COGR) 1998 report recommends that universities establish a system that can effectively and ethically deal with management of intellectual property. This requires properly trained personnel, often supplemented by the services of external entities. It involves the establishment of written policies and procedures to govern intellectual property management, as well as the rights and responsibilities of university personnel and external sponsors (COGR, 1998).

The Southern Technology Council reported the results of a study of 21 research universities. The report indicated that the following factors were present in the universities reporting the most start-up companies resulting from university technology:

a sensitivity to the potential of institutional technology to match the needs of the regional or state economy, explicit inclusion of economic development as an institutional mission or goal, flexible policies that encourage faculty involvement in start-ups by incorporating reduced appointments, leaves, leasing of or in-kind investment via university lab space and equipment, and other opportunities to participate in the launching of new technologies. Most universities in the study had high expectations about faculty reporting potential conflict of interest issues, but few direct prohibitions, and a great deal of flexibility in the operations of their technology transfer offices (Tornatzky, et al, 1995).

Additional factors associated with success include appropriate rewards for faculty engaged in innovative research activities, the use of business incubator programs, venture forums, and other entrepreneurial support systems. For example, Virginia's Center for Innovative Technology (CIT) actually provides pre-seed money in the range of \$5,000 to \$250,000 for things like market analysis or the development of prototypes, with a return on the money in the form of loan repayments or allowing CIT to take equity interest in companies. Other universities have joined with regional and national corporations to establish significant venture capital funds (Georgia, Alabama, and Washington are examples). And the most common source of financing for new businesses across the country is individual "angel" investors, a term used to describe individuals with an entrepreneurial interest in new technology who are willing to invest in university's research and resulting technologies (Tornatzky, et al, 1995).

Dempster and Goldberg (1996) describe the creation of the Long Island Research Institute in New York. It was the result of combined efforts of four regional

research institutions: the University at Stony Brook, Brookhaven and Cold Spring Harbor Laboratories, and North Shore University Hospital. Necessary funding was provided by local business investors who generated \$10 million to establish the Long Island Venture Fund. Together these two entities, supported by state and regional organizations, have generated substantial economic returns in the form of new business ventures, as well as licensing income on new technologies (Dempster and Goldberg, 1996).

In their conclusion, the authors identified the “lessons” to be learned from this success story. They emphasized the need to have professionals with both technical and business experience. They underscored the importance of good relationships and contacts in the business and the research communities. This ensures the kind of funding that is required for successful commercialization. Additionally, they focused on the need for continuing support and assistance to startup companies, as well as a thorough knowledge of the companies’ needs. Finally, they concluded that without an “aggressive champion” for each project, and strong institutional and public support, the vision would never have become a reality. (pp. 5-6).

These examples of successful innovations in the world of university technology transfer represent efforts that are taking place around the country. The institutions that have been most enterprising are not always the ones that are most heavily funded. The MIT’s and Stanford’s may not have to reach very far for the kind of financial support that most public institutions struggle to realize. But the examples included in the section indicate that the ongoing need to improve the university’s ability to facilitate the

transfer of technology to the marketplace is producing innovative and aggressive strategies designed to facilitate that transfer.

The Southern Technology Council study was actually the only study that took a comprehensive look at the underlying structure of successful university technology transfer activities. The conclusions reached by the authors of that research encompass many of the kinds of efforts discussed above. Some of the most pertinent recommendations resulting from this study are summarized below:

- 1) Match research to regional and state industry needs;
- 2) Engage in cooperative relationships with industry to get a better understanding of external perspectives;
- 3) Incorporate economic development into institutional mission and goals;
- 4) Incorporate technology transfer and other economic development activities into the organizational strategic plan;
- 5) Establish institutional policies that maximize institutional flexibility;
- 6) Establish entrepreneurial support groups;
- 7) Enlist the services of university business and incubator programs;
- 8) Encourage support from state political and business leaders;
- 9) Establish a nonprofit corporation to work with universities in the commercialization of their technology, particularly start-ups;
- 10) Review and work on revising state laws and university policies that inhibit the flow of technology from the university to the private sector;
- 11) Provide reward and encouragement for faculty engaged in innovative projects (emphasis added to underscore focus of this research project);

- 12) Provide more education of university personnel, state and local leaders, and the general public about the university's role in economic development (emphasis added to underscore focus of this research project) (Tornatzky, et al, 1995).

University Technology Transfer Today: Its Controversial Status

The results of research conducted in the land grant institutions have traditionally been considered to belong to the people of this country. The changes taking place today concerning ownership of inventions created within land grant universities in this country have generated a great deal of conflict, both within and outside of the universities (See Press and Washburn, March, 2000).

Today, within the limits of the law and university policy, most land grant institutions have access to an institutional technology transfer office with the capability of licensing that technology to an outside entity. While the structure of the institution may vary somewhat from one university to the next, and the management of technology transfer activities within each institution may be considerably diverse, the nature of technology transfer raises the same issues at all land grant research institutions. Therefore, the following discussion will highlight the primary issues revolving around technology transfer in the public university.

Sheila Slaughter and Larry Leslie rely on Campbell's 1995 publication of the results of faculty surveys conducted in more than 100 U.S. universities, citing the overall result that faculty in all fields believed that the benefits of university/industry collaboration were substantial. Moreover, after conducting what they termed an "exhaustive" literature search for possible costs and benefits, Slaughter and Leslie

interviewed faculty and administrators at two universities about the relative weights of the costs and benefits of technology transfer activities within the university. The interviewees identified the following items, paraphrased and summarized here, as the areas of primary concern:

- 1) Lack of laboratory facilities, equipment and support for research of other faculty. More explicitly, faculty felt that indirect costs to the university on the funded projects were consistently underestimated and the faculty without private sponsorship resented the inability to effectively compete for laboratory space and departmental resources;
- 2) Loss of time and resources for basic research, with faculty feeling pressured to produce revenue generating technology;
- 3) Loss of time of academic administrators;
- 4) Concern that revenue generated through private sponsors would result in loss of funding from other sources, particularly state and federal resources (this is a practical concern for administrators who recognize that royalties generated by technology transfer activities are neither long-term nor stable);
- 5) Loss of teaching time and emphasis;
- 6) The concern that faculty will delay publications and withhold research results for fear of losing potential value of new technology, thereby interfering with the free dissemination of information;
- 7) Loss of faculty and staff to private corporations;
- 8) Actual costs in the areas of underfunded research projects, patent costs and other legal fees, product or process liability; and the fact that most technologies do not

produce significant revenues to compensate the university for these costs; in fact, most universities currently do not profit from technology transfer activities. (Slaughter and Leslie, 1997).

Kenneth Dueker, writing for “Food and Drug Law Journal” in 1997, identified three broad categories of risk for commercialization activities of technology licensing offices at universities. These are the potential economic loss to investors and the university, the potential for university property to cause harm to third parties, and the exposure to potential liability for violation of contracts, regulations, or laws, usually regarding conflict of interest issues (Dueker, 1997, p.470).

Gary Matkin specifically identifies two main areas of conflict of interest that come into play when university-industry alliances are formed: first, the problem of faculty commitment to outside activities that interfere with responsibilities to the university; and second, the inappropriate use of faculty position within the university for personal gain (Matkin, 1994, p. 49; Press and Washburn, March, 2000). Either of these can occur when faculty become involved in starting their own businesses or entering into consulting arrangements with other companies. Faculty may be in a position to exploit university facilities, equipment, and support personnel for personal benefit. They may enter into consulting arrangements that permit them to be paid for work that should be conducted on their personal time, and use university time to conduct the work. They may do the same thing when overloaded with the work of starting their own companies based on technology they developed. These are all very real concerns and can successfully be addressed only if faculty ethics are above reproach.

Finally, a recent article in “Atlantic Monthly” highlights some of the most negative aspects of university technology transfer, citing examples of scenarios in various institutions that have created a furor among the faculty and in the public eye (Press and Washburn, March, 2000). The article highlighted examples of faculty greed and institutional corruption of mission. Discussions among university technology transfer officers indicate that their response to that article is generally that it focused on isolated worst-case scenarios and omitted information that would clarify some of the situations cited. (Personal communications with members of Techno-L listserv, March, 2000). Nevertheless, the article is another indication of the controversy surrounding the subject of university technology transfer activities.

Returning to Slaughter and Leslie’s study referenced above, the benefits associated with technology transfer that were identified as most important to the university were actually assessed by the vast majority as “far outweighing the costs.” The direct benefits include the increased funding support from university-industry alliances. This is particularly important in light of the fact that federal and state funding has been declining in recent years (1997, pp.254-255). The income from technology transfer, even when minimal, is also important in light of the fact that it is discretionary income and therefore a “means to exercise academic freedom” (Dueker, 1997, p. 457). The indirect benefits identified included the following:

- 1) Improved relations with external stakeholders, including the general public, industry, and government agencies;
- 2) Increased prestige for the institution as a center of excellence, as well as increased prestige for the individual researchers;

- 3) Increased sharing of university researchers' time to the area of interest, identified as "spillovers to research";
- 4) "Spillovers to teaching," with students reaping the benefits of faculty expertise and enthusiasm in the classroom as they shared insights and information obtained from their research;
- 5) Future consulting opportunities for faculty, which were tied to the growth in reputation of faculty within the industry and the rapport established with industry;
- 6) Graduates' opportunities for employment were enhanced, either through the experience of working with professors on sponsored projects or through contacts with industry established by research faculty;
- 7) Recruitment of postgraduates working on the sponsored research projects;
- 8) Additional personnel are often funded through university-industry collaborations;
- 9) Additional equipment is purchased through privately funded research contracts and grants;
- 10) Additional funding for employment of students within the departments;
- 11) Occasionally, recruitment from private industry by the university.

Additionally, there was considerable agreement among the interviewees that the partnerships and alliances with industry had infused faculty with a new enthusiasm and excitement (Slaughter and Leslie, 1997, pp. 121-128).

This conclusion is reinforced by two other studies conducted during the last decade. The first, a 1986 survey conducted under the leadership of Harvard Professor David Blumenthal concerning industry-sponsored biomedical research, indicated that,

faculty who had interactions with their commercial counterparts in industry taught the same amount, published more, produced more patented discoveries, and served in more administrative capacities at their universities than faculty not involved in industry-sponsored ventures (Dueker, 1997, pp. 470-471).

The second, conducted at the University of Wisconsin-Stout and incorporated into a 1989 report by Owen and Entorf, described a survey of selected faculty in technology-based institutions that found a correlation between faculty engaging in technology transfer activities and the following:

faculty consulting for firms, ongoing cooperative or internship programs, graduate students doing field work for industry projects, the presence of a clear university patent policy, and universities receiving gifts or grants from industry (Rahm, 1994, p. 269).

These benefits sound enticing and certainly support university technology transfer, but one cannot assume that faculty indoctrinated into the traditional culture of the research university have accepted the university's recent preoccupation with technology transfer activities. Many faculty are much more concerned about their status in the eyes of their peers than with their status with the university administration. In fact, many believe that if they attain a certain status among their peers, the university will have no choice but to embrace them and their work, regardless of their acceptance or disregard of the university's underlying agenda (various personal communications with members of Louisiana State University faculty, throughout the Fall of 1999).

The Role of Faculty in Technology Transfer

The role of faculty in the land grant research institution is crucial to the successful commercialization of new technology developed by the faculty. Without faculty participation, the university technology transfer efforts cannot be truly fruitful because the technology transfer manager relies upon the faculty to report new developments that may have economic value. It is important to remember that it is usually faculty who file the invention disclosures within the university. In doing so, they initiate the technology transfer process. They will only do this if there is a clear understanding of the process and, more significantly, the value the university and peers place upon development of new technology.

While an outsider may believe that faculty would naturally disclose new discoveries to the university technology managers, the reality is that, if the university has not educated its faculty about the technology transfer policies and process, many faculty may be unaware of the need to make such a disclosure or the nature of the process. Indeed, even where there is awareness, some faculty may refuse to contact technology managers because the nature of filing for legal protection inherently limits a researcher's ability to share the information with others in the field. This flies in the face of traditional practices among university researchers. Other faculty may feel that royalty distribution within the university is unfair. This could lead to faculty researchers secretly taking the new development elsewhere for technology transfer, a process referred to as "back dooring." Finally, some faculty members may simply be unwilling to invest the time and energy necessary to process the paperwork, knowing that only a

few of the technologies patented will be licensed, and even fewer of those will ever produce significant income.

Administrative awareness of the need for faculty participation in the effort is demonstrated by changes in most land grant university policies since the enactment of Bayh-Dole, and more specifically by recent consideration given to the generation of economic development in the community. Traditionally, university faculty have been assessed and evaluated based on three factors: (1) research (as evidenced by publications, preferably in the most academically elite journals); (2) teaching; and (3) service. Today, more and more institutions are considering patent and licensing of faculty technology in the assessment of faculty research. These institutions have begun to focus on increasing faculty awareness of the important role of technology transfer. The information pipeline to faculty for most universities may involve newsletters, web pages, workshops, and a number of other activities designed to alert faculty to university practices and policies related to intellectual property developed by university personnel. This education process is just beginning to evolve in many institutions.

Beyond education is the need to convince faculty that development and disclosure of new technology is truly valued by the institution. If technology development will be rewarded when promotion and tenure are under consideration, then faculty need to be made aware of this. In a 1993 publication, Robert M. Diamond, professor of instructional development, design and evaluation at Syracuse University and Director of Changing Priorities in Higher Education, a project sponsored by the Lilly Endowment, made the following comment about university administration and faculty reward: "The institutional reward system must send a clear signal to faculty that

what is valued by the institution will be rewarded at all points in the promotion and tenure system.” (Diamond, p.6, 1993). Sending a clear signal to faculty that technology that has the potential to contribute to economic development will be highly regarded and rewarded requires a change in the traditional culture of the university system in this country.

Cultural change within the university system is not something that will happen overnight. Despite the recent attention given to alternative review and reward systems, the institutional culture in research universities is resistant to change. Melinda Spencer, citing Chaffee and Tierney, asserts that dominant cultures may change over time, but this will occur slowly and will require strategic management. Throughout the process, the institutional culture will be a compelling influence in determining which management practices will work in moving a deeply imbedded culture to change (Spencer, et al, 1989).

Even when a new reward system is instituted, the ability of new rewards to impact faculty behavior and beliefs may be limited. There are still many faculty who will resist change on the grounds that a university should not be a for-profit center. Many researchers will resist the concept of university technology transfer as being somehow unwholesome--a dirtying of the hands in a system that should restrict its research to “disinterested inquiry” (Press and Washburn, March, 2000).

But recent changes in society cannot be ignored and some authors, including Walter Powell and Jason Owen-Smith, are already asserting that a “transformation, equivalent in scope to the Industrial Revolution, is underway in which the leading edge of the economy is more and more dependent on the production of knowledge” (1998, p.

266, citing Drucker and Nonaka). They believe this transformation is creating a “collapse of the distinction between basic and applied science” as universities pursue cutting-edge research through a variety of new alliances and partnerships, including interdisciplinary and multi-institutional teams (Powell and Owen-Smith, 1998, p. 266).

Again, this does not mean that faculty are ready to drop the old standard of valuation of their work in order to adopt the new. Research faculty are often more concerned about gaining the respect of their peers in their particular field of expertise than a nod of approval from university administrators. This increases the difficulty of any attempts to encourage faculty to devote time and attention to practical and perhaps economically valuable new technology if it is perceived as a distraction from their more academic pursuits.

There are many factors that encourage faculty to focus on a particular kind of behavior. From the perspective of behavioral theory, one can assume that “internal needs, personality dispositions, and external incentives and rewards will cause an individual to behave in predictable ways” (Blackburn and Lawrence, 1995, p. 19). More specifically, from a behaviorist viewpoint, an organization can theoretically reinforce desired behaviors by providing “external incentives” that will direct members of the organization to perform in a certain manner or to meet certain criteria. This belief is supported by the prevailing view in management and motivation theory, which assumes that human beings are selfish by nature (Sergiovanni, 1992).

There is an ongoing debate, however, over whether intrinsic or extrinsic factors actually create the greatest motivation for individuals to behave in a particular manner. Extrinsic motivation theorists believe external factors are powerful incentives because

people are rational and will act to maximize rewards. “Whether it is a promotion, a public recognition of good work, or extra resources, faculty will do what the organization wants when they believe their behaviors will be rewarded” (Blackburn and Lawrence, 1995, pp 283-284). And universities today “are being called upon to assist in ameliorating the considerable social, health, and economic problems facing American society” (Roberts, Wergin, and Adam, 1993). If they are to achieve a reasonable level of success in this endeavor, universities will be forced to carefully consider innovative ways in which to acknowledge and reward faculty engaged in the activities the institution wishes to foster.

Intrinsic motivation theorists would argue that external rewards will not change behavior much unless the internal motivation exists. From this perspective, the enjoyment of or belief in the importance of the action is paramount. One is reminded by Robert Froh and his associates that faculty often choose their careers for reasons other than monetary reward. There are powerful intrinsic rewards associated with working in a university community that provide motivation to those in the higher education community (Froh, Menges, and Walker, 1993). While universities cannot gauge exactly which kind of reward is most important to their individual faculty members, it is in the university’s interest to ensure that it creates a climate that fosters the interests of the university and its public.

For the nation’s land grant universities, the impact of carefully conceived royalty distribution policies cannot be overemphasized. Royalties to faculty inventors who have conducted the research with federal funding are mandated by federal law. The amount and actual distribution of those royalties are determined by internal institutional

policy. There may not be sufficient attention given to the issue of how those policies enacted and implemented might impact the behavior and attitudes of individuals within the university. Rhoades and Slaughter discuss organizational policy as a way to increase alignment within the organization. Organizations tend to make changes that are consistent with institutional beliefs and values, but with a specific goal of bringing “increased legitimacy and resources to the organization” (Rhoades and Slaughter, 1991, p. 66).

While the faculty generally receive a royalty share for development of new technology if it is licensed, there is no long history of development and the reward to faculty varies by university. The patenting and licensing of intellectual property are relatively new phenomena that, in many universities, represent a distinct departure from the practices of the past. Faculty in many research universities were discouraged from seeking research funding from private entities with commercial interests in the not too distant past, and new technology developed in the university was often publicly released without protection of proprietary rights (See Matkin, 1990; Muir, 1997; and Press & Washington, March, 2000).

In addition to the impact of formal policies, the informal practice of recognizing faculty for the development of new technology being adopted in some institutions may play a significant role in leading universities to look in new directions for evidence of scholarly activity. A few universities have begun presenting awards to faculty inventors in the form of plaques, certificates, or even cash. Others have organized elaborate receptions or dinners to honor the entrepreneurial activities of faculty on their campuses. (This information was obtained through personal communications with university

technology transfer officers via the Techno-L listserv, Spring, 1999). Whether these changes are actually influencing faculty and to what extent are questions not yet answered. In today's society, given the nature of technology and the current state of industry, public release is in many cases no longer a reliable method of getting new technologies to the consumer. Currently, there is a strong political and social movement in the direction of greater partnering between land grant universities and private entities to market new technologies and, when possible, to contribute to local economic development (Drabenstott, November 8, 1999; Steinbock & MacKenzie, 1995) .

One thing is clear. A critical aspect of success in university technology transfer is the introduction of the concepts of intellectual property protection and technology transfer to faculty so that they will understand the institutional process, as well as the internal and external forces driving this relatively new phenomenon. Without ensuring an awareness of the issues and a basic understanding of the process, universities are fighting an uphill battle in terms of creating a real culture change within the institution.

Summary

University technology transfer is becoming more important as universities are increasingly reminded that they will be navigating in a global economy in the future. If the United States hopes to retain its status as a world leader, it must continue to foster the entrepreneurial spirit which has become the trademark of free enterprise.

Our universities are the incubators for the leaders of the next generation. They are also the incubators of new ideas, new technology, and a large portion of our new scientific developments. For university administrators operating within the traditional framework and philosophy of our land grant institutions, the complicated issues

associated with technology transfer, partnerships with industry and its “alien” culture, and the need to enact change that strikes at the deep-rooted culture of the institution, may require a herculean effort. Yet, if they fail to harness and exploit the results of our university research, they will be failing those who look to the universities for answers to the world’s most pressing problems.

Universities must move forward with deliberation and careful attention to the internal and external stakeholders that provide the support base for the institutions. Despite resistance in some quarters, a culture change is taking place; one that brings with it a great deal of risk. There is a risk that this new activity will alienate supporters who feel they are already paying for development of new technology with their tax dollars or other financial support, and that new developments in a public university should be freely distributed. There is the risk of lawsuits resulting from disgruntled faculty developers, users of the technology, or potential infringement suits from others claiming first rights to new developments. Finally, there is the risk of losing sight of one of the missions of university researchers, which is to share insights and developments with other researchers and the public, since acquiring intellectual property protection is based in part on the fact that no prior public disclosure has been made.

One of the ways in which universities can more effectively manage the risk and enhance the benefits of technology transfer is to ensure that faculty are knowledgeable and willing participants in the process. They will not be unless they have a clear understanding of the value society and the university place on the development of new technology. Faculty must be convinced that this is a valid and vital role for them, and one that conforms to their personal and professional values. Finally, faculty will be

willing to engage in this new arena only when adequately assured that the rewards and benefits are worth the extra effort and inherent pitfalls associated with this new activity. Encouragement and reward are as important an aspect of fostering change as education and awareness. Without faculty acceptance, it would be impossible for a university to succeed in this endeavor.

A major culture change requires a major commitment on the part of the leaders of that change. Evidence of that commitment can be found in the efforts the institution makes to encourage faculty, its internal stakeholders, to embrace the new culture. The intent of this study is to discover basic information concerning faculty perceptions of their role in this new arena of technology transfer, and whether faculty perceptions differ in a university with a successful technology transfer program from the perceptions of faculty at an institution not yet realizing significant benefits from technology transfer. The data collected in this study will be useful for these and other land grant universities seeking information and direction in increasing the success of their technology transfer programs.

Gary Matkin, in his 1993 presentation at the Symposium on Technology Transfer and Public Policy: Preparing for the Twenty-First Century, reminds us of the inevitable problems that must be overcome in the attempt to cultivate an attitude of appreciation for this new culture and the necessity of being able to work effectively within this new arena:

The trend toward increased university and faculty involvement in commercial activity is irreversible: The commitment to economic development and commercialization of intellectual property is too strong and too advanced to be undone or even slowed down very much. Having stepped into the marketplace, the university will find itself governed by new rules. It will have to take legal

action . . . and will be sued in turn. Errors of judgment or association that bring negative attention to the university will inevitably occur . . . (p. 12).

Matkin anticipates increasing numbers of internal crises, external lawsuits, and negative publicity resulting from the university's lack of readiness to handle the changes associated with commercializing its technology. But he recognizes that internal and external forces will not permit us to move backwards. Instead, he advocates a position of balance between traditional roles and the new demands being placed upon universities today. "The balancing act will never end, but if it is successful long enough, it should become more like riding a bicycle than like walking a high wire." (Matkin, 1993, p. 12).

CHAPTER 3: METHODOLOGY

From the discussions that are taking place among university technology transfer managers, it is clear that there is some uncertainty and controversy over which might be the best path forward when attempting to engender institutional success in university technology transfer. Among the issues being discussed by university administrators are those concerning faculty awareness of and reward for engaging in technology transfer activities. Current literature regarding the factors related to university success in technology transfer indicates that university policy and practices play an important role in determining faculty participation in the process. The importance of this issue cannot be overstated. Without the active participation of faculty, there can be no successful technology transfer program. The question of what it takes to encourage faculty to embrace the process is at the forefront of many discussions initiated by university technology transfer professionals. The purpose of this study is to determine the awareness of faculty in land grant universities regarding selected aspects of purposes and processes of university technology transfer and their perceptions regarding the influence of selected personal and institutional characteristics on their participation in the university technology transfer process.

Population and Sample

The target population for this study is defined as faculty currently employed in land grant universities in the United States. The accessible population is defined as selected faculty currently employed in two designated land grant universities in the United States. The sampling procedure for selecting the study participants (the drawn sample) included the following steps:

First, two land grant universities were selected for participation in the study on a purposeful basis. These institutions were selected based on having certain similar basic demographic characteristics, including the existence of an active technology transfer program, similar intellectual property policies, locale, type of population, and economic base.

Land grant institutions were established with a common purpose and operate under public scrutiny that does not apply to private institutions. As public institutions, they are bound by state laws and restrictions that may not affect private entities. Although some of the land grant institutions have established private foundations to assist with technology transfer activities, they must operate within the scope of the policies and obligations of the institution as dictated by a state governing board of higher education and state ethics laws.

One of the institutions was selected on the basis of having met the criteria to be considered highly successful in technology transfer. The second institution was selected as falling significantly below the standard set by the criteria established as a measure of success in technology transfer.

In order to make these selections, it was necessary to have some method for measuring success. The first obstacle to overcome was locating a source of accurate information. The Association of University Technology Managers (AUTM) has polled its members since 1991 on various aspects of the technology transfer process and the results of these polls is the primary source of data used by other institutions attempting to gauge technology transfer activity within and among the member institutions. There are over 300 universities and research institutions with membership in AUTM. Over

half of those participate in the AUTM survey, and roughly ninety percent of the top one hundred research universities responded to the survey in 1996, 1997, and 1998. Thus, the AUTM Survey Report was the source used to determine which universities would be included in this study.

Using the AUTM polling results requires that the researcher recognize that self-reporting has certain drawbacks, including the fact that some of the universities report as a system and others file separate reports for separate campuses within a system. Some universities have established a foundation to handle their technology transfer activities and their reports are filed through the foundation. Despite potential weaknesses, AUTM is the only entity to publish this information and is thus the best reasonably accurate assessment of university technology transfer activity in the United States.

Land grant institutions reporting the results of their technology transfer efforts in the last three years to the Association of University Technology Managers (AUTM) were reviewed in order to choose the sample institutions for this study. Another reason for choosing this source is that the reporting institutions are perceived to be actively involved in technology transfer activities. Taking the time to respond to the survey indicates that the institution perceives technology transfer to be a significant activity conducted as part of the university mission.

Once the AUTM report was established as the best source of technology transfer information, specific criteria were established to gauge the success of technology transfer activity within the institutions. As discussed above, there are inherent difficulties in assessing success in university technology transfer. Simply looking at

dollars generated does not necessarily indicate that an institution is conducting its business in a well organized, efficient manner. It could indicate that the institution has had one lucky “hit” that has generated millions of dollars regardless of the internal or external environment. More information is needed to assess the effectiveness of university licensing efforts, and other factors must be considered as relevant indicators of successful technology transfer operations.

Gary Matkin identifies some of these considerations, including: ability to monitor new developments and solicit disclosures from faculty, and to make sound evaluation of the disclosures submitted; ability to secure and maintain patents--which usually translates as the ability to select good patent counsel; effective marketing, which involves a number of variables, including maintenance of good relationships with licensees and skill at negotiation; ability to interpret and apply policy and to recommend policy changes as the need arises; and good business practices in the administration of the technology transfer office (Matkin, 1990) . The technology transfer activities at the two institutions were measured against the standards of success identified with the field of technology transfer: significant profit in the form of licensing related income, increasing numbers of patents and licenses, and some indication of economic development through the establishment of start-up companies using university technology.

The primary factors that can be isolated and identified with successful university technology transfer activities are:

1. Awareness of faculty--indicated by disclosure activity (reporting new inventions to the university technology transfer office);

2. Marketing and negotiating skills--indicated by increasing licensing activity;
3. Local economic development--indicated by evidence of support of new start-up companies and licensing to in-state businesses.
4. Licensing income--indicated by increasing income levels resulting from university technology transfer activities.

Patent filings and issuances are also reported to AUTM, but these activities have been given less weight because they are greatly influenced by finances or patent office actions that are more often beyond the control of the university technology transfer offices.

Another concern that must be satisfied is that each of the selected institutions currently employs a technology transfer manager who is willing to support and encourage faculty participation in the study. Once the two institutions were selected for inclusion in the study, academic units that have a high likelihood of developing a new technology with a high potential for successful technology transfer were identified. For example, engineering colleges have a high potential for developing a marketable product or process, while a history department would be unlikely to develop a marketable product or process.

After careful consideration and on the advice of the experts who assisted and advised in development of the survey, it was determined that faculty from the following departments within each institution should be included in the survey. The instrument was distributed among faculty in the engineering departments and most of the life sciences departments, specifically including veterinary science, plant pathology,

agronomy, biology and microbiology, chemistry, animal science, and food science within the two institutions. The selected departments were those in which there appeared to be a high probability of having faculty engaged in applied research and likely to produce new intellectual property that could be transferred to the marketplace.

Upon identification of the academic units to include in the study from each institution, a complete listing of faculty in the designated units was compiled for each of the institutions, identifying the accessible population. One hundred percent of these selected faculty identified from each institution were included in the study.

Instrumentation

The purpose of this study was to gather information concerning faculty perceptions of university technology transfer and to compare the perceptions of faculty towards university involvement in technology transfer activities by the relative success of the institutions in technology transfer. Because the nature of the information sought was both descriptive and explanatory, the instrument selected for gathering the information was a survey, which was submitted to faculty most likely to be involved in the development of marketable technology. The survey instrument was comprised of two parts: (1) a section requesting background information; and (2) a section requesting faculty opinion on various aspects of and issues related to university technology transfer. The instrument was developed after a thorough review of the literature relating to university technology transfer. A 5-point likert-type scale was then attached to the appropriate questions, with responses ranging from “strongly agree” to “strongly disagree.”

First, content validity of the instrument was established through a review of the survey by a panel of six experts consisting of the following: two research faculty from higher education institutions in the South and on the West Coast, two technology transfer directors in research institutions, and two administrators in land grant research institutions. The experts studied and suggested revisions to the instrument to ensure that it would measure the things it purports to measure and to determine whether important questions were omitted or unclearly stated.

Second, to further ensure the validity of the instrument, it was pre-tested with a small sample of tenured life sciences faculty within Louisiana State University (LSU). Approximately fifty life sciences faculty within the LSU AgCenter were asked to complete the survey and to submit questions and comments regarding the content and form of the survey. This provided the researcher with additional information regarding the faculty's assessment of the clarity of the survey instrument and its effectiveness in eliciting the desired information.

Data Collection

After the institutional sample was identified, a representative of the technology transfer office at each selected institution was contacted by phone to solicit interest and willingness to participate in the study. Once willingness to participate was determined, the names of the faculty sample were collected and the following steps were taken:

1. A web site to house the survey instrument was established (a copy of survey instrument is attached as "Appendix A");
2. An e-mailed letter with a hotlink to the web site was sent to each selected faculty member from both institutions ("Appendix B").

Non-response follow-up procedures included the following:

1. After one week, all non-respondents received a second letter reminder, again with the hotlink attached;
2. After two weeks, a second reminder was sent to all identified faculty within the two universities;
3. If the response rate was below 70% (as it turned out to be), the researcher planned to and, in fact, did contact a random sample of the non-responsive faculty by phone to encourage response.

Ethical Considerations

Because this research involves human subjects, it was necessary to ensure that ethical principles were conscientiously considered and applied. The Belmont Report of 1979 sets the guidelines and principles for protection of human subjects. Those include: 1) Respect for persons; 2) beneficence; and 3) justice. Steps were taken to ensure compliance with these principles and guidelines. Although this project was exempted from Louisiana State University IRB oversight (See Appendix C), the researcher made every effort to ensure that participants were thoroughly informed of the purpose of this study, that their privacy was protected to the extent possible, and that any potential risk of harm was minimized.

Data Analysis

Once the surveys were returned, statistical analyses were conducted to determine whether there were significant differences in faculty perceptions of technology transfer activities within the two selected institutions. The following statistical tests were conducted in reference to each of the objectives:

Objective one was to describe the engineering and life sciences faculty at two land grant universities based on specific personal and demographic characteristics. These characteristics included the following: the number of years since the doctoral degree was completed, the number of years of experience at the current institution, academic rank, success in obtaining competitive research grant funding, and contributions toward a university patent/license. The first two characteristics were measured on a continuous scale of measurement and summarized using means and standard deviations. The remainder of the characteristics were measured on a categorical scale and summarized using frequencies and percentages.

Objective two was to determine the perceptions of faculty at the two universities regarding technology transfer activities. This was measured using the mean and standard deviation of each item in the scale. Factor analysis was used to determine if underlying constructs existed in the data.

Objective three was to compare faculty at an institution defined as successful in technology transfer and an institution that is relatively unsuccessful on selected demographics and on faculty perceptions of university technology transfer. This was done using the T-test and the Chi-square test of independence on the mean ranking to compare these two groups.

Summary: Why This Approach Was Chosen

The process described above was the most logical and effective for satisfying the purpose of this research. The study conducted here was an initial probe into the perceptions of faculty relative to the phenomenon of technology transfer in the university. As such, a case study approach was used, focusing on two universities with

many similarities but different levels of technology transfer success. The use of quantitative analysis of the survey results was designed to increase the reliability and the validity of the research.

According to D.A. de Vaus, one of the best ways to increase reliability of an instrument, is to use a set of questions or “multi-item indicators” to measure a concept rather than a single indicator (de Vaus, 1995). The instrument designed for this study incorporated several related questions that explored the attitudes of respondents through questions that solicited information regarding awareness of technology transfer activities within the institution, as well as the personal opinion of the respondents.

de Vaus also reminds his reader that, “A valid measure is one that measures what it is intended to measure.” (de Vaus, p. 55, 1995). The pre-tests of the survey instrument described above were intended to strengthen validity. The pre-test gave the researcher an opportunity to question the participants in the pre-test and discover, not only potential problems, but effective solutions to any problems encountered.

No measurement of the impact of university technology transfer activities was attempted by this study. The faculty survey instrument was designed to gather information based on opinion, feelings, and motivations, all difficult to quantify. This research intended to determine to some degree whether faculty have accepted this fairly recent addition to the mission of our land grant universities. As indicated by de Vaus, this basic kind of descriptive and simple explanatory research plays an important role in highlighting certain social issues and stimulating action (de Vaus, 1995). This kind of study, with its focused selection of research personnel and instrument geared toward indication of faculty attitudes toward university technology transfer, can play a key role

in identifying an essential and fundamental factor in the technology transfer success of land grant universities: How does the university solicit and extract faculty buy-in and willing participation in a relatively new phenomenon that flies in the face of traditional university culture?

CHAPTER 4: ANALYSIS OF RESULTS

Sample

The purpose of this study was to determine if a relationship existed between the relative success of a university's technology transfer program and the perceptions of its faculty concerning the importance and appropriateness of university involvement in technology transfer. In order to obtain answers to the questions being asked regarding faculty perception of university technology transfer, surveys were sent to selected faculty in specified program areas in the two universities selected for this study during the spring of 2000.

The two land grant universities used in the study are referenced herein as University X (less successful) and University Y (more successful). As illustrated in Table 1, they were selected based on similar demographic factors but different technology transfer program activity. The survey instrument was distributed among faculty most likely to be involved in the development of marketable technology. This included all faculty in the engineering departments and the life sciences departments (including veterinary science, plant pathology, agronomy, biology and microbiology, animal science, and food science) within the two institutions.

The demographic similarities between the two universities included the following: Both universities are land grant research institutions. Both have active technology transfer programs and have had one or more persons devoting at least half of their time to technology transfer for at least ten years. The universities are both situated in southern states with a predominantly rural environment where agriculture plays a significant economic role. Neither university is set apart by the unique kinds of

advantages that North Carolina enjoys with its Triangle Research Park or that Texas A & M enjoys with its huge state support base, both in terms of numbers and dollars. Like most universities in the country, the two selected institutions were feeling the pinch of decreasing state and federal dollars directed to higher education.

Table 1. Comparison Of The Two Universities Selected For This Study

Comparisons	University X	University Y
Type of Institution	Land Grant Research Inst.	Land Grant Research Inst.
Location	Southern / Rural State	Southern / Rural State
Schools and Colleges	12	14
Approx. Size by Student Population	30,000 Students	30,000 Students
Size by SY's (fiscal year 1999 funds in thousands/scientist years*)	186.2	186.7
Est. Annual Research Expenditures 1996-99	\$125 million	\$216 million
Tech. Transfer initiated	1990	1979
Licensing Income (over a 3 year period)	< \$3 million	>\$7.5 million
Faculty Disclosures of New Inventions (annually)	35-45	75-85
New Licenses (annually)	7-20	20-30
New Patent Filings (annually)	15-30	20-30
New Start-up Business from University Technology (annually**)	1-2	4-6

*CSREES Reports (FY 1999)

**AUTM Survey (1996-1998)

Here the similarities between the two institutions end. Despite the lack of unique economic advantages associated with a few other southern rural states' universities, University Y has far exceeded University X in terms of the results of its technology transfer activities and its research funding levels. University X reported

annual research expenditures of approximately \$125 million over the three year period from 1996 through 1998. In the AUTM surveys, University Y reported annual research expenditures ranging from \$209.3 million to \$216.4 million for that same time period. The fact that the two universities' reported annual research expenditures differ so dramatically indicates that this is a major advantage that University Y maintains over University X in this very competitive environment.

University Y's office of technology transfer has been in existence since 1979. The University X technology transfer office, on the other hand, reports that it has only been conducting these activities with at least a one half time person since 1990. As a result, there is a strong likelihood that the technology transfer program at University Y is more progressive and that it has had more time to adopt the kind of policies that foster successful university/industry collaborations.

As discussed in Chapter 3, the technology transfer activities at the two institutions were measured against the standards of success identified with the field of technology transfer: significant profit, increasing numbers of patents and licenses, and some indication of economic development through the establishment of start-up companies using university technology. These two universities were selected for this study from a group of approximately 130 universities responding to the AUTM survey during the three year period from 1996 through 1998. Both have active technology transfer programs, but there has been a substantial difference in the amount of activity actually taking place. The technology transfer indicators used in the selection and listed in Table 1 included licensing, disclosure, and patent activity.

University Y was the institution defined as more successful at technology transfer, based on awareness, marketing and negotiating skills, and local economic development. In contrast, University X is experiencing less technology transfer success, indicated by more erratic disclosure activity in recent years; relatively stationary licensing activity; and very few new start-up businesses. Patent filings and issuances were also reported, but these activities have been given less weight because they are greatly influenced by finances or patent office actions that are more often beyond the control of the university technology transfer offices.

The final selection criterion used was the generation of licensing income from technology transfer. Income was used as a selection criterion cautiously, because consideration must be given to the fact that licensing income fluctuates and varies at times due to the expiration of patents and market factors affecting product viability. However, it is a significant and accepted measure indicating success in the field. Thus, in order to account for fluctuations and to create a more accurate picture of actual licensing income derived from new technologies, a combined income over three reporting periods was used. University X reported licensing income totaling less than \$3 million during the three year period from 1996 through 1998, with annual figures hovering around \$1 million or less. This is significantly below University Y. University Y's licensing income reported to AUTM during the same time frame has increased at a steady pace from a little over \$1 million in 1996 to over \$3 million in 1998, for a combined amount of over \$7.5 million. The above licensing income figures place University Y in the top twenty reporting universities on the basis of income from licenses of technology. This becomes even more significant when one considers that

University Y's sponsored research expenditures are significantly smaller than most of the others in the top group (See Table 1).

Once the two institutions were selected, each faculty member identified as a part of the sample received the cover letter with a web site attached that contained the survey in the form of a web page allowing the user to click on the appropriate response and return the document electronically. Three separate requests were made of faculty for returns on the survey. A total of 885 faculty across the two land grant universities were included in the sample to be surveyed. A total of 191 surveys were returned with responses to some or all of the items. Of the 451 surveys sent to University X faculty, 121 were completed and returned, a response rate of 27%. Of the 434 surveys sent to the University Y, 70 were completed and returned, a response rate of 16%. Although current university catalogues were used to obtain the faculty email addresses, more than 100 surveys were rejected by their respective servers as having addresses that were either not correct or no longer operational.

The response rate was considerably lower than anticipated by the researcher. Therefore, a follow-up phone survey of random selected but non-responsive faculty was conducted in an attempt to discover the reason for the low response rate. More than 30 phone calls were made. Several faculty could not be reached. Some of those contacted indicated that they failed to respond to the survey because they have heavy workloads and receive many requests from students to assist with surveys and questionnaires. Most of those also refused to answer any survey questions over the phone. The majority of those who were willing to answer a few of the questions had responses that were similar to those of the respondents to the survey instrument. They were mostly tenure

track faculty who had received competitive grant funding within the past three years and who believed that technology transfer was a beneficial and appropriate university activity. The responses of the phone interviewees suggests that the survey responses analyzed in this study are representative of the larger sample group.

Once the responses were received, the information was assessed with the three research objectives in mind. The findings presented below are organized in accordance with the objectives of the study.

Findings

Objective One: Demographic Characteristics of Faculty

The first objective of the study was to describe the life sciences and engineering faculty at land grant universities on selected personal and professional demographic characteristics. The characteristics were identified and established according to the responses to the first nine questions in the survey. Respondents were asked to provide information in the following areas: 1) number of years that they have had a doctorate, 2) number of years on the faculty at their current institution, 3) current academic rank, 4) whether they have had success in obtaining competitive grant funding within the past 3 years, 5) whether they have been listed as an inventor on a university patent or license, 6) whether they had met with their institution's technology transfer officer, 7) their awareness of the university's royalty sharing policy, 8) their awareness concerning faculty incentives to participate in technology transfer at their university, and 9) whether their university publicizes successful university inventions. (The first three variables required different numerical or categorical responses and separate tables were

constructed to reflect the results. The results of responses to variables 1 and 2 are illustrated in Table 2.)

Table 2. Demographic Characteristics Of University Faculty

Variable	Range	Mean	Std. Dev.
Time period of having doctoral degree	1 - 39 years	17.86	9.1
Time at current institution	1 - 43 years	14.31	9.01

The first variable examined was the number of years the faculty member had held the doctoral degree. This was measured by asking the participants in what year they completed their doctorate. This measurement was then used to calculate the variable of interest, as shown in Table 2. The 184 faculty responding to this item indicated that the time period they had held doctoral degrees ranged from 1 to 39 years with a mean of 17.86 years and a standard deviation of 9.1.

The second variable examined was the number of years the respondents had been on the faculty at their current institution. This was measured by asking the participants in what year they joined the faculty at their current institution and using the responses to calculate the variable of interest. The length of service at the current institution ranged from 1 to 43 years, with a mean of 14.31 and a standard deviation of 9.01 (See Table 2).

Table 3 illustrates the results of responses to variable 3, which asked the respondents to identify their academic rank. The academic rank of the majority of respondents from both institutions were either associate professors ($n = 51$, or 26%) or full professors ($n = 89$, or 46%). Seventy two percent ($n = 140$) of respondents fell into

one of these two academic ranks. Of the others, 13% (n = 25) identified themselves as assistant professors, making up a total of 165 or 86% in tenure track positions.

Table 3. Academic Rank

Measurement	Prof	Assoc Prof	Asst. Prof	Instructors	Endowed Prof	Other
Number (n)	89	51	25	6	4	16
Percentage (%)	46	26	13	3.1	2.1	8.4

The remaining respondents identified themselves as follows: 3.1% (n = 6) were instructors, 2.1% (n = 4) were endowed professors, and 8.4% (n = 16) fell into the “other” category. The instrument requested respondents who indicated “other” to specify what “other” was, none of the 16 respondents in this area provided the specific information requested. The researcher believes that most “other” categories would include research associates, endowed chairs, and adjunct faculty.

Table 4 illustrates the results of responses to variables four through nine. These six variables required a response of yes, no, or don’t know. No other options or explanations were requested.

Table 4. Characteristics of Faculty in Relation to Technology Transfer

CHARACTERISTICS	RESPONSE *		
	Yes n/%	No n/%	Don’t Know n/%
Recpt of competitive grant funding w/i past 3 yrs	133/70%	57/30%	n/a
Contributor on patent/license	54/28.4%	136/71.6%	n/a
Met with tech transfer officer	108/56.8%	73/38.4%	9/4.7%
Univ.royalty sharing policy	139/73.2%	3/1.6%	48/25.3%
University provides incentives for faculty inventions	76/40.0%	35/18.4%	79/41.6%
University publicizes successful inventions	139/73.9%	17/9.0%	32/17.0%

*A total of 190 Respondents answered each of these items.

The first question in this group asked whether the faculty member had received competitive grant funding within the past three years, the majority of survey respondents (133 of 190 or 70%) indicated they had obtained competitive grant funding from outside the university within the past three years. When asked whether they had filed for or been listed as an inventor on a university patent or license, 136 of 190 respondents (71%), indicated they had never been listed as an inventor on a patent application. The respondents were also asked whether they had ever met with anyone from their institution's technology transfer office. Over half of the responding faculty, (n =108, 56%) indicated that they had met with someone from their technology transfer office (See Table 4).

The measuring instrument included three items, also shown in Table 4, which were designed to identify faculty members' perceptions of selected university policies regarding technology transfer. The first of these items pertained to whether or not the university's policy included royalty sharing for faculty inventors. Responses to this question included 72% (n = 139) who indicated that their institution did have such a policy in place. The second item relating to university policy asked the respondents to indicate whether or not their institution provided incentives for faculty to develop new inventions. Even though a large number of faculty responded "yes" to this item (n = 76, 39.8%), the largest group of respondents for this item indicated that they did not know (n = 79, 41.4%). The remainder (n =35 , 18.3%) responded "no" to this item. Finally, the faculty were asked if their institution publicizes successful university developed inventions. According to 139 of 191 respondents (72%) there is publicity generated by the universities about new faculty inventions.

Objective Two: Perceptions of Faculty

The second objective of the study was to determine the perceptions of faculty at land grant universities regarding university technology transfer activities. The participants were asked to respond to 23 items designed to determine information about the perceptions and attitudes of faculty at these two land grant institutions toward university technology transfer. Participants were asked to record their responses on a 5 point Likert-type scale. The questions, with the exception of the final two survey questions, gave faculty the following response options: 1) strongly disagree, 2) disagree, 3) no opinion, 4) agree, and 5) strongly agree. Table 5 illustrates the results of the responses to these items.

To facilitate the interpretation of the responses to these items the researcher established an interpretive scale as follows:

1.50 or lower = "Strongly Disagree;" 1.51 to 2.50 = "Disagree;" 2.51 to 3.49 = "No Opinion;" 3.50 to 4.49 = "Agree;" 4.50 or higher = "Strongly Agree."

Using these descriptions, the items with which the faculty most strongly agreed were in the "Agree" interpretive category and the item with which they least agreed was in the "Disagree" category. Overall, 11 of the 23 items received mean response values in the "Agree" category; 11 received mean response values in the "No Opinion" category; and one item received a mean response rating in the "Disagree" category (See Table 5).

As indicated in Table 5, the items with which the responding faculty most strongly agreed were, "My university should be involved in technology transfer as it relates to faculty inventions because it is a means of generating income to support

research” and “It is appropriate for universities to be involved in technology transfer-related activities.” Each of these items received a mean rating of 4.25 (SD = .98 and SD = .84 respectively).

Table 5. Perceptions of Faculty Regarding University Technology Transfer

id	Item	Mean	*Standard Deviation	*Response Category
1	It is appropriate that a portion of royalties earned from a faculty member's invention supports my university's technology transfer office.	4.25	.98	AGR
2	It is appropriate for universities to be involved in technology transfer-related activities.	4.25	.84	AGR
3	Technology transfer is important to my university.	4.15	.89	AGR
4	My university should encourage faculty to create new technologies/inventions.	3.93	.86	AGR
5	My institution has been successful at technology transfer.	3.84	.76	AGR
6	My university should be involved in technology transfer as it relates to faculty inventions, because it is a means of generating income to support research.	3.73	.95	AGR
7	If I had freedom to choose whether to commercialize my research results or freely disseminate the information, I would opt for the latter.	3.72	.81	AGR
8	A technology transfer office is/could be a benefit to me.	3.65	.98	AGR
9	One or more of my colleagues has personally benefitted from technology transfer within the university.	3.64	1.02	AGR
10	Within my department it is common for faculty to discuss potential applications of our research.	3.54	1.18	AGR
11	Creation of inventions should be a consideration in tenure and promotion decisions.	3.51	1.16	AGR
12	I anticipate that I will need the services of the university technology transfer office at some point in my career.	3.44	1.07	NOP
13	In the past three months, I have read an article about the successful commercialization of one of our faculty's new inventions.	3.29	1.13	NOP

(table continued)

14	Faculty should share in the profits resulting from their inventions.	3.25	.82	NOP
15	My university should encourage all faculty to attend a seminar/training session on tech transfer.	3.18	1.09	NOP
16	University tech transfer leads to private companies driving the direction of the research.	3.14	1.06	NOP
17	University involvement in tech transfer creates conflict among its faculty.	3.04	.95	NOP
18	University technology transfer eliminates the free exchange of research information.	3.03	1.12	NOP
19	A university technology transfer office can help get new inventions into public use.	2.93	1.08	NOP
20	My university should place greater emphasis on applied (versus basic) research.	2.92	1.16	NOP
21	The emphasis on tech transfer and applied research has had a negative impact on the quality of teaching within my university.	2.61	1.11	NOP
22	My university should be involved in tech transfer as it relates to its faculty's inventions, but should not use the process to profit monetarily.	2.57	1.09	NOP
23	The potential problems resulting from tech transfer activities outweigh the benefits to the university.	2.37	.93	DIS

* Mean values based on response scale 1 = strongly disagree, 2 = disagree, 3 = no opinion, 4 = agree, 5 = strongly agree.

^b Response categories based on the following scale established by the researcher: SD-Strongly Disagree = <1.50, DIS-Disagree = 1.50 to 2.49, NOP-No Opinion = 2.50 to 3.50, AGR-Agree = 3.51 to 4.50, and SA-Strongly Agree = >4.50.

The item which received the third highest level of agreement was, "Technology transfer is important to my university." This item received a rating of 4.15 (SD = .89). The item that had the lowest level of agreement among the responding faculty was, "The potential problems resulting from technology transfer activities outweigh the benefits to the university" (Mean rating = 2.37, SD = .93). The large number of "no opinion" category responses actually resulted from a large number of varied and weak agree and disagree responses to these items.

The opinion section of this survey consisted of 23 items. Calculations of correlations and differences between each of these items individually and the selected demographics would have been cumbersome to interpret. It would also have created a high level of inflation of the probability of experiment-wise error (alpha level). Therefore, to further summarize the information regarding perceptions of faculty, factor analysis was done to determine if underlying factors could be identified in the data. When the analysis was conducted, the optimum number of factors identified in the data was six. This six factor solution provided the researcher with satisfactory loadings for all of the items and produced no single item factors. After the factor composition was determined, each of the factors was labeled by the researcher, and the items included in each factor were mathematically combined into six factor scores. These are summarized in Table 6.

Table 6. Statistics on Factored Groups--Summarized

	N		Mean	Std.Deviation	Minimum	Maximum
	Valid	Missing				
D. MISSION	190	1	4.21	.76	1.00	5.00
F. FUTURE	186	5	3.79	.77	1.33	5.00
B. BENEFITS	185	6	3.47	.46	1.75	4.75
C. POLICY	187	4	3.38	.69	1.25	4.75
E. SUCCESS	189	2	3.37	.66	1.25	5.00
A. PROBLEMS	185	6	2.91	.68	1.67	4.83

Note: Table arranged from highest mean to lowest; factors labeled A through F by the order in which they factored and in which they are discussed below.

The first factor consisted of six items and was labeled "Problems" since it included items that related primarily to problems that are potentially associated with the technology transfer process. The items included in the factor labeled as problems are:

Factor A--Problems

1. University technology transfer eliminates the free exchange of research information.
2. University involvement in tech transfer creates conflict among its faculty.
3. The emphasis on tech transfer and applied research has had a negative impact on the quality of teaching within my university.
4. University tech transfer leads to private companies driving the direction of the research.
5. The potential problems resulting from tech transfer activities outweigh the benefits to the university.
6. If I had freedom to choose whether to commercialize my research results or freely disseminate the information, I would opt for the latter.

The “Problems” scores ranged from a low of 1.67 to a high of 4.83 with a mean value of 2.91 (SD = .68). While awareness of potential problems and conflicts was clearly evident, most faculty respondents indicated a more positive than negative view of university technology transfer. They specifically disagreed with the statement that the problems outweigh the benefits.

The second factor identified in the scale responses was labeled “Benefits” and consisted of four items that focused on the beneficial outcomes of the process of technology transfer to the individual and the institution. The items are:

Factor B--Benefits

1. It is appropriate that a portion of royalties earned from a faculty member’s invention supports my university’s technology transfer office.

2. My university should be involved in tech transfer as it relates to its faculty's inventions, but should not use the process to profit monetarily.
3. A university technology transfer office can help get new inventions into public use.
4. My university should be involved in technology transfer as it relates to faculty inventions, because it is a means of generating income to support research.

This computed factor score had a mean value of 3.47 ($SD = .46$) with values ranging from 1.75 to 4.75. Once again, the faculty respondents showed a belief in the potential benefits of university tech transfer activities.

The third factor was labeled "University Policy" because the four issues identified were related to potential decisions by the university administration regarding technology transfer within the institution.

Factor C--University Policy

1. My university should encourage all faculty to attend a seminar/training session on tech transfer.
2. My university should encourage faculty to create new technologies/inventions.
3. Creation of inventions should be a consideration in tenure and promotion decisions.
4. My university should place greater emphasis on applied (versus basic) research.

The "University Policy" sub-scale score had a mean value of 3.38. The values ranged from a low of 1.25 to a high of 4.75 ($SD = .69$). The results appear to indicate a belief that, if the university administration wished to encourage technology creation and development, policy should reflect this inclination.

The fourth factor indicates the faculty's perception of whether technology transfer is a legitimate activity for the university and consistent with the institutional mission. This factor was labeled "Consistent with Mission" and included the following items:

Factor D--Consistency with University Mission

1. Technology transfer is important to my university.
2. It is appropriate for universities to be involved in technology transfer-related activities.

The "Consistent with Mission" sub-scale scores ranged from a low of 1.00 to a high of 5.00 with a mean value of 4.21 (SD = .76). Clearly, faculty see university technology transfer as consistent with the university mission.

The fifth factor was labeled "Success" because the items therein were related to the success of the individual and the institution as a result of university technology transfer. Those items were:

Factor E--Success

1. One or more of my colleagues has personally benefitted from technology transfer within the university.
2. In the past three months, I have read an article about the successful commercialization of one of our faculty's new inventions.
3. My institution has been successful at technology transfer.
4. Within my department it is common for faculty to discuss potential applications of our research.

The sub-scale score values ranged from 1.25 to 5 with a mean of 3.37 (SD = .66) for this factor. As there was a significant difference between the success factor responses from the two institutions, this factor will be discussed further in Chapter 5.

The sixth and final category was labeled “anticipation of future value of the technology transfer process to faculty.” Items included in this factor were:

Factor F--Future

1. Faculty should share in the profits from their inventions.
2. I anticipate that I will need the services of the university technology transfer office at some point in my career.
3. A technology transfer office is/could be a benefit to me.

The scores ranged from 1.33 to 5.00, with a mean of 3.79 (SD = .77), and indicated the faculties’ positive perception of the potential of receiving valuable assistance from their technology transfer office in the future.

The final survey item asked the respondents to rank the selected functions of a university technology transfer office in order of importance, with 1 being most important and 6 being least important. The results were measured using the mean of the ranks to establish the perceived priority among faculty. The functions identified in the question were: a. obtain patents for faculty inventions; b. Negotiate with commercial partners to market the inventions; c. Protect faculty interests; d. Protect university interests; e. Assist faculty in starting up new businesses; and f. Educate faculty on all aspects of technology transfer. And as Table 7 illustrates, the responses to this survey item indicated where faculty priorities lie.

Table 7. Priority Functions of a University Technology Transfer Office

Functions	N		Mean	Std.Deviation
	Valid	Missing		
*Protect faculty interests	187	4	2.48	1.23
*Obtain Patents for Faculty Inventions	188	3	2.73	1.43
*Protect University Interests	187	4	3.12	1.59
*Educate Faculty on Technology Transfer	187	4	3.16	1.76
*Negotiate with commercial partners	187	4	3.80	1.45
*Assist faculty to start up new businesses	187	4	5.30	1.24

*Minimum = 1.00 Maximum = 6.00

With a range from 1.0 to 6.0, item c, protect faculty interests, received the highest mean importance ranking with a mean score of 2.48. Item a, obtain patents for faculty inventions, followed as a close second, with a mean of 2.72. Faculty ranked “assist faculty to start up new business” lowest in importance. The mean ranking provided by the respondents was 5.30, with a standard deviation of 1.24.

Although faculty had strong preferences, the preferences indicated to the researcher that, while faculty have an understanding of the concept of technology transfer and accept it as an appropriate university activity, they exhibit a lack of understanding of the actual process of technology transfer. This is not surprising given the fact that technology transfer is somewhat peripheral to faculty concerns and daily responsibilities.

Objective Three: Comparison of Faculty at Universities X and Y

The third objective of this study was to compare faculty at an institution defined as successful in technology transfer and an institution that is relatively unsuccessful on the following measures:

1. Number of years they have had a doctorate
2. Number of years experience at their current institution
3. Academic rank
4. Attainment of competitive research grant funding within the past three years
5. Number of occasions whereupon contributions toward a university patent/license were made
6. Perceptions toward university technology transfer activities relating to the appropriateness of the activities and importance of the activities.

First, a comparison was conducted across universities based on the demographics discussed in objective one. The independent samples t-test was used to compare the following two factors: years since a doctorate was obtained and years on the faculty of the current institution. No significant differences were found when looking at year of graduation or years on the faculty at the current institution. As clearly indicated in Table 8, the universities' faculties were very similar in these respects.

Table 8. Comparison of Selected Demographic Characteristics by Relative Technology Transfer Success of University

Variable	univ x M/SD	univ y M/SD	t-test		
			t	df	p
YRS DOC	18.23/9.12	17.20/9.24	.73	182	.47
YRS FAC	15.13/9.44	12.91/8.09	1.63	186	.11

For variables that were measured on a categorical scale, the researcher used the chi-square test of independence procedure to determine if each of the variables investigated was independent of the variable institution (operationalized as a university that had been highly successful in technology transfer and a comparable university that had been less successful). The variables investigated included: current academic rank, whether they have had success in obtaining competitive grant funding within the past 3 years, whether they have been listed as an inventor on a university patent or license, whether they had met with their institution's technology transfer officer, their awareness of the university's royalty sharing policy, their awareness concerning faculty incentives to participate in technology transfer at their university, and whether their university publicizes successful university inventions. Table 9 reflects the results of these items.

Table 9. Summary of University Comparison by Demographic Variables

Characteristics	df	χ^2	p
Current academic rank	5	6.30	.28
Receipt of competitive grant funding within past 3 years	1	3.88	.049
Contributor on patent/license	1	2.90	.09
University royalty sharing policy	2	3.56	.17
Met with tech transfer officer	2	.27	.87
University provides incentives for faculty inventions	2	2.00	.37
University publicizes successful inventions	2	3.10	.21

Results of these analyses revealed that all but one of the factors were found to be independent of the institutional affiliation of the faculty member. The factor which was found to be associated with faculty of a particular institution was "Whether or not the faculty member had been successful in obtaining outside funding in the past three years"

($\chi^2_{df=1} = 3.88, p = .049$). As shown in Table 10, the nature of the association between these variables was such that a higher percentage of faculty in the more successful institution (University Y) reported that they had been successful in obtaining outside funding in the past three years than in the less successful institution (University X).

Table 10. Cross tabulation of the Reported Faculty Success in Obtaining Outside Funding by University Affiliation

Success in Obtaining Outside Funding over the past three years		UNIV		Total
		X	Y	
Yes	Count	78	55	133
	% within UNIV	65.0%	78.6%	70.0%
	% of Total	41.1%	28.9%	70.0%
No	Count	42	15	57
	% within UNIV	35.0%	21.4%	30.0%
	% of Total	22.1%	7.9%	30.0%
Total	Count	120	70	190
	% within UNIV	100.0%	100.0%	100.0%
	% of Total	63.2%	36.8%	100.0%

$$\chi^2 = 3.88$$

A comparison was also conducted between universities based on faculty ranking of the importance of selected functions of a university technology transfer office. The statistical procedure used to accomplish this comparison was the independent samples t-test. Results indicated that there was no significant difference between universities based on faculty perceptions of the importance of technology transfer office functions. In fact, the responses of faculty at both institutions were astonishingly similar. These results are set forth in Table 11.

Table 11. Importance of Technology Transfer Functions by University

Importance of TT Functions by University					
Variable	Univ X M/SD	Univ Y M/SD	df	t	p
Educate Faculty on Tech Transfer	3.27/1.76	2.96/1.74	185	1.18	.24
Assist faculty with start up of new business	5.38/1.14	5.17/1.39	185	1.11	.27
Negotiate with commercial partners	3.72/1.47	3.94/1.41	185	1.00	.32
Protect university Interests	3.03/1.61	3.26/1.55	185	.94	.35
Obtain patents for faculty inventions	2.76/1.41	2.68/1.47	186	.35	.73
Protect faculty interests	2.47/1.27	2.49/1.16	185	.10	.92

The final portion of this objective was to compare faculty between the two institutions on their perceptions of university technology transfer. This was accomplished by determining whether there were significant differences between the two universities on any of the six factor scores resulting from the factor analysis of the items in the perceptions scale (See Table 12).

Table 12. Comparison of More & Less Successful Universities On Faculty Perceptual Factors

Variables	Univ x M/SD	Univ y M/SD	t	df	p
PROBLEMS	2.92/.63	2.88/.77	.35	183	.74
POLICY	3.42/.67	3.32/.73	.93	185	.36
BENEFITS	3.43/.48	3.53/.42	-1.44	183	.15
MISSION	4.24/.72	4.15/.84	.76	188	.45
SUCCESS	3.23/.64	3.61/.63	-3.92	187	.00
FUTURE	3.76/.75	3.83/.81	-.62	184	.53

A t-test procedure was used to statistically compare each of the six factors.

These comparisons revealed that the subjects differed significantly between institutions in only one area, faculty perception of institutional success in technology transfer.

University X (less successful) faculty rated the success of their university significantly

lower ($M = 3.23$, $SD = .64$) than University Y (more successful) faculty rated their institutional success rate ($M = 3.61$, $SD = .63$). As indicated in Table 12, in five of the six factors no differences were found in faculty perceptions.

When the comparisons were made, the results of this particular portion of the study generated some surprise. It appears that faculty have assimilated the concept of university technology transfer to a greater degree than heretofore believed by many university technology transfer professionals. As will be discussed further in Chapter 5, the similarities of the responses to the opinion section of the survey instrument across both universities indicate a high level of awareness and acceptance of university technology transfer activities.

CHAPTER 5: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Study Overview

Today's research universities are being called upon to serve the public, not only as institutions of higher learning, but also as a driving force for economic development, diversification, and growth. Although there are many ways in which universities and other educational institutions enhance economic development, there is a strong focus on the university's activities that translate into more direct financial benefits. Because technology transfer is perceived as an integral part of university activities designed to engender economic development, a strong drive to facilitate and enhance technology transfer activities has evolved. A growing awareness that faculty cooperation and support are necessary to the success of university technology transfer has raised a number of questions about the perceptions of faculty participants regarding aspects of university technology transfer.

Traditionally, public universities, particularly land grant universities, freely distributed the results of their research to the public. In recent years, while much of the work of land grant universities is still made available to the general public, the trend toward granting exclusive licenses for certain university technologies has increased. There is strong indication that this trend will continue and that those universities which are successful at the patenting and licensing process will benefit economically, as will their communities and states. Faculty participation, an integral part of this endeavor, is dependent upon the willingness of the faculty to report new technologies to the university and assist in the development of a patent application.

This leads us to a pivotal question: Are faculty willing to participate? In fact, a determination of faculty's willingness to participate in university technology transfer is based on a number of issues. How do faculty in land grant universities perceive this activity? Is it deemed by faculty to be important and relevant to their work and to the mission of the university? Do faculty understand their own ability to benefit from the development of new inventions? Does their understanding impact their acceptance of the technology transfer process?

The work conducted here examined faculty perceptions of university technology transfer in the public land grant university by using two similarly situated institutions and a case study approach. It also sought to determine whether faculty perceptions correlate with institutional success. Several themes emerged from the analysis of the research results. This study does not answer all the questions, but it has revealed information that may be valuable for public universities involved in technology transfer.

There are several limitations to this study. It is a case study, exploratory in nature, involving only faculty in selected disciplines in two land grant universities. The study uses a non-random sample, but does so for the reasons identified in the methodology chapter, particularly because the selected faculty are those in fields that are most likely to result in the development of new technology. However, the small number surveyed and the low response rate are limitations. This researcher recommends that further research involving a broader range of research universities be conducted to contribute to the body of knowledge, gain more conclusive results, and yield a greater understanding of faculty perceptions of university technology transfer.

Summary

Purpose and Objectives

The purpose of this study was to gather information concerning faculty perceptions of university technology transfer in order to discover whether there is a significant positive correlation between the relative success of a university's technology transfer program and the perceptions of its faculty toward the appropriateness and importance of university involvement in these technology transfer activities. The objectives were as follows:

1. To describe faculty at land grant universities based on the following personal, professional, and demographic characteristics:
 - a. Number of years since obtaining a doctorate
 - b. Number of years experience at the current institution
 - c. Academic rank
 - d. Attainment of competitive research grant funding within the past three years
 - e. Number of occasions whereupon contributions toward a university patent/license were made.
2. To determine the perceptions of faculty at institutions regarding the appropriateness and importance of technology transfer activities.
3. To compare faculty at an institution defined as successful in technology transfer and an institution that is relatively unsuccessful on the following measures:
 - a. Number of years they have had a doctorate
 - b. Number of years experience at their current institution

- c. Academic rank
- d. Attainment of competitive research grant funding within the past three years
- e. Number of occasions whereupon contributions toward a university patent/license were made
- f. Perceptions toward university technology transfer activities relating to the appropriateness of the activities and importance of the activities.

Procedures and Methodology

The target population consisted of selected faculty at two land grant universities in the southern portion of the United States. The faculty selected were those whose areas of research were most likely to result in the development of marketable technology. The two land grant universities had active technology transfer programs, but one exhibited considerably more success (designated as University Y) at technology transfer than the other (designated as University X).

Participants in the study were asked to complete a researcher designed survey consisting of 33 items. Content validity of the questionnaire was established through review by a panel of experts consisting of research faculty, technology transfer directors, and administrators in land grant research universities. The survey instrument was comprised of two parts: (1) a section requesting background information, and (2) a section requesting faculty perceptions on various aspects of and issues related to university technology transfer.

The survey instrument was sent to the selected faculty members by email, with an internet site attached for their responses to the study. One hundred ninety-one faculty members participated in the study, 121 from institution X and 70 from institution Y.

Findings

Responses to the first part of the survey instrument revealed certain demographic information about the faculty respondents, including their awareness of their university's policy and activity in the field of technology transfer.

The faculty responses indicated that they had held their doctoral degrees from as few as one year to as many as 39 years, with a mean of 17.86 years. The length of service at the current institution ranged from 1 to 43 years, with a mean of 14.31 years. The academic rank of 86% of the faculty was that of assistant (13%), associate (26%), or full (46%) professor.

Seventy percent indicated that they had received competitive grant funding within the past three years. Seventy-one percent had never been named as an inventor on a patent or license, but fifty-six percent had met with someone from their university's technology transfer office. Seventy-two percent of respondents indicated their university had a policy of royalty sharing with faculty inventors, forty percent believed their institution provided incentives for technology development, and seventy-two percent were aware of publicity generated by the university regarding new technology development. This researcher was surprised by the high percentage of faculty ($n = 79$, 41.4%) who indicated that they did not know whether their institution provided incentives for faculty development of new technology.

Faculty were also asked to rank the following technology transfer functions in order of importance:

- a. Obtain patents for faculty inventions;
- b. Negotiate with commercial partners to market the inventions;
- c. Protect faculty interests;
- d. Protect university interests;
- e. Assist faculty in starting up new businesses;
- f. Educate faculty on all aspects of technology transfer.

The faculty respondents ranked the functions in order of priority are as follows:

1. Protect faculty interests (Mean rank = 2.48);
2. Obtain patents for faculty inventions (Mean rank = 2.73);
3. Protect university interests (Mean rank = 3.12);
4. Educate faculty on all aspects of technology transfer (Mean rank = 3.16);
5. Negotiate with commercial partners to market the inventions (Mean rank = 3.80);
6. Assist faculty in starting up new business (Mean rank = 5.30).

A comparison of the two institutional responses was also conducted. In terms of the demographics and faculty awareness of university technology transfer policy, only one significant demographic difference between the respondents of University X and University Y was noted. Respondents from University Y, the more successful institution in the area of technology transfer, had a significantly higher likelihood of having received competitive grant funding within the last three years (79% at University

Y versus 65% at University X). All other demographic factors were found to be independent of the institutional affiliation of the faculty member.

When reviewing the findings regarding faculty perceptions and institutional affiliation, no significant difference was found between universities on the mean rankings of the importance of technology transfer office functions. However, the comparison of universities regarding faculty perceptions revealed that the subjects differed significantly ($\chi^2_{df=1} = 3.88, p = .049$) between institutions in one area: faculty perception of institutional success in technology transfer. The faculty at University Y, the institution defined as more successful in technology transfer, indicated a higher level of achievement with items included in the factor defined as “Success” than those in University X (less successful).

Conclusions

Based on the findings of this study, the following conclusions were drawn by the researcher.

1. The faculty surveyed across both institutions were very much alike demographically.

The above conclusion is based on the fact that, except for the extent of success at obtaining outside research funding, there were no significant differences found in the demographic characteristics measured of the 191 faculty respondents. Most had been at their current institution for a significant period of time. The majority of the respondents were tenure track faculty (assistant, associate, or full professors). These respondents were not new to university policies and practices, but were well acquainted with the traditions and the culture of the land grant research institution.

2. The majority of survey respondents indicated they had obtained competitive grant funding from outside the university within the past 3 years.

This conclusion is supported by the fact that 70% of faculty respondents specifically indicated that they had received competitive grant funding within the past three years. Thus, they were faculty who were actively engaged in the competitive process of obtaining funding for their research projects.

3. Most had never been listed as an inventor on a university patent or license, but over half of the responding faculty indicated that they had met with someone from their university's technology transfer office.

This conclusion is based on the responses to specific items indicating that 71.6% of faculty respondents had never been listed as an inventor on a university patent or license, but that 56.8% had met with someone from their technology transfer office. This conclusion conforms to the relatively small number of patents obtained by research universities annually in comparison to the external funding provided for ongoing research. As indicated in the literature review, most of the technology created in university laboratories is far from being market-ready.

4. The majority of faculty respondents were generally aware of technology transfer processes and policies within their respective universities.

The above conclusion is based on the following. Support for this statement appears in the faculty's response to question 7, 8, and 9, where they indicated that they are aware of university royalty sharing policy, faculty incentives, and publicity generated by the university when new inventions are developed.

5. Faculty at land grant research universities surveyed are supportive of the university technology transfer process.

This conclusion is based on the following. Faculty indicated that they believe that technology transfer is an appropriate and important activity that is consistent with university mission and goals (mean ranking = 4.21).

6. The faculty surveyed believe that the primary functions of university technology transfer office should be protection of faculty and the university interests, but that furthering the entrepreneurial interests of faculty is not of primary importance.

This conclusion is supported by the manner in which faculty prioritized university technology transfer functions. Faculty respondents ranked the functions in the following order of importance:

1. Protect faculty interests
2. Obtain patents for faculty inventions
3. Protect university interests
4. Educate faculty on all aspects of technology transfer
5. Negotiate with commercial partners to market the inventions
6. Assist faculty in starting up new business

The fact that they included protection of faculty generated inventions within the top three priorities is further indicative of the importance of protecting both faculty inventors and university interests. The top three priorities had mean rankings of 2.48, 2.73, and 3.12 respectively. Faculty respondents placed assisting with starting new businesses at the bottom of the priority list, with a mean ranking of 5.30.

7. Faculty respondents at the different institutions were similar in their perceptions of the university technology transfer process.

This is supported by the fact that the faculty responses were consistently similar in their opinions regarding university technology transfer in the areas of policy, mission, problems, and current and future benefits.

8. Faculty respondents in the more successful institution indicated they had greater success in obtaining competitive research funding.

This conclusion is supported by a finding of significant difference in responses to this question in the demographic portion of the survey instrument.

While this was an interesting development, the information gathered here does not determine the nature of the correlation between success in technology transfer and success in obtaining research grants. Whether one causes the other or whether both are related to other factors are issues for further research.

9. Faculty respondents are generally aware of the level of success their institution has achieved in the arena of technology transfer.

The universities' respondents differed significantly in their responses to the question of institutional success at technology transfer. Faculty in the more successful institution (University Y) responded more favorably to the survey items regarding institutional success in technology transfer (mean ranking = 3.61) and faculty in the less successful institution (University X) responded less favorably to the same items (mean ranking = 3.23).

Implications and Recommendations

As stated above, the majority of respondents were senior level tenure track faculty. As such, they would also be the ones most likely to be interested in a long-term career in the university, and most likely to exhibit a corresponding interest in university policy and processes. In the last few years, however, universities have begun to capitalize on their technologies, and with increased publicity, it seems likely that this knowledge is widespread among all faculty within the universities surveyed. One thing is quite clear. The faculty respondents are aware of the university's interest and participation in the transfer of new technologies to the commercial sector.

The information obtained in this study displays a faculty awareness of institutional success in this endeavor and recognition of the potential for future benefits to the individual and to the university. Moreover, the positive feedback generated herein addresses one of the questions raised in the literature, that of faculty acceptance of technology transfer as a legitimate activity of the university. Faculty respondents believe technology transfer is consistent with the mission and goals of their land grant research university. The researcher believes this information should be of particular interest to university technology transfer professionals and other administrators who are concerned about the faculty's willing participation in the technology transfer process.

Despite awareness of areas of potential conflict of interest, exhibited by their varied and somewhat less positive responses to questions concerning these issues, the faculty indicated that they believe the benefits of university technology transfer outweigh the potential problems. They were actually asked to respond to a statement indicating that problems outweighed benefits and the faculty clearly disagreed. In fact,

this was the only item in the entire opinion section where the mean score of all responses indicated disagreement with the statement. Additionally, in all questions regarding problems associated with technology transfer, faculty responses either denoted their belief that the benefits were greater than the problems or their responses fell into the neutral category of “no opinion.”

It was interesting to note that faculty generally seem to believe that technology development should be a consideration in tenure and promotion decisions. This strengthens the researcher’s conviction that faculty have accepted the value of technology transfer, as well as the concept. They appear to believe that university policy, including its reward system, should reflect this new aspect of university culture.

Faculty were asked to rank certain technology transfer functions, and their responses showed a strong preference for functions related to protection of faculty interests and inventions. While not surprising, it does raise the question of whether faculty recognize that a technology transfer office established and funded by the university administration operates for the benefit of the university first and foremost. (Protecting the interests of the university received a third place ranking in the list.) Of course, in protecting the university’s interests, the office would necessarily take great pains to protect the newly created technology, which effectively protects the faculty interests in that area. The protection of other faculty interests would be most likely effected by the policies established and enforced by the institution.

The education of faculty concerning technology transfer policy and practice ranked fourth. While this particular function may have been of lesser concern to the faculty than some of the others, the education of faculty should be a priority for

university administrators who wish to achieve success in this arena. Without a basic understanding of the need for timely disclosure to the university and confidentiality concerning matters that might be the subject of patent protection, faculty may inadvertently cause the university to lose its rights to patents.

Finally, in the priority ranking of university technology transfer office functions, the researcher believes it is significant that negotiating with commercial partners was ranked only just above assisting faculty with start-up business. The low ranking of assistance with faculty start-ups is understandable given the conflicts of interest that may arise when faculty engage in starting a new business with university owned technology. The researcher suspects the ranking may also reflect an uneasiness with the concept of faculty profiting from their publicly supported research position.

As stated above, the faculty ranked the commercialization responsibility next to last although it is the crux of the concept of transferring technology to the commercial sector. Without this, there can be no use by or benefit to society. Thus, although faculty are aware of technology transfer and their basic role in the process, it appears they are not so aware of the role of the technology transfer office in commercializing the new technologies developed within the institution. The faculty respondents appeared to be oblivious to the fact that obtaining patents, which was ranked so highly, is an expensive and virtually useless gesture if the technologies covered by those patents are not made available for public use. In most cases, this transfer to usefulness can only happen with the assistance of a commercial partner acquired through the efforts of the tech transfer officer.

As stated earlier, faculty responses were similar in their opinions regarding university technology transfer in the areas of policy, mission, problems, and current and future benefits. And those opinions were generally positive. Those responses express a strong belief that the activity of technology transfer is appropriate and important to the land grant research university. They exhibit support for the implementation of policies that foster this activity. And the researcher submits that the faculty responses ultimately convey a belief that the benefits to themselves, the university, and society are significant enough to outweigh the complex problems that must be managed in the process.

The responses to these factored categories act as another indication to the researcher that the resistance that is anticipated and often discussed by university administrators and technology transfer professionals is neither as prevalent nor as powerful as it is believed to be. It appears that the faculty respondents in this study have assimilated this process as part of today's university culture and practice. It is significant that they seem to have done so in spite of an astute awareness of the potential and actual problems associated with technology transfer.

The researcher believes that these universities and others will find the results of this study useful and helpful in enlisting faculty support of and participation in the transfer of new research developments. Apparently, faculty are paying attention to the publicity generated by the internal development and the external licensing of new technologies by the institution. Knowledge of this awareness should be helpful to university administrators who hope to encourage faculty participation in the technology transfer process.

Faculty appear to be generally supportive of university technology transfer, but a university may enhance that support by clearly signaling to faculty that technology development is considered to be a significant contribution to the university and their field of expertise. While many people would consider the potential to receive significant royalty income to be highly motivating to faculty, this alone does not ensure faculty support and participation in the process of technology transfer. It may be more important to faculty that their research results actually contribute to knowledge in their field of expertise and to society.

As discussed in the literature review, individuals who choose careers as university researchers generally do so for reasons other than monetary reward. The regard of their peers is, however, a powerful motivating factor. Thus, one way the university might encourage participation is by establishing policies that reflect the institution's regard for certain activities. For example, this study revealed that faculty would likely be influenced by the knowledge that the development of new technology will be considered in tenure and promotion decisions within the institution. In fact, the faculty responses encouraged this consideration. They generally seem to believe that technology development should be a consideration in tenure and promotion decisions. This strengthens the researcher's conviction that faculty have accepted the value of technology transfer, as well as the concept. The respondents seem to believe that university policy, including its reward system, should reflect this new aspect of university culture.

The researcher recommends that future research include an attempt to determine the nature of the relationship between competitive grant funding success and technology

transfer success. While it is reasonable to assume that the level of funding support available for research plays a role in the generation of new research developments, this is a complex issue. The amount of funding is not the only significant factor. The area of research, the nature of the projects embarked upon, and the goals of the funding institution and the researcher will all impact the results of the research. Additional factors impacting the potential use of research results include a determination by the institution or sponsor of the possibilities for practical application, the numerous kinds of ownership and commercialization issues, and whether or not the new developments are best suited for free and open public distribution through publication and presentations to other scientists instead of seeking legal protection for commercialization.

An additional area of study that could produce significant information is the nature of the relationship between the faculty's belief in their university's technology transfer success and faculty's willingness to participate in the process. This study suggests that faculty must perceive their institution as being reasonably successful in the process. Otherwise, they may have little faith in their university's technology transfer office to offer an opportunity to realize the kinds of benefits generally associated with technology development and commercialization. It seems likely that confidence in the system and its ability to get the job done effectively will influence faculty support of technology transfer within a particular university, but that question is not answered by this study.

The knowledge that the faculty surveyed are supportive of the university technology transfer process is a significant finding of this study. Many institutions have operated under the belief that the faculty are reluctant to participate in the process

because it departs from the traditional university concept of free and open distribution of knowledge. Apparently, faculty understand that some kinds of knowledge and technologies will be widely distributed only through the existence and efforts of the patenting and licensing process. Their understanding of the need for legal protection and licensing of new technologies should be encouraging to universities interested in technology transfer.

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APPENDIX A: FACULTY SURVEY

This survey is part of a doctoral research project and your participation is greatly appreciated. Please note that your responses to this survey will be kept confidential, although the results generated from this study will be made available to your technology transfer office for its use in developing policy to meet the needs of your campus. Individual copies of the results may be requested.

The term “technology transfer” as used in this survey refers to the conveyance of inventions from one entity to another under license agreements, for the purpose of commercialization.

PLEASE COMPLETE ENTIRE SURVEY.

PART I: Background information

1. In what year did you complete your doctoral or highest degree?
19—
2. In what year did you join the faculty at this institution?

3. What is your current academic rank?
——instructor ——asst prof ——assoc prof ——prof
——endowed prof ——other (Please specify _____)
4. Have you received a competitively funded grant within the past 3 years?
_____ yes _____ no
5. Have you ever filed for or been listed as a contributor on a university patent/license ?
——yes ——no
6. Have you ever met with anyone from your institution's technology transfer office?
—— yes _—— no —— don't know
7. Does your university have a technology transfer policy that includes a royalty share to inventing faculty?
_____ yes _____ no _____ don't know
8. Does your university provide incentives for faculty to develop new inventions?
—— yes —— no —— don't know
9. Does your institution publicize successful university developed inventions?
—— yes —— no —— don't know

PART II: Opinion

10. Technology transfer is important to my university.
-----strongly disagree—disagree -----no opinion -----agree -----strongly agree
11. It is appropriate for universities to be involved in technology transfer-related activities.
-----strongly disagree—disagree -----no opinion -----agree -----strongly agree
12. My university should place greater emphasis on applied (versus basic) research.
-----strongly disagree—disagree -----no opinion -----agree -----strongly agree
13. My university should encourage all faculty to attend a seminar/training session on tech transfer.
-----strongly disagree—disagree -----no opinion -----agree -----strongly agree
14. A technology transfer office is/could be a benefit to me.
-----strongly disagree—disagree -----no opinion -----agree -----strongly agree
15. One or more of my colleagues has personally benefitted from technology transfer within the university.
-----strongly disagree—disagree -----no opinion -----agree -----strongly agree
16. Within my department it is common for faculty to discuss potential applications of our research.
-----strongly disagree—disagree -----no opinion -----agree -----strongly agree
17. My university should encourage faculty to create new technologies/inventions.
-----strongly disagree—disagree -----no opinion -----agree -----strongly agree
18. My university should be involved in tech transfer as it relates to its faculty's inventions, but should not use the process to profit monetarily.
-----strongly disagree—disagree -----no opinion -----agree -----strongly agree
19. University tech transfer leads to private companies driving the direction of the research.
-----strongly disagree—disagree -----no opinion -----agree -----strongly agree
20. The emphasis on tech transfer and applied research has had a negative impact on the quality of teaching within my university.
-----strongly disagree—disagree -----no opinion -----agree -----strongly agree
21. Creation of inventions should be a consideration in tenure and promotion decisions.
-----strongly disagree—disagree -----no opinion -----agree -----strongly agree
22. University involvement in tech transfer creates conflict among its faculty.
-----strongly disagree—disagree -----no opinion -----agree -----strongly agree

23. The potential problems resulting from tech transfer activities outweigh the benefits to the university.
 ----strongly disagree—disagree ----no opinion ----agree ----strongly agree
24. I anticipate that I will need the services of the university technology transfer office at some point in my career.
 ----strongly disagree—disagree ----no opinion ----agree ----strongly agree
25. My university should be involved in technology transfer as it relates to faculty inventions, because it is a means of generating income to support research.
 ----strongly disagree—disagree ----no opinion ----agree ----strongly agree
26. Faculty should share in the profits resulting from their inventions.
 ----strongly disagree—disagree ----no opinion ----agree ----strongly agree
27. University technology transfer eliminates the free exchange of research information.
 ----strongly disagree—disagree ----no opinion ----agree ----strongly agree
28. It is appropriate that a portion of royalties earned from a faculty member's invention supports my university's technology transfer office.
 ----strongly disagree—disagree ----no opinion ----agree ----strongly agree
29. A university technology transfer office can help get new inventions into public use.
 ----strongly disagree—disagree ----no opinion ----agree ----strongly agree
30. If I had freedom to choose whether to commercialize my research results or freely disseminate the information, I would opt for the latter.
 ----strongly disagree ----disagree—no opinion ----agree----strongly agree
31. My institution has been successful at technology transfer.
 ----strongly disagree—disagree ----no opinion ----agree----strongly agree
32. In the past three months, I have read an article about the successful commercialization of one of our faculty's new inventions.
 ----strongly disagree—disagree ----no opinion ----agree ----strongly agree
33. Rank the following functions of a university technology transfer office in order of importance with 1 being most important and 6 being least important:
 a.----- obtain patents for faculty inventions
 b.----- negotiate with commercial partners to market the inventions
 c.----- protect faculty interests
 d.----- protect university interests
 e.----- assist faculty to start up new businesses
 f.----- educate faculty on all aspects of technology transfer

APPENDIX B: LETTER TO FACULTY

Dear Faculty Member:

I am a doctoral student with Louisiana State University and am interested in faculty perceptions of university technology transfer activities. In developing my research hypothesis, I interviewed your technology transfer representative who suggested I approach faculty in the life sciences, sciences, and engineering departments with the attached brief survey.

I have attached the survey to this memo through a hotlink to the following web site:
<http://www.agctr.lsu.edu/jacobi/louisiana.htm>

As I mentioned above, this survey is part of my doctoral research project and your participation is greatly appreciated. Please note that your responses will be kept confidential, although the results generated will be made available to your technology transfer office for its use in developing policy to meet the needs of your campus. Individual copies of the results may be requested.

I ask that you please either email or fax the completed survey to me by May 1, 2000, to permit me sufficient time to compile my data. Please feel free to contact me if you have any questions.

Once again, thank you for taking the time to participate.

Sincerely,

Paula T. Jacobi
Louisiana State University
ph: (225) 388-6030
fax: (225) 388-6032
email: pjacobi@agctr.lsu.edu

APPENDIX C. APPLICATION FOR EXEMPTION FROM INSTITUTIONAL
OVERSIGHT

HSSC accession #: _____ LSU Proposal #: _____

LSU Office of Sponsored Research/OSR388-1492; FAX 6792
117 David Boyd Hall
LSU:HUMAN RESEARCH SUBJECTS

Unless they are formally qualified as meeting the criteria for exemption from Institutional Review Board (IRB) oversight, ALL LSU research/projects using living humans as subjects, or samples or data obtained from humans, directly or indirectly, with or without their consent, must be approved in advance by the LSU IRB. This Form helps the PI determine if a project may be exempted, and is used to request an exemption.

NOTE: Even when exempted, the researcher is required to exercise prudence in protecting the interests of research subjects, obtain informed consent if appropriate, and must conform to the Ethical Principles and Guidelines for the protection of Human Subjects (Belmont Report) and LSU Guide to Informed Consent; (Available form OSR or <http://www.osr.lsu.edu/osr/comply.html>)

Instructions: Complete checklist, pp 2-4; if exemption appears possible, see instructions on p. 4. Otherwise apply to the IRB*

Principal Investigator Paula T. Jacobi Student? Y/N

Department/Unit Educational Leadership & Research Ph: _____

Project Analysis of Policy and practices of university technology transfer

Agency expected to fund project N/A

Subject pool (eg. Psychology students) N/A

Circle any "vulnerable populations" to be used: (children <18; the mentally impaired, ~~pregnant women, the aged, other~~). ~~Projects with incarcerated persons cannot be~~ exempted.

I certify my responses are accurate and complete. If the project scope or design is later changed I will resubmit for review. I will obtain written approval from the Authorized Representative of all non-LSU institutions in which the study is conducted.

PI Signature _____ Date _____ (no per signatures)

Screening Committee Action: Exempted x Not Exempted _____

Reviewer D. Landin
Signature

[Signature]

Date 3-16-99

Comments _____
cc PI (signed face page only); OSR Director (application with protocol) 117 David
Boyd Hall, LSU.

Help available from Karen Baiamonte 388-1492; karenb@lsu.edu

VITA

Paula Jacobi is the Assistant Director for Intellectual Property at the Louisiana State University Agricultural Center. Her duties involve the evaluation of new technologies, management of efforts to secure patents and copyrights, negotiation and monitoring of licensing agreements, and ensuring that research agreements are in compliance with university policy and state and federal law. Prior to accepting the position at Agricultural Center, she spent several years as a practicing attorney. She later served as an associate professor and program coordinator at LSUE, another campus within the LSU System. Currently, Ms. Jacobi is a member of the Science and Technology and the Agribusiness Task Forces of the Louisiana Economic Development Council and serves on the Boards of Directors of Louisiana Alliance for Biotechnology and the Baton Rouge Technology Council. She is also an officer and member of the Board of Directors of a family owned corporation that has been doing business in Louisiana for over twenty years. Ms. Jacobi was the recipient of a Kellogg Leadership Fellowship in 1996, which led to research in the area of copyright protection in distance education. She is a member of the Louisiana Bar Association, the Association of University Technology Managers, and the Licensing Executives Society. Ms. Jacobi is a licensed attorney with a juris doctorate from Tulane Law School. She is currently a candidate for the Doctor of Philosophy in the Department of Educational Leadership, Research, and Counseling at Louisiana State University which will be conferred in May, 2001.

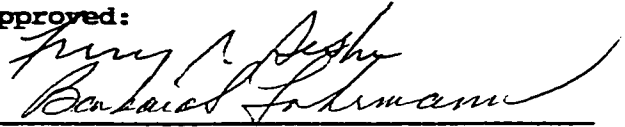
DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Paula T. Jacobi

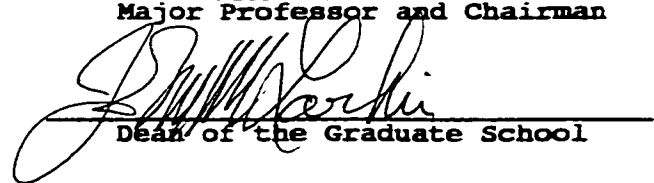
Major Field: Educational Leadership & Research

Title of Dissertation: A Comparison of Faculty Perceptions of University Technology Transfer by Level of Institutional Success in the Technology Transfer Process

Approved:

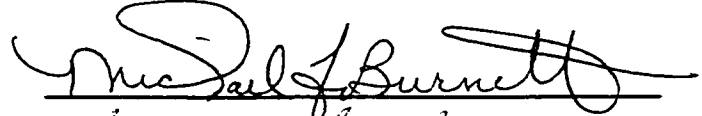


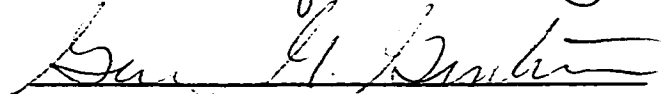
Major Professor and Chairman

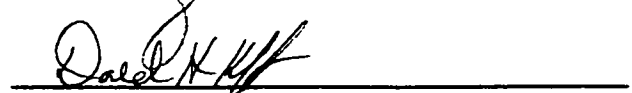


Dean of the Graduate School

EXAMINING COMMITTEE:







Date of Examination:

December 11, 2000
