INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI

A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor MI 48106-1346 USA
313/761-4700 800/521-0600

TECHNOLOGY TRANSFER PERFORMANCE:

THE IMPACT OF ENTREPRENEURIAL RESPONSES TO INSTITUTIONAL AND COMMERCIAL PRESSURES IN US UNIVERSITIES

A Dissertation

Presented to

The Faculty of the College of Business Administration

University of Houston - University Park

In Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

By

Barbara Anne Kuhns

May, 1999

TECHNOLOGY TRANSFER PERFORMANCE:

THE IMPACT OF ENTREPRENEURIAL RESPONSES TO INSTITUTIONAL

AND COMMERCIAL

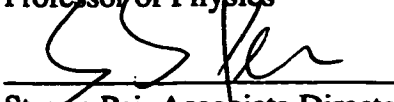
PRESSURES IN US UNIVERSITIES

APPROVED:

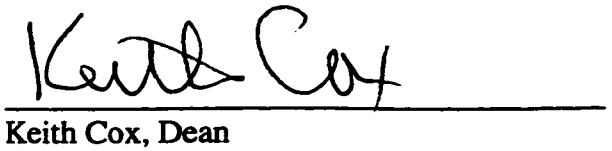
Robert T. Keller, Professor of Management, Chairperson of Committee

Robert C. Hill, Associate Professor of Management

Alex Ignatiev, Director - Space Vacuum Epitaxy Center and - Professor of Physics



Steven Pei, Associate Director for Research - Space Vacuum Epitaxy Center and Professor of Engineering



Keith Cox, Dean
College of Business Administration

ACKNOWLEDGEMENTS

Organizations and individuals contributed to the success of this research. I am grateful to the many university technology transfer office directors who completed the survey. For funding assistance, I thank the Space Vacuum Epitaxy Center and the Shell Corporation's Interdisciplinary Scholars Program. Globalport, Inc., in particular Phil Bellmore, provided superb website design and hosting as well as a database interface that allowed me to easily collect survey data on-line.

The process of completing this research, the dissertation and the doctoral program sets the stage for me to fulfill an almost unacknowledged dream. Many people encouraged me along the way. To everyone, I offer my most sincere thanks.

First, Connie Ritter deserves the patience award as my best friend and constant supporter in the many years of my second academic career. Providing a window on the Chilean Andes while I collected data, ran statistical analyses and wrote the final chapters was only the most obvious of her contributions. Thank you for sharing the pursuit of a dream and a second career.

Colleagues and friends, notably Paulette Bogert and Gretchen Gemeinhardt, helped me stay on track while offering a welcome refuge of laughter and chuckles as I encountered and created molehills and mountains during this long learning process.

My parents, Audrey and Carl Kuhns, I thank for somehow instilling in me the belief that a person can accomplish their goals at anytime. They were not alone, I suspect, in helping me learn that lesson. My aunt Thelma and late uncle David, as well as my grandmother, Dorothy, all contributed to that most important lesson.

I thank my committee members for their support and assistance. Bob Keller, Bob Hill, Alex Ignatiev and Steven Pei each contributed their unique advice to help me complete the process and learn a great deal about research, discipline and persistence.

Special thanks to Señora Sonia Garay Molina whose efficiency and good cheer helped me persist with few distractions as I occasionally gazed at the Andes from the hacienda in the foothills of the cordillera.

Finally, I cannot forget Duffer and Maggie for quietly keeping me company those long hours in front of the computer screen. Their attention and devotion, as well as occasional distractions, are embedded in all of my work.

TECHNOLOGY TRANSFER PERFORMANCE:

THE IMPACT OF ENTREPRENEURIAL RESPONSES TO INSTITUTIONAL AND COMMERCIAL PRESSURES IN US UNIVERSITIES

ABSTRACT

A Dissertation

Presented to

The Faculty of the College of Business Administration

University of Houston - University Park

In Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

By

Barbara Anne Kuhns

May, 1999

ABSTRACT

A study of 77 university technology transfer organizations examined the impact of institutional, commercial, and entrepreneurial factors on technology commercialization performance. Data were collected from surveys of directors of university technology transfer offices; the Association of University Technology Managers (AUTM) Annual Licensing Surveys; the National Science Foundation; the National Academy of Science; the Carnegie Foundation; Intellectual Property Education Coalition; and Peterson's Guide to Graduate and Professional Programs. Statistical techniques for hypotheses testing included analysis of variance (ANOVA), correlation analysis and multiple regression. Research results show that successful university technology transfer offices operate with an entrepreneurial orientation. However, the offices must also attend to demands from both institutional and commercial stakeholders to commercialize technology in their highly institutionalized settings.

High performing technology transfer offices revealed a strong commercial orientation but all offices had similar levels of institutional orientation. Technology transfer offices classified as having a commercial orientation had higher commercial performance (as predicted), and, contrary to predictions, strong institutional performance before controlling for university size. Results also indicate that successful university technology transfer offices attend to both the university's traditional academic (or institutional) demands and to the commercial demands of their environments to move technology from the laboratory to the market. Technology transfer offices operating with mixed institutional and commercial orientations generated more patents, royalties, and licenses than technology transfer offices having only institutional orientations after controlling for university size. The study uncovered entrepreneurial orientation as a significant factor associated with strong university research funding on a per faculty basis and with strong patent performance on a per faculty basis. Thus, independent of university size, entrepreneurial orientation in a technology transfer office contributes to strong performance.

TABLE OF CONTENTS

TABLE OF CONTENTS
Continued

LIST OF TABLES

List of Tables

Continued

LIST OF FIGURES

CHAPTER ONE

THE PROBLEM AND ITS IMPORTANCE

The following dissertation research examines one set of factors expected to impact the performance of university technology transfer organizations. The study investigates effects on university technology commercialization of operating in institutional environments. More specifically, I seek to answer the following question: *How do institutional pressures and commercial pressures affect the performance of university technology transfer organizations?* The question arises from what appears to be an inherent conflict between the institutional settings of university technology transfer organizations and their commercial purpose of transferring or commercializing technology. The institutional pressures seem likely to conflict with the charge to commercialize technology. From a theoretical perspective, answers to the research question extend our understanding of the performance impact of institutional and commercial, or entrepreneurial, organizational responses to competing pressures within institutional environments. In a practical vein, results of the study provide valuable insights to create more effective university technology commercialization programs. Any organization caught in the crossfire of institutional pressures and commercial demands might benefit by applying results from this research. Examples include: Federal research laboratories, military research centers, public and private hospitals, or social service organizations.

Theoretical Importance

In the present study I look for a link between institutional theory and concepts from entrepreneurship research. The research examines university technology transfer offices as examples of organizations which must pursue commercial activities and results while operating in an institutional environment (e.g., Melcher, 1998; Piercey, 1998). The dissertation research first examines how organizations respond to institutional and technical-commercial dimensions (Scott, 1987) of their environment. Second, the research assesses how organizational responses to institutional and technical-commercial environmental pressures impact performance.

Environmental Pressure, Organizational Response & Performance

The study addresses research needs identified by Oliver (1991), Scott (1995) and Lynn and Rao (1995). The model developed for the study includes an assessment of institutional and technical-commercial environmental pressures (Scott, 1987; Scott & Myer, 1991) facing technology transfer centers. It examines organizational responses to conflicting institutional pressures (Oliver, 1991) and adds entrepreneurial orientation (Covin & Slevin, 1991; Lumpkin & Dess, 1996; Miller, 1983; Naman & Slevin, 1993) as a potentially effective response to technical-commercial pressures, even within an institutional environment. The study assesses the impact of environmental pressures on organizational responses. It also examines the relationship between institutional organizational responses and performance. Finally, the research tests the relationship between aspects of commercial orientation, including entrepreneurial orientation, and performance (Brown & Davidsson, 1998; Wiklund, 1998).

Institutional-Technical Commercial Pressures

The research explicitly evaluates institutional and technical-commercial pressures confronting organizations. Scott (1995:129) identified a need for examining these pressures: "The extent to which there is conflict between institutional and technical [commercial] rules or more accurately, between procedural and outcome requirements should not be asserted but assessed." The study responds to Scott's call for such research by quantifying and applying measures of both institutional and technical-commercial pressures then assessing their impact on organizational responses and performance.

Responses to Institutional-Technical Pressures

The research tests part of Oliver's (1991) typology of organizational responses to competing institutional pressures. In her theoretical framework of organizational responses to competing pressures Oliver (1991:165) suggested:

> "...the likelihood that organizations will conform to institutional pressures is not exclusively dependent on the legitimacy or economic rationality (or lack thereof) anticipated by conformity (social or economic fitness). Rather, it depends, in interaction, on the degree of discrepancy between organizational goals and institutional requirements (consistency), the likelihood that institutional constituents create conflict for the organization in meeting incompatible goals simultaneously (multiplicity), and the degree of organizational dependence on the pressuring institutional constituents for its legitimacy or economic viability (dependency)."

The current research expands on Oliver's model of organizational response to environmental pressures by explicitly considering the technical-commercial dimension and by identifying commercial orientation (including the construct of entrepreneurial

orientation) as a viable response to environments reflecting both institutional and technical-commercial pressures.

Entrepreneurial Orientation

The theoretical foundation of this dissertation study attempts to link two factors that seem to affect many types of contemporary organizations in the US and worldwide. The study examines the relationship between institutional pressures and commercial or entrepreneurial requirements of organizations operating in multidimensional environments. Institutional pressures and demands define the operating procedures, provide structural and operational resources, and establish the legitimacy of many organizations. As organizations in powerful institutions face challenges to change in order to survive or capture new opportunities, the organizations are exposed to increasing pressures to operate in what Scott (1987) termed *technical environments*.

Technical pressures (called technical-commercial or simply commercial pressures in this study) refer to matters related to production efficiency, economic exchange, and product orientation (Scott, 1987; DiMaggio & Powell, 1991; Scott, 1991). Confronted with demands to become more commercial (or technical) while operating in highly institutional settings, organizations must change their methods of operating to ensure continued viability. Concepts from *entrepreneurial* views of ventures and organizations embody the types of activities required for successfully changing the direction and modes of operations for organizations confronted with both institutional and technical demands.

Entrepreneurial orientation describes firm-level dimensions that have been associated with entrepreneurial performance (e.g., Brown & Davidsson, 1998; Covin & Slevin, 1991; Lumpkin & Dess, 1996; Merz & Sauber, 1995; Naman & Slevin, 1993; Wiklund, 1998). In this study, I explore the entrepreneurial orientation construct as a key component of commercial responses to technical-commercial pressures in the environment. The research compares the performance impact of entrepreneurial responses with the performance impact of institutional responses (Oliver, 1991).

Impact on Performance

University technology transfer centers and research units provide excellent examples of organizations confronted with competing or conflicting institutional and technical-commercial pressures. The environments are highly institutionalized yet the technology transfer function must operate as businesses with marketing and sales-related negotiating prowess in order to successfully commercialize technology. One type of focus that might foster an aggressive commercialization program could be an entrepreneurial focus. Therefore, the present study tests and evaluates the relationship between entrepreneurial orientation and performance in an institutional setting. It also uses a US-based sample which would extend to US organizations recent studies of Swedish companies (Brown & Davidsson, 1998; Wiklund, 1998). In addition, the research draws upon the technology transfer performance criteria identified and classified by Autio and Laamanen (1995) and Spann, Adams, and Souder (1995).

Summary of Theoretical Contributions

The results of the present research could contribute in a number of ways to developing a greater understanding of the effects on performance of institutional and technical pressures. First, the study assesses institutional and technical-commercial pressures. Second, the research tests a model that examines organizational-level entrepreneurial orientation in the context of an institutional environment. Results of the study linking institutions and entrepreneurial behavior could fill a gap in theories about how organizations successfully adapt to the demands of changing or conflicted institutional environments. The entrepreneurial response to technical-commercial pressures expands the potential responses to conflicted or changing institutional environments. Third, the research explicitly tests responses to competing institutional pressures. Fourth, the dissertation research adds an examination of the relationship between responses to institutional pressures and performance of organizations. Fifth, the research offers a US-based test of the link between entrepreneurial orientation and performance that could extend the application of the entrepreneurial construct to environments characterized by conflicting institutional pressures and a variety of technical pressures.

Practical Implications and Applications

The practical implications and applications expected from this research focus on university technology commercialization efforts but could extend to other related types of organizations. Specifically, and closely related, results could apply to all types of organizations affected by the Bayh-Dole Act of 1980, such as research centers funded by the Department of Defense, Department of Energy, National Aeronautics and Space

Administration (NASA) R&D programs, US military research programs, National Institutes of Health, etc., (e.g., Deutsch, 1997). Results could also apply to any organization confronted with changing or conflicting demands that can be categorized as institutional and technical-commercial.

The Bayh-Dole Act of 1980 (officially, the Patent and Trademark Amendments of 1980) opened the regulatory gates to commercializing the results of government-funded research including research conducted at federal laboratories and universities. With the passage of the act, universities were allowed and encouraged to benefit from the results of academic research. According to the U.S. Government Accounting Office, the Bayh-Dole Act "promotes the use of federally funded inventions by small business and nonprofit organizations....by allowing (1) nonprofit organizations such as universities to retain title to and market the inventions they create using federal research funds and (2) federal agencies to grant exclusive licenses for federally owned inventions to provide more incentive to business (GAO, 1998:1)."

University Technology Transfer

Prior to the passage of the Bayh-Dole Act, few universities actively pursued financial benefits for their research and technology developments as evidenced by the small number of technology transfer offices operating before 1980. According to data published by the Association of University Technology Managers, of the 121 universities reporting founding dates for their technology transfer offices, only 13 offices (11.1%) were founded between 1925 and 1979, prior to the passage of the

Bayh-Dole Act (AUTM, 1997). The passage of the Bayh-Dole Act in 1980 motivated many universities to formalize proactive technology transfer programs to take advantage of the results of their rich research traditions.

Universities and the US economy benefit from the expanded emphasis on commercializing research technologies. In 1997, accredited US colleges and universities invested $23.8 billion in research and development, according the National Science Board and the National Science Foundation (National Science Board, 1998). The licensing income reported by 130 active US university technology transfer programs in 1996 was $501.7 million up nearly 20% from the prior year (ATUM, 1997:2). The Association of University Technology Managers estimates (perhaps somewhat optimistically) that "$24.8 billion of US economic activity can be attributed to the results of academic licensing, supporting 212,500 jobs (AUTM, 1997:2)."

Regardless of the actual economic impact of jobs or business revenue generated by academic licensing, the real levels of R&D spending and licensing income provide strong evidence of the importance of understanding university technology transfer processes and performance (e.g., CNN, 1998; Machen, 1998; Melzer, 1998). Several large scale reports quantify university technology output (e.g., AUTM, 1997; GAO, 1998; National Science Board, 1998). A number of studies use a case study method to evaluate the processes or results of university technology transfer efforts and provide practical suggestions (e.g., Burnham, 1997; Del Campo, Sparks, Hill & Keller, 1998; Harmon, et al., 1997; Lopez, 1998; Mejia, 1998). A few provide theoretically grounded explanations using quantitative tests seeking to identify factors relating to successful

technology commercialization (e.g., Mian, 1997; Kassicich, Radosevich, & Umbarger, 1996). However, none of the published reports uncovered while preparing this research used clear theoretical foundations as well as large sample quantitative data collected from a number of different sources. This research combines formal theory with multi-sourced data from a large sample of US university technology transfer offices. This research proposes theoretical foundations for some of the complex issues facing university technology transfer organizations. The study then tests the theory in an attempt to fill a gap in our understanding of the processes and precedents affecting successful university technology transfer in the US.

Technology Commercialization in the United States

In the United States, university and government-affiliated research centers increasingly attempt to transfer and commercialize technology. For example, according to Chemical Engineering Magazine (1990:46), the Federal Technology Transfer Act of 1986 was enacted to "provide US companies with a way to tap into the know-how generated by some 700 government-run labs, which [in 1990 spent] $65 billion." Regional technology centers, university technology transfer projects and university-assisted federal government technology transfer programs exist throughout the United States. Stanford University, Massachusetts Institute of Technology (MIT), the University of Wisconsin, and many others operate revenue-generating technology transfer programs (e.g., AUTM, 1997; CNN, 1998; Foster, 1998; GAO, 1998; Machen, 1998; Melcher, 1998; Melzer, 1998; Piercey, 1998). The National Aeronautics and Space Administration (NASA) technology transfer centers as well as university-assisted projects supported by

the Department of Defense, the US Navy, the US Army, and the Department of Energy provide evidence of the interest in commercializing publicly-funded basic and applied research (e.g., Brown & Berry, 1991; Deutsch, 1997; GAO, 1998; Shrum & Wuthnow, 1988; Steele, Schwendig, & Johnson, 1990).

Changing views of the roles of universities and in the sources of funding for university research may contribute to the interest in technology commercialization. Universities confront challenges to expand their funding bases due reductions in state and federal funding sources as student enrollments decline (Fairweather, 1990). Private defense and space contractors seek avenues for commercializing government-specific technologies as the contractors experience declining federal contract revenue (Adams & Spann, 1993; 1995). Universities and their constituent communities have been reevaluating the role of basic research to consider direct benefits to the communities in terms of new jobs or industries (e.g., Brust, 1990; Melcher, 1998; Technology Access Report, 1989:12) or in terms of direct benefits to the students (National Science Board, 1998). Successfully transferring publicly-funded technologies is becoming increasingly important, whether driven by hopes of opening new revenue sources, greater relevance of research to society, or by demands for a direct contribution to the economic well-being of communities.

Technology Commercialization Worldwide

The trend toward encouraging technology diffusion and commercialization of publicly-financed research is not limited to the United States. For example, the Canadian federal

government has established regional economic diversification offices that work with private industry and universities to expand technology transfer efforts throughout Canada (personal communication, D. J. Smith, August, 1995). Universities in Canada, Japan, Northern Ireland, Great Britain and Germany have developed programs specifically directed toward diversifying funding and transferring technologies from academia to commercial production (e.g., Bailetti & Callahan, 1992; Buschberger, 1998; Beveridge, 1991; Bower, 1992; Brust, 1990; Cutler, 1989; Kenward, 1991; Phillips & Eto, 1998; Senker, 1991; Vedovello, 1998;Waugaman, 1990). The European Union has established an information and funding network to encourage technology transfer and commercialization (CORDIS, 1996; European Commission, 1995). The network, named CORDIS, (Community Research and Development Information Service) is part of a broader effort within the European Community to commercialize publicly-funded R&D, as well as to disseminate potential technology applications with the intent to spur economic expansion.

Summary of Practical Importance

Because of the increasing interest in commercializing publicly-funded R&D, the results of a study testing theoretically-grounded factors affecting technology transfer and commercialization could provide valuable information to support effective programs. The study applies to a broad range of technology transfer organizations in both the public- and private-sector, domestically and internationally. Such a study could provide insight into factors affecting the successful management of technology transfer programs in government-sponsored research, university research centers, and projects

operating within and between firms in private industry. Examples include: the Department of Defense, US Navy shipbuilding facilities, Department of Energy research centers (e.g., Fermi Labs, Argonne National Laboratories, Sandia Laboratories), NASA facilities, as well as university technology transfer programs. Results of the study of organizational-level characteristics could contribute to improving organizational factors affecting technology commercialization. The results could lead to modifications of organizational reward systems, structural relationships, funding criteria, and evaluation measures to improve the efficacy of publicly-funded research commercialization ventures, especially those operating in a university setting.

The model could be applied to other types of organizations facing funding or market changes in an institutional environment. For example, it might be applied to community literacy programs, medical practices, hospitals, and social service organizations. Any organization moving from an institutional foundation toward a market-responsive mode of operations could benefit from the results of tests of the proposed model. The practical implications for the research framework suggest a wide range of applications for organizational managers facing dramatic changes in their environments.

Summary of Importance

The present study investigates the possible relationship between institutional and technical-commercial pressures and responses, including entrepreneurial actions, on technology commercialization programs. Results of the research could extend

theoretical understanding and provide practical answers to problems confronting technology transfer organizations. The study explores the effects of conflicting pressures on organizational outcomes in institutional environments. The results of the study could provide critical data for planning effective technology transfer projects in the US. Future research stemming from the model developed could investigate similar technology commercialization and technology transfer programs worldwide in a variety of organizational settings.

Organization of the Dissertation

Chapter 2 presents a review of the research literature related to institutional pressures, organizational responses, and technology transfer performance. Chapter 3 describes the research model and the hypotheses. Chapter 4 describes the research methods, including the population, the sample, the variables and the analyses methods. Chapter 5 presents the research results. Chapter 6 interprets the results and suggests further research indicated by the findings of the present study.

CHAPTER TWO

LITERATURE REVIEW

In the literature review I discuss three research areas that form the theoretical foundations for this study: institutional theory, entrepreneurial orientation; and technology commercialization performance. In the first section I review historical foundations and applicable research from the broad area of institutional theory of organizations. The first section presents: 1) historical foundations of institutional theory; 2) institutional theory applied to organizations; 3) institutional pressures and organizational response; and 4) institutional and technical-commercial pressures. In the second section I present an overview of entrepreneurial orientation and research using this construct. The discussion of entrepreneurial orientation includes: 1) an overview linking institutionalism and entrepreneurship; 2) a definition of entrepreneurial orientation; 3) a review of research using entrepreneurial orientation; and 4) concepts related to entrepreneurial orientation. The third section of the literature review chapter discusses research related to university technology commercialization performance, including: 1) university technology commercialization measures; 2) Federal research technology commercialization measures; and 3) annual university technology licensing surveys. The chapter concludes with summary of the literature review.

Institutional Theory

The discussion of institutional theory begins with an overview of the historical foundations of institutional theory. Following the historical background, I discuss recent

research that directly relates to the study of institutional and technical-commercial pressures in university technology transfer centers and research units.

A number of extensive reviews (e.g., Powell & DiMaggio, 1991; Scott, 1994; Scott, 1995) of institutional theory have summarized and organized the broad array of research being conducted that uses institutional theory. I do not attempt to replicate their work, but instead focus on those studies that can be applied to understanding technology commercialization in university settings. I categorize the studies into two broad groupings. First, I present those studies that examine institutional pressures in general, and organizational responses to those institutional pressures. Second, I review theoretical and empirical studies that pursue questions related to organizational responses to both institutional and technical (technical-commercial) pressures. In each section of the literature review I explain how the research applies to the present study and to university-affiliated technology transfer centers and research units.

Historical Foundations

Institutional theory, as a framework for study of organizations, evolved from the traditions of economics, sociology and political science. Scott (1995) and Powell and DiMaggio (1991) provide interesting discussions of the historical evolution of what is now being labeled 'new institutionalism' or neo-institutionalism. Because others have presented thorough reviews of the historical foundations of institutionalism, only a brief summary of highlights will be presented to establish a frame-of-reference for this dissertation research proposal.

In economics, Scott (1995) attributes early institutionalism to Gustav Schmoller's (1900-1904) writings which called for examining economics within the context of social settings rather than in the abstract. Thorstein Veblen, John R. Commons, J. A. Schumpeter, John Kenneth Galbraith and Gunnar Murdal are included in the list of economists embracing and exploring an institutional approach to economics, as explained by Scott (1995).

Van de Ven (1993) highlighted the influences of John R. Commons on new institutionalism and suggests that most present day institutional theorists do not acknowledge the strong linkages between the works of Commons and neo-institutionalism in organizational analysis. According to Kenneth H. Parsons a student and associate of Commons, John R. Commons explored economics with a focus on individual freedom, choice and power in the social context of joint and collective action (Parsons, 1970). Commons' integration of collective and joint action with individual power was heavily influenced by the changing social conditions in the late nineteenth and early twentieth century America -- the rise of industrialization, rate regulation of the powerful railroads and the rise of labor unions. The influence of John R. Commons may be best summarized in his own words:

> "...an institution is collective action in control, liberation and expansion of individual action...Capitalism in its highest form, as found in the United States, is built upon [the] legal foundation of private property, latterly modified by the emergence of joint-stock corporations, holding companies, banks, labor unions, and political parties seeking control of the sovereign power or the state. ... [E]conomists must analyze these political, economic, and social relations by which the values are made available to, or secure for, the individual (1950, 1970:21-22)."

Ronald Coase is credited with establishing neo-institutionalism in economics according to Powell and DiMaggio (1991:3). Coase and his colleagues emphasized realism grounded in a theoretical framework of microeconomics. Neo-institutionalism in economics suggested that the effects of transactions costs' motivations are moderated by bounded rationality incomplete information, and agency. DiMaggio and Powell (1991:3-4) explained the emergence of institutions in neo-institutional economic theory as: "Institutions arise and persist when they confer benefits greater than the transaction cost (that is the costs of negotiation, execution, and enforcement) incurred in creating and sustaining them." Institutions offer a counterbalance to information uncertainty by providing rules and patterns for acceptable economic exchange. For an in depth examination of the evolution of institutionalism in economics see the work of Douglass C. North (e.g., 1981; 1984; 1990).

Proponents of neo-institutionalism in political science examine the role of structures on political behavior. The structure of the legal system, rules, the US Congress and legislative committees are institutions that influence political behavior (DiMaggio & Powell, 1991). Moe (1984, 1986) and Shepsle (1986, 1989) offer thorough discussions about the roles of institutions and institutionalism in political science.

The early roots of neo-institutionalism in sociology, according to Scott (1995:8-15), have been attributed to Emile Durkheim, Max Weber and later Talcott Parsons. From Durkheim come the notions of social institutions as symbolic systems. Weber is attributed with developing economic sociology which encouraged theoretical foundations while studying economics in a social context. Parsons described institutions

and institutionalized systems in terms of shared values and norms that guide an individual's actions. Institutional views of organizations are also found in Selznik's work. Selznik (1957) described an organizational process of becoming 'institutionalized' in which values become embedded in an organization (Scott, 1987). Durkheim, Weber Parsons, and Selznik among other early institutionalists in sociology influenced the works of contemporary organizational neo-institutionalists such as John W. Meyer, Brian Rowan, W. Richard Scott, and their students and colleagues. Scott (1987) and DiMaggio and Powell (1991:11) credit Meyer (1977) and Meyer and Rowan (1977) with the first explication of new institutionalism related to organizational studies. For concise, but thorough, reviews of the sociological roots of new institutional theories of organizations refer to Scott (1995) and DiMaggio and Powell (1991).

Institutional Theory and Organizations

Several recent works present thorough reviews of current research testing the various aspects and concepts proposed by institutional theorists. Scott (1995), Scott and Meyer (1994), and Powell and DiMaggio (1991) develop the theoretical framework and review empirical studies based on neo-institutionalism. Therefore, the present review will discuss only those studies which have direct bearing on the proposed model and research.

Questions most often asked when examining institutional theory relate to the process of becoming institutionalized and to the impact of institutions on organizations,

especially on organizational structure and processes within the organization. Scott (1994) classifies the research of neo-institutionalism into two broad categories -- studies using variance theories to examine institutional factors and studies using process theories to examine institutional formation and evolution. In variance studies, institutionalism has been examined as both an independent variable and a dependent variable. The levels of analysis used in variance studies include intraorganizational, organizational field and the societal level.

The current dissertation research fits with studies using institutionalism as an independent variable. The current research specifically directs attention to institutional pressures facing organization sets and explores how those pressures affect organizational-level performance outcomes.

The next section discusses research that illuminates the issues of institutional pressures and their effects on organizations. Institutional pressures are a key part of the environment of many types of organizations including university technology transfer and research programs, medical practices, hospitals, regulated industries, religious organizations, and public schools. Because university technology transfer programs operate in highly institutionalized settings, I expected to find that institutional pressures affect the operations and performance of these organizations. The following review of recent research treating institutional pressures as key factors affecting organizational structure, processes and performance outcomes extends recent reviews reported by Scott (1995), DiMaggio and Powell (1991), and Scott (1994).

Institutional Pressures and Organizational Response

This section examines research that provides insights and answers to the question: How do institutional environments affect organizations? Most studies examine structural effects (i.e., structural isomorphism) in which organizations adopt structural forms and processes that are similar to successful organizations in their field (e.g., Tolbert & Zucker, 1985; Edleman, 1992; Gupta, Dirsmith, & Fogarty, 1994; Slack & Hinings, 1994; Judge & Zeithmal, 1992). Other studies look at the effects of competing institutions and the effects of resources dependence (e.g., D'Aunno, Sutton & Price, 1991). Competing institutional pressures and resources dependence have been examined in terms of the effect on structure, processes and on the performance of organizations (e.g., Goodstein, 1994). Recent studies have also examined the effects of institutional pressures on strategic choices and actions of organizations (e.g., D'Aunno et. al., 1991; Goodstein, 1994) .

Institutional Pressures and Civil Service Reform. Tolbert and Zucker (1983) developed what has become a classic analysis of institutional pressures as sources of change in organizational structure and processes. They conducted an analysis of the adoption of civil service reforms occurring between 1880 and 1935. Their analysis revealed that characteristics of the cities predicted early adoption of the reforms. The city characteristics were not predictive of later adoptions indicating that the late adopters were following an institutionalized pattern of organization and process. Tolbert and Zucker (1983) concluded that adoption of innovation and change may at first be related to organizational need or characteristics, but as the mass of adoption

builds, then other organizations follow in what DiMaggio and Powell (1983) called mimetic isomorphism. Organizations look to successful organizations and copy characteristics or activities in an attempt to mimic the successful organization. Many subsequent studies examining the effects of institutional pressures (e.g., Abrahamson and Rosenkopf, 1993; Edleman, 1992; Judge & Zeithaml, 1992) build on and extend the findings of Tolbert and Zucker's (1983) influential research.

Tolbert and Zucker's (1983) study suggests a possible direction for additional research of the processes involved with university technology commercialization. If, for example, the present study finds a relationship between entrepreneurial orientation and technology commercialization, conducting a longitudinal study might reveal that entrepreneurial activities follow a pattern of diffusion of similar to that found by Tolbert and Zucker (1983). The diffusion of university technology transfer centers (a structural characteristic) may also occur in a pattern similar to that found by Tolbert and Zucker. However, while these issues are closely related and likely to be important to understanding factors related to institutional pressures, organizational response and performance, they are beyond the scope of the current research. Tolbert and Zucker's work merits consideration in the present study primarily because of its influence on so much of the recent research examining institutional pressures and organizational responses.

Bandwagon Effects, Institutionalism and Innovation. Abrahamson and Rosenkopf (1993) developed a mathematical model to predict bandwagon effects on innovation diffusion. The model is intended to be applied in settings where bandwagon

pressures (i.e., pressures resulting from other similar organizations adopting innovations) might influence diffusion of innovations of technology, organizational processes or forms, or strategies. The model uses institutional theory to explain the tendency of organizations to adopt innovations even if the innovations do not have a known economic or technical efficiency benefit to the organization. That is, once a few (perhaps respected or highly visible) organizations adopt an innovation, other organizations in their field adopt the same innovation without evaluating or knowing that the innovation will benefit them in the same way it benefited the early adopters. The model predicts that bandwagon adoption occurs especially when high levels of ambiguity exist surrounding the benefits of the innovation and when some organizations evaluate returns that exceed the cost of adopting the innovation. Once a few organizations have adopted the innovation and ambiguity exists, such as difficulty in measuring the benefits of the innovation, adoption of the innovation proceeds because of bandwagon or institutional pressures. Abrahamson and Rosenkopf (1993) provide a mathematical modeling tool for predicting the kinds of responses to institutional pressures found by Tolbert and Zucker (1983) in their classic study.

Framework of Strategic Responses to Institutional Pressures. Oliver (1991) postulated that organizations respond to institutional pressures not only by adopting similar processes and structural characteristics, but also by changing strategies. She suggests that organizations respond by active choice and are not limited in their response patterns to the somewhat passive, taken-for-granted ways found by many classic institutional researchers such as Tolbert and Zucker (1983). Oliver's framework

suggests that organizations respond to institutional pressures in a variety of ways ranging from compliance to rejection of the demands of the institutional pressures.

Oliver (1991) incorporates concepts from resource dependence theory (Pfeffer & Salancik, 1978) as complementary explanations for organizational responses to institutional pressures. Power and influence relationships play critical roles in affecting organizational responses to institutional pressures in Oliver's framework. The determinants of the organization's strategic response reflect consideration of the complex operating environments that face many organizations. Key factors influencing an organization's strategic choice of its response to institutional pressures include: the influence of constituents, conflicts in the environment, dependence on external sources for resources, financing or legitimacy, and organizational goals.

In Oliver's view, organizational goals as well as institutional requirements and dependence on the institution are key determinants of the organization's response to institutional pressures. Organizations respond not just by accepting institutional demands, but by evaluating the organization's self-interests and considering how the institutional demands match or conflict with the interests of the organization. Oliver (1991:165) states: "...the likelihood that organizations will conform to institutional pressures is not exclusively dependent on the legitimacy or economic rationality (or lack thereof) anticipated by conformity (social or economic fitness). Rather, it depends, in interaction, on the degree of discrepancy between organizational goals and institutional requirements (consistency), the likelihood that institutional constituents create conflict for the organization in meeting incompatible goals simultaneously (multiplicity), and the

degree of organizational dependence on the pressuring institutional constituents for its legitimacy or economic viability (dependency)." Oliver outlined five general responses ranging from least to most resistant to institutional demands: acquiescence, compromise, avoidance, defiance, and manipulation.

Oliver's (1991) propositions specifically address environments characterized by conflicting demands, goals or pressures from multiple institutions. Health care organizations, educational systems, universities, some government agencies as well as research and technology commercialization organizations increasingly face such conflicting demands from multiple institutions. Oliver did not label economic pressures as 'technical' following Scott (1987) or technical-commercial demands, as used in this dissertation. Oliver viewed economic pressures, or pressures to act in a more efficient manner, as pressures from one or more institutional forces in the environment. The economic or efficiency pressures derive from institutional sources and resource dependence theory (Pfeffer & Salancik, 1978) offers a framework for examining the organizational responses to such pressures. Thus, Oliver presents institutional theory and resource dependence theory as complementary explanations for organizational responses to environmental pressures.

Oliver (1991:161) builds a case for applying resource dependence theory (Pfeffer & Salancik, 1978) implications when studying organizations facing conflicting environmental demands. Resource dependence theory suggests that organizations actively make strategic choices to confront, challenge or adapt to their environments. Researchers using institutional theory tend to look for ways that organizations adopt

characteristics of similar organizations in the environment or blend into the environment. Oliver suggests that this compliance or acquiescence represents only one part of the spectrum of responses to institutional pressures. Active choice in responding to the environmental pressures leads Oliver to use resource dependence theory to explain how and why organizations defy or manipulate their institutional environments in order to satisfy selected goals or pressures deemed more critical for the organization.

Health care organizations, for example, face conflicting demands from at least two powerful sources of institutional pressure. At the societal level, the movement toward health care reform pressures managed care insurance payers to control costs. The managed care insurance payers in turn pressure health care providers diagnose and treat patients using lowest cost methods. Health care providers face conflicts from a competing institution, that is, their professional standards, training and ethics that drive toward the best care at any cost. Applying Oliver's framework would suggest that a combination of factors will influence the health care organization's response to the pressures. For example, dependence on insurance payers for survival and continued operations might lead the organization to acquiesce or find a way to compromise to meet both sets of pressures.

Oliver's framework could also easily be applied to technology transfer units and research centers. The present study does not attempt to classify organizational responses using Oliver's (1991) categories to technology transfer centers and research units. However, Oliver's work provides a rationale for examining strategic choices in the form of active responses to institutional pressures. In the situation of technology

transfer centers, one form of active response may be found in an entrepreneurial orientation (Covin & Slevin, 1991; Lumpkin & Dess, 1996; Miller, 1983) that facilitates the organization's creative and competitive responses to pressures in the environment.

Oliver's (1991) framework lays out broad categories of responses to institutional pressures. Her framework applies to many types of organizations and institutions. Other researchers and theorists have examined institutional pressures and responses using more specific examples and settings. The following sections review recent empirical and theoretical studies which highlight a variety of perspectives on organizational responses to institutional pressures.

Institutional Pressures and Organizational Survival. Baum and Oliver (1991) investigated ways in which institutional linkages affect survival of organizations. Organizations with strong institutional linkages had better survival rates than those having few or weak linkages. While this research examined linkages with institutions and not specifically institutional pressures, it is important because it suggests that institutional affiliations confer benefits on organizations and are not simply constraints on the choices and patterns of activities of the organizations. Benefits from institutional affiliation include financial support, other types of resources, taken-for-granted legitimacy, and access to clients, customers or constituents that would not otherwise be available. Baum and Oliver's (1991) study emphasizes the complex relationships as well as the duality of institutional benefits and constraints in organizational environments. Baum and Oliver (1991) support the expectation that technology transfer offices will experience benefits as well as constraints in their institutional settings.

Institutional Pressures, Organizational Processes and Structure. Edelman (1992) found that institutional demands resulted in structural and procedural conformity as organizations established EEO/AA (Equal Employment Opportunity and Affirmative Action) rules and departments. Organizations instituted rules and in some cases set up EEO/AA offices as symbolic gestures and to secure legitimacy in terms of the legal pressures. The conformity in the form of a structural change preceded any process changes and in many cases substituted for any changes in hiring and promotion practices. Procedural changes followed pressures that related to resources and other factors that affected continued legitimacy (acceptance) or existence of the organization. For example, early compliance to EEO/AA regulations was found in organizations having Federal contracts and those having unions. Federal contractors were required to establish EEO/AA compliance procedures in order to continue providing goods or services to the Federal government. Unionized firms established EEO/AA procedures as a result of pressure from the unions, presumably in an attempt by the unions to retain control over a personnel- and contract-related function. Legal and political pressures (institutional) led to establishing EEO/AA offices (structural response) which in turn led to increased rules and policies even as legal and political pressures declined. It would appear that the structure (offices or departments responsible for EEO/AA compliance) became institutionalized and thus affected the rules and policies. The existence of the offices became the measure for assessing compliance, at least in terms of legal challenges. Edelman concluded that the presence of the offices may be the first step in actual compliance and change or the office may simply be symbolic gestures. If they are

symbolic gestures, the organizations may be attempting to pacify (Oliver, 1991) their institutional constituents while maintaining managerial control over the actual practices (Edelman, 1992:1567).

Applying Oliver's (1991:160) categories of response to institutional pressures to Edelman's (1992) study, the organizations setting up offices for EEO/AA management would be acquiescing to institutional pressures because of the need for continued legitimacy and resources. The causes of compliance would be related to both institutional and technical-efficiency pressures, as well as to dependence and coercion pressures, applying Oliver's predictive factors.

Results of Edleman's (1992) analysis suggest that university technology transfer centers could create an appearance of compliance with institutional or technical pressures without substantive compliance. For example, technology commercialization organization might set up a spin-off company with officers, incorporation papers, etc., but never produce or sell any products. They might then report that they had successfully commercialized a technology as evidenced by the existence of the spin-off company. Setting up the company, a form of structural compliance similar to the EEO/AA offices, might satisfy the requirements for continued funding, university recognition and legitimacy. The technology transfer organization may be so strongly entrenched in its institutional foundation that it does not realize that forming a company is only one small step in selling products. In the latter interpretation, the organization would not be trying to avoid compliance or manipulate the situation.

Institutional Pressures, Structure and Work Unit Performance. Gupta, Dirsmith and Fogarty (1994) provide a link between institutional environments, work unit structure and organizational work unit performance. Their study of US Government Accounting Office (GAO) teams concluded that the institutionalized setting related to the types of control, the task characteristics and performance outcomes of the audit teams.

Two major contributions of the Gupta et al., (1994) study have implications for this dissertation research. First, the authors established causal linkages between the institutional environment of the organization, organizational processes and organizational performance. In a related manner, this research examines linkages between two types of environmental characteristics, organizational response to the pressures and the impact on performance. Second, Gupta et al., (1994) explicitly measured characteristics of one type of institutional environment, a need identified by Scott (1994:84). The present research also measures characteristics of an institutional environment, specifically in terms of pressures resulting from the characteristics in the institutional environment of university settings.

Institutional Environment and Organizational Processes. Judge and Zeithmal (1992) used institutional theory and strategic choice theory to examine antecedents to board involvement in management decisions. They found that different institutional environmental factors had distinctly different effects on the extent and nature of board involvement in management decisions. Judge and Zeithaml (1992:785) suggest that "previous researchers have not considered the impact of different institutional

environments..." which may have resulted in conflicting evidence about board involvement. They examined the relationships among institutional characteristics, structural and process responses, and organizational performance, as did Gupta, Dirsmith and Fogarty (1994) in their study of GAO audit team performance. Judge and Zeithaml (1992) however did not explicitly measure or assess institutional environmental characteristics. In terms of the present research, the results of the Judge and Zeithaml (1992) study lends support for predictions about relationships among institutional pressures, organizational process responses and performance.

Types of Institutional Pressures and Structural Change Response. Slack and Hinings (1994) examined structural change in response to institutional pressures in a study of Canadian sports organizations. An agency named Sport Canada, operating under the authority of Canada's Ministry of State for Fitness and Amateur Sport, was charged with the task of coordinating support for Canada's Olympic participation. The agency's program guided the activities of the amateur sports organizations. In 1984 the sports authority established planning guidelines that called for increasingly business-like operations from the amateur sports organizations. Slack and Hinings detailed the institutionalization of the amateur sports program in Canada and empirically examined the structural changes in the sports organizations. Their longitudinal study examined the change process in terms of structural changes in the organizations. Slack and Hinings (1994) found a significant reduction in the diversity of organizational forms during the study period. According to institutional theory, one response to institutional pressures is structural isomorphism, or structural similarity of the organizations

operating under the influence of the same institutional pressures. Slack and Hinings conclude that the institutional pressures affected the structure and operational processes of the sports organizations. A major contribution of this study is the explicit discussion of types of pressures that influenced the isomorphic changes. Coercive pressures (DiMaggio & Powell, 1983) in the form of financial incentives influenced the sports organizations to conform to the planning guidelines and operate in more business-like ways. By following the guidelines of the governmental agency, a sports organization achieves legitimacy which "can then be used as a source of status with the state agency and in this way the sports organization ensures that it continues to receive the resources it requires to operate (Slack & Hinings, 1994:818)."

Slack and Hinings also found an increase in the professionalization of management, training of volunteers and staff, and more similarities of staff member qualifications between Sport Canada and the sports organizations. These latter similarities were classified as mimetic isomorphism (DiMaggio & Powell, 1983) because the sports organizations copied the patterns of the governmental agency to achieve similarity and therefore, legitimacy. The study of sports organizations also yielded evidence of normative isomorphism (DiMaggio & Powell, 1983) in the acceptance and following of the guidelines, even in the absence of coercive pressures.

While the Slack and Hinings (1994) study does not deal with conflicting institutional pressures, it does offer insight for the present study. The measures of institutional pressures, while specific to the sports organizations, offer a basis for developing measures of institutional pressures that can be applied to the university

setting. The present study will not evaluate structural isomorphism in the context of university technology transfer offices. However, as technology commercialization goals become well accepted and perhaps become institutionalized, pressures may lead to structural and procedural isomorphism of the organizations. Although interesting and intriguing for possible future research, examination of the processes of institutionalization and structural isomorphism is beyond the scope of the present study.

Conflicting Institutional Pressures. D'Aunno, Sutton and Price (1991) explicitly looked at the effects of competing or conflicting institutional pressures on organizational practices, resources and goals. The study compared hybrid mental health-drug abuse programs with programs based on mental health treatment models and with models based on the Alcoholics Anonymous approach. The authors interpret the results as suggesting that hybrid organizations that followed practices similar to the (mental health model) parent organizations received greater support. However, the authors acknowledge that the greater support levels may be confounded by the fact that mental health organizations have greater resources (environmental munificence) than does the institution of Alcoholics Anonymous. They also interpret the data to suggest that hiring and treatment approaches reflect the institutional alliance of the treatment program. That is, programs modeled after the Alcoholics Anonymous approach hired more ex-addicts, fewer professionals and required sobriety of their clients. Programs modeled after mental health treatment approaches used the professionally mandated diagnostic approach and treatment approach, hired more professionals and did not emphasize sobriety. Interestingly, the data did not reveal differences in approaches

based on the percentage of drug abuse clients, a factor that seemingly would influence the treatment type and sobriety requirement. One possible explanation might be that the mean percentage of drug abuse clients was nearly 87% for the entire sample of 333 units responding. Thus there may not have been sufficient variance to detect differences in programs based on this variable.

The D'Aunno, Sutton and Price (1991) research suggests that organizational practices and processes may conform with institutional characteristics because of the organization's need for resources. This finding supports part of Oliver's (1991) framework that includes resources dependence as a factor affecting an organization's strategic choices. Thus, examining the proportion of funding and financial support from various sources for university research and technology transfer offices could provide an indication of institutional pressures. The research conducted by D'Aunno, Sutton and Price (1991) also lends support for using organizational processes as indicators of a type of response to institutional pressures.

Institutional Pressures, Strategic Choice and Technical Outcomes. Goodstein (1994), in a study of organizational responses to work-family issues, specifically tests organizational responses to institutional pressures using Oliver's (1991) framework. Goodstein examines organizational responses as strategic choices that are influenced by institutional pressures and the organization's perception of the impact on technical outcomes, such as increased profits, lower costs or lower employee turnover. Goodstein applies Oliver's (1991) categories of factors that are expected to influence an organization's response to institutional pressures. He also uses several of Oliver's

categories of responses to institutional pressures: acquiescence; compromise; avoidance; and defiance. Goodstein used the categories to represent degrees of a continuum of responses ranging from compliance to active resistance. His findings support the conclusion that: "organizations vary in the strategies they pursue to adapt to institutional pressures and that the level of organizational responsiveness to institutional pressures is significantly related to a set of institutional and technical factors (Goodstein, 1994:375)." Goodstein (1994) concluded that institutional as well as technical factors were related to the organizational response of compliance with institutional pressures.

Goodstein's (1994) study offers insights for testing the effects of institutional and technical-commercial pressures on organizational responses. The study's results indicate that organizations actively select strategic responses to institutional pressures, as theorized by Oliver (1991). The results suggest that organizations do consider technical or rational economic factors in choosing a response to institutional pressures. The results also suggest that institutional and technical pressures can interact in their impact or effect on an organization's response to their environment. Organizations can respond in a variety of ways to both institutional and technical-commercial types of considerations when choosing a response to environmental pressures or conditions.

Strategic Choice Responses to Institutional Pressures. Ingram and Simons (1995) replicated Goodstein's (1994) application and test of Oliver's (1991) model of organizational response to institutional pressures. Ingram and Simons examined institutional pressures and responses to work-family issues, as did Goodstein. However, Ingram and Simons added the concept of 'countervailing power' (Pfeffer & Salancik,

1978) to the model by including a measure of the power base of women employees. Their results confirm Goodstein's findings about the types of institutional pressures and the categories of organizational response ranging from compliance to resistance. Ingram and Simons (1995:1478) concluded that "organizations respond to pressures consistent with their goals, or at least pressures that are not diametric to their goals."

Summary of Institutional Pressures Research. The preceding section presented an overview of the historical foundations of institutional theory. A discussion and application of examples of contemporary research results demonstrated how institutional theory can be used to help answer questions about the effects of institutional pressures on technology commercialization at universities.

The research reviewed in the preceding section described findings showing how organizations respond to institutional pressures. Oliver (1991) developed a framework for classifying organizational responses to institutional pressures, emphasizing an organization's active strategic choice. Several studies examined organizational responses, such as structural, procedural or process conformity, to institutional pressures in general. Three of the studies, Goodstein (1994), Ingram and Simons (1994), and D'Aunno, Sutton and Price (1991) explicitly dealt with organizational responses to conflicting institutional pressures. Goodstein (1994) began to bridge the institutional and technical-commercial dimensions of an organization's environment by explicitly evaluating the impact of organizational choices on technical (economic or financial) outcomes. In the next section I review research that deals with both institutional and technical, or technical-commercial, pressures affecting organizations.

Institutional and Technical-Commercial Pressures

In this section of the literature review, I discuss theoretical bases and recent research findings that shed light on the effects of institutional and technical-commercial pressures. First, a theoretical overview of institutional and technical environments lays a foundation for a review of related empirical research. Next, a review of recent studies provides insight about the effects of institutional and technical-commercial pressures on organizational performance. Research results will be discussed in terms of applying the findings to technology transfer offices as well as other types of organizations.

Overview of Institutional and Technical Dimensions. Organizations influence and are influenced by their environments Scott (1987). Scott conceptualizes two key dimensions of the environments of organizations: *technical* and *institutional,* as explained below. Technical (technical-commercial) and institutional environments create differing sets of expectations and pressures for organizations. Technical environments emphasize technical rationality, exchange, goal achievement and production efficiency. As Scott (1987:26) explains: "*Technical environments* are those in which organizations produce a product or service that is exchanged in a market such that they are rewarded for effective and efficient performance." In contrast, "*institutional environments* are characterized by the elaboration of rules and requirements to which individual organizations must conform in order to receive legitimacy and support...in the extreme case...organizations are rewarded for the institution of the correct structures and processes (Scott, 1987:126)." Institutional environments influence actions using rules,

shared values and norms, professional training, or taken-for-grantedness of activities or patterns of behavior.

The definitions of technical and institutional environments suggest two opposing ends of a continuum. However, Scott (1987) and later, Scott and Meyer (1991) preferred to describe institutional and technical characteristics as *dimensions* of environments of organizations. In the present research, technical-commercial and institutional will also be considered as dimensions of the environment. Organizations may be confronted with characteristics or pressures from both technical-commercial and institutional environments as depicted in the two-by-two matrix in Figure 1. The pressures may be stronger or weaker along the dimensions of technical-commercial and institutional, suggesting that organizations may respond differently to the distinctive environments. Applying the combined environments model as shown in Figure 1, the orientations and activities of organizations in conflicted environments could be placed within the two-dimensional framework of both technical-commercial and institutional. In this model, organizations could optimize their relationships within their institutional and technical-commercial environments and be successful, without being hindered by one focus or the other. Other organizations could emphasize one dimension or the other, and also be successful, at least in terms of the expectations of the environment of focus.

FIGURE 1

Technical & Institutional Environments

Descriptive Characteristics

Technical-Commercial Environments	Institutional Environments: Weaker	Institutional Environments: Stronger
Stronger	Lightly regulated, few professionals, and few traditions. Highly focused on efficient and effective output.	Highly regulated, tradition-bound, or professional. Highly focused on efficient /effective output.
Weaker	Few traditions, regulations or professional standards. Low attention to effectiveness, efficiency or output.	Highly tradition-bound, professionalized or regulated. Lower focus on output, effectiveness or efficiency.

Adapted from Scott, W.R. 1987. Table 6.1. p. 126.

University-affiliated technology transfer offices represent clear examples of organizations that face both institutional and technical-commercial pressures. Universities are highly institutionalized systems (e.g., Covaleski & Dirsmith, 1988) characterized by professionalism and long-established norms, values, rules and procedures. One professional norm is that of rewarding research faculty based on their publication records. Technology transfer organizations charged with the task of commercializing technology (a technical-commercial pressure) need to protect discoveries with a patent application to facilitate securing a licensing agreement or sale. The research organization and its researchers face conflicts between the publication

norm and the commercialization goal (e.g., Bird et al., 1993). The rules and procedures, as well as established processes in a university might delay a patent application beyond the date required for patent protection of the discovery once it has been revealed in a publication. In the language of institutional theory, this is an example of institutional pressures conflicting with technical-commercial pressures in the environments of university technology transfer centers.

University technology transfer offices might find ways to optimize relationships with both institutional and technical-commercial factors in their environments. The technology transfer offices might be instrumental in establishing new policies or in developing procedures to execute policies that allow timely publication and still protect a discovery by quick patent decisions and filings. The technology transfer offices in this example satisfy requirements of both the institutional and technical-commercial spheres of influence. In this case the technology transfer offices would fit in the strong-strong position on the institutional and technical-commercial dimensions of Figure 1.

Technical Demands are Institutional. Scott (1995:130) argues that "all technical systems are grounded in institutional environments so conflicts should not be seen as automatic or inevitable." This implies or suggests that conflicting institutional demands drive any observed conflicts between institutional and technical pressures. At a macro-level all organizations can be seen as operating in an institutional framework...the institutions of society, government, religious values, affect organizations on some level. However, if one wants to examine specific types of institutional effects on specific types of organizations, then it is appropriate and logical to look at distinctions between

institutional pressures and technical-commercial pressures. Following Scott's (1995) argument and logic, technical pressures derive from an alternate institution and it becomes a matter of semantics. For the present study, institutional and technical-commercial pressures are examined as distinct elements in an organization's environment. The separation of the two elements is done with the understanding that technical-commercial pressures could be viewed and classified as deriving from institutions such as corporations, venture capitalists or even government agencies, using Scott's (1995) broader view of institutions and their effects.

Overview of Research of Institutional and Technical Pressures

DiMaggio and Powell (1991:32-33) reviewed key studies that address the relationships between institutional and technical influences on organizations. They concluded that institutional and technical influences can contribute distinct but equally positive factors affecting organizational structure and efficiency. Institutional pressures and characteristics should not be restricted to non-profit or governmental organizations. Technical characteristics are not limited to commercial or profit-driven organizations and organizational fields. Institutional practices and processes may contribute to the efficiency of an organization, rather than merely add costs. The conclusions of the studies reviewed by DiMaggio and Powell (1991) fit with Scott's (1987) and Scott and Meyer's (1991) conceptualization that institutional and technical characteristics can affect organizations as interacting dimensions rather than opposing forces in an environment. A number of studies published subsequent to DiMaggio and Powell's

(1991) review provide additional insights about the relationships between institutional and technical pressures on organizations.

Organizational performance and its relationship to institutional-technical pressures is of particular interest for the present study. Recent research investigating the performance impact of institutional-technical environments has been conducted using a variety of organization types, including: a Japanese business network, non-profit rehabilitation agencies, the California cattle industry, school systems in England and Wales, and hospital systems in Norway. In a case study, Lynn and Rao (1995) examined the failure of the pre-World War II Suzuki *zaibatsu* (the predecessor to the modern *keiretsu* business networks in Japan) in the context of its institutional and technical environments. Shanks-Meile and Dobratz (1995) investigated the performance impact of institutional-technical environments of blindness rehabilitation agencies. In a case study of the California cattle industry, Elsbach (1994) examined the effectiveness of institutional and technical arguments for communicating about controversial events. Pettersen (1995) found a separation of the institutional role of budgets and the technical role of accounting information in a study of the Norwegian hospital system. Edwards, Ezzamel, Robson, and Taylor (1995) developed a case study of the school system in England and Wales showing the effects of an environment evolving from a generally institutional one to a mixed, institutional-technical environment.

Support from Institutional and Technical-Commercial Environments. Lynn and Rao (1995) analyzed the Suzuiki *zaibatsu* using an institutional framework. The analysis explicitly applied the complementary forces of institutional and technical

pressures as shown in Figure 1 and as discussed by Scott (1987), Scott and Meyer (1983) and DiMaggio and Powell (1991). The Suzuki zaibatsu encountered failure on both institutional and technical dimensions. Its relationship with the political powers and with its trading partners collapsed almost simultaneously, leaving the zaibatsu without legitimizing support or means to achieve its trading/technical goals.

Lynn and Rao's (1995) case study suggests that organizational performance depends at least in part on its response to both the institutional and technical-commercial dimensions of the environment. Responses to pressures or characteristics in each dimension related to the performance of the organization. Publicly-funded technology transfer organizations, faced with conflicting pressures or goals, can succeed or fail based on their technical-commercial as well as institutional relationships. Lynn and Rao (1995:76) concluded that "organizational researchers need to analyze a broad range of intermediate organizational forms in a comparative context. The extended middle between the market and hierarchy is also populated by joint ventures, consortia, coalitions, trade associations and professional societies (Powell, 1990; Williamson, 1991). Additional research is sorely needed to she light on the efficiency considerations and institutional processes that not only promote such organizational arrangements but also precipitate their failure."

Technical versus Institutional Environments. Shanks-Meile and Dobratz (1995) examined performance and organizational structure effects of institutional and technical-commercial environments. Shanks-Meile and Dobratz studied blindness rehabilitation agencies operating in highly competitive (rational-technical) versus non-competitive

(institutional) environments. They hypothesized differing responses based on a rational-technical model as contrasted with an institutional model. Their findings suggest that in high competition situations, organizations competed for clients using outreach programs, retained clients longer than was necessary, and had fewer board members. The outreach programs to attract new clients and the smaller board size suggested that the agencies operated using rational-technical choice model. The retention of clients was interpreted as an institutional response rather than a response driven by effectiveness criteria as would be indicated in response to technical-commercial pressures. That is, the organizations responded by being more institutional even in the face of competitive pressures. Alternatively, the responses could be interpreted as being rational for the survival of the organization although not necessarily in the best interest of the clients. The clients could also be viewed as critical resources for the agencies, and thus the study may reveal more about the relationships between institutionalized environments and scarce resources than about responses to technical and institutional pressures.

The results of the Shanks-Meile and Dobratz (1995) study could be re-interpreted in the context of a relationship between organizational response and environmental pressures. The blindness rehabilitation agencies operating in high competition markets react to pressure to change from long-established (institutionalized) patterns of behavior to new ways to secure clients and adequate funding to assure continuation of the work of the agency. The increase in the outreach programs may be a commercial or entrepreneurial response reflecting the need to increase the client base. The blindness

rehabilitation agencies in highly competitive situations are forced operate in a conflicted environment at the crossroads of institutional and technical-commercial competitive pressures. The agencies respond with some institutionally-oriented actions and others which could be characterized as commercially-oriented or entrepreneurial. The retention of clients longer than was normally required for rehabilitation could be interpreted as an entrepreneurial action, especially if the agencies offer ancillary services to secure additional support (resources) from the funding sources or the clients.

Evolution: Institutional to Mixed Environments. Edwards, Ezzamel, Robson and Taylor (1995) analyzed changes in the educational systems in England and Wales. This case study examines the evolution from an environment that would fit into a strong institutional, weak technical position to a mixed, more equally balanced institutional-technical position on the matrix in Figure 1. The schools were confronted with administrative changes resulting from a directive to operate more like private enterprises, or in the language of institutional theory, in a more technical style. Specifically, changes in the budgeting and accounting processes were being used to impose a more technical or outcome oriented management approach, at least in the financial management of the systems. The authors concluded that incremental change allowed the schools to more easily adapt to the changing environment. Incremental change minimized resistance to the imposition of changes in the accounting and budgeting system that also could affect the quality of education provided to the students. The case study also described a move from one institutional set of pressures

to a new type of institutional pressure imposed by the new accounting and budgeting system.

Based on the conclusions of the Edwards et al., (1995) study, in highly institutionalized settings such as those in universities, technology commercialization organizations should incrementally move from their institutional roots toward more technical-commercial activities. However, such gradual change could minimize the disruption to researchers and academic professionals at the cost of losing opportunities for commercializing new technological developments.

Competing Institutional and Technical Pressures. In his study of Norwegian hospitals, Pettersen (1995) also categorized budgets and planning for budgets as an institutional form of influence because they were created by political/governmental bodies and constitute a form of external legitimacy and control. Accounting information (tracking the actual expenditure of funds), viewed as a relatively more outcome-related management activity, was categorized as a technical-orientation to management control. In the system, hospitals typically overspent their government-imposed budget in the interest of providing the necessary patient care according to the standards of the medical profession rather than standards implied and imposed by the budget process. Using Oliver's (1991) scheme of strategic responses to institutional processes, the overspending of the budgets by the hospitals would be a response of defiance by dismissing the budget rules. The Pettersen (1995) study incorporated conflicts between institutional and technical processes as well as conflicts between competing institutions. The competing institutional forces are the government-political pressures expressed in

the top-down imposition of budgets and the institutional norms and values of the medical profession (Scott, 1995; Abbott, 1988).

Technology transfer organizations also face two sets of conflicting pressures similar to the Norwegian hospitals in Pettersen's (1995) study. First, technology transfer offices must balance conflicts between researchers' professional values which are institutional by definition (Scott, 1995; Abbott, 1988) and the more technical goals of commercializing technology (e.g., Bird et al., 1993). Second, technology transfer offices deal with competing or conflicting institutional processes or pressures. University processes and rules may conflict with the processes and rules of other sources of legitimacy and funding, such as those imposed by patent laws or business prospects.

Institutional and Technical Content. Elsbach (1994) studied the effectiveness of institutional versus technical types of messages in two deductive and one inductive study related to the California cattle industry. Elsbach also attempted to combine aspects of institutional theory with impression management theories to assess the ways organizations management external perceptions. The first deductive study, analyzing actual messages presented by cattle industry spokespersons, found that the content of the messages explaining controversial events could be classified as institutional and technical. The second deductive study found that the distinct messages resulted in different perceptions of the intended audiences. The more institutional-type messages contained references to the US Department of Agriculture standards, total quality management programs, the Bureau of Land Management, and the US Forest Service.

The institutional messages implied legitimacy through established programs, procedures and legitimate government authorities. Elsbach (1994:66) suggested that links to institutional characteristics or bodies enhance credibility, prove social endorsement and mitigate questions about legitimacy in the eyes of the public. The technical-content messages referred to efficiency, production needs and resources for raising cattle and managing an on-going business. The audiences for the technical (technical-commercial) messages tended to be within the industry or more knowledgeable about the business of the cattle industry. Elsbach concluded that industry spokespersons communicated institutional and technical aspects of their businesses to manage impressions of legitimacy and attempt to enhance the organization's performance by securing approvals of various stakeholder groups. Elsbach's third study provided an experimental test of the theoretical framework derived from the deductive studies. The effectiveness of the statement was evaluated using statements from the cattle industry and subjects from industries other than the cattle industry. Effectiveness of the messages was found to be linked with their institutional and technical-commercial content.

Elsbach's (1994) study highlights a unique dimension of the importance of institutional and technical-commercial characteristics of an organization's environment. The results suggest that managing both the institutional and technical-commercial dimensions contributes to the performance of an organization. Multidimensional organizational responses contribute complementary factors toward the success of an organization operating within combined institutional and technical-commercial environments. The study also provides an example of organizations that face both types

of environments although the cattle businesses would most likely be considered as operating in a predominantly technical-commercial environment. The cattle businesses, using messages to a variety of constituents can be seen as attempting to optimize their relationships with both the institutional and technical-commercial pressures in their environments.

In much the same way, organizations such as university-affiliated technology transfer offices and publicly-funded research organizations must manage relationships with constituents or stakeholders who represent a variety of combinations of institutional and technical-commercial pressures. The Eslbach (1994) results suggest that different types of management strategies or messages could be required for the different types of stakeholders. These results also suggest that organizations could be effective in managing one set of constituents but not another set. For example, an organization having a history of operating in a highly institutional setting may interact effectively with their institutional stakeholders but not those in the more technical-commercial portions of their environment. University-affiliated technology transfer centers may be skilled and effective in the institutional environment but not in the more technical-commercial environment in which they must operate in order to successfully transfer technologies.

Summary: Research of Institutional and Technical Pressures. The recent studies that illustrate the relationship between institutional and technical-commercial influences in an organization's environment support Scott's (1987) perspective on the issue. Scott (1987:509), in his review of institutional theory and research, offered a

clarification of the institutional-technical relationship to guide future research: "...institutional arguments need not be formulated in opposition to rational or efficiency arguments but are better seen as complementing and contextualizing them." University technology transfer organizations operate within technical-commercial environments as well within the context of multiple institutions. The technology transfer organization's response to the technical-commercial and institutional environmental factors can affect its performance, as evidenced by the recent studies discussed above.

The preceding four sections described how institutional theory has been studied and how it could apply to university-affiliated technology transfer centers and research units. The first section summarized a brief history of the development of neo-institutional theory and explained institutional theory. The second section examined recent research that has explored the effects of institutional pressures. The third section presented an overview of the theoretical foundation of the relationship between institutional and technical-commercial pressures in an organization's environment. The fourth, and final section, reviewed recent research that dealt with both institutional and technical or technical-commercial factors affecting organizations. The next section discusses *entrepreneurial orientation* as it might relate to organizational responses to institutional and technical-commercial environmental pressures.

Entrepreneurial Orientation

The discussion of entrepreneurial orientation is divided into five major sections. First, I present an overview linking entrepreneurship and institutionalism. Second, I present definitions of the entrepreneurial orientation construct. Third, recent entrepreneurial orientation studies are reviewed. Fourth, I briefly present related concepts. The section concludes with a summary of entrepreneurial orientation and its relationship to a study of university research units and technology transfer centers.

Overview: Linking Institutionalism and Entrepreneurial Orientation

Entrepreneurship and institutionalism seem like conflicting concepts. However, DiMaggio and Powell (1991:28) ask a critical question that helps connect entrepreneurship and institutionalism: "Under what conditions are challengers and entrepreneurs able to refashion existing rules or create new institutional orders?" Before new institutional orders emerge, new processes and, in some cases, new structures must be initiated. Van de Ven (1993) convincingly argues that institutional factors support as well as constrain entrepreneurship, in the context of the emergence of new industries. He also clearly establishes that entrepreneurial activities are not limited to for-profit organizations or settings.

In changing environments, organizations may respond either in the direction of change or in the direction of established institutional patterns. Organizations operating in conflicted or changing environments such as found in university-affiliated technology transfer centers, or medical practices and managed care, could respond in two ways. First, organizations may respond in ways that follow the established patterns, that is in

accordance with institutional policies, practices norms or values. Second, organizations may seek alternatives that meet other goals or pressures in ways that challenge the institutional pressures. Entrepreneurial orientation, or actions that are considered to be entrepreneurial in nature, may be a predictor of successful change and adaptation to conflicting institutional and technical-commercial pressures. Hospitals, universities, medical practices, as well as research organizations, may respond with entrepreneurial activities in order to meet the challenges of becoming more 'business-like' or more commercial in their goals and operations.

Research of organizations in institutional environments has examined existing organizations that operate in highly institutionalized settings. The research has looked at organizations challenged to operate in a more economically rational (technical) mode but still remain within the institutional boundaries. Research that explores organizations moving from institutional to technical-commercial operations modes usually describes the changes as becoming more business-like.

The organizations attempting to move toward more technical-commercial operations modes in extant research have adopted processes from private enterprise. The processes adopted appear to have been taken from existing businesses in on-going industries and often reflect a bias toward large, bureaucratic organizational forms. Yet the organizations attempting to incorporate more 'business-like' operations methods must often initiate dramatic changes in the way they operate. For example, Slack and Hinings (1994) chronicled such changes for amateur sports organizations that moved from their loosely organized volunteer characteristics to more business-like structures

and operations. Slack and Hinings (1994) linked the structural and operational changes in amateur sports organizations to institutional pressures and institutional responses, but the responses differed from the previous institutional orientation of informal, volunteer organizations. Studying a similar transition, Edwards, Ezzamel, Robson , and Taylor (1995) examined the institutional pressures leading local schools more business-like operations and a radical change in the control of the educational programs. The organizations in these two examples adopted changes that seem to follow structures and processes used by long-established corporations or firms in private industry. Yet early adopters of structural and procedural change, such as those in Tolbert and Zucker's (1983) study, had to create new organizational forms and processes. The early adopters were innovators who responded with creativity, risk-taking and actions competing for scare resources that led to the new organizational structures or processes which later become institutionalized. Institutional theories do not explain the processes or characteristics of the early movers.

One response to pressures to operate in a more technical-commercial manner might be reflected in an entrepreneurial orientation (Covin & Slevin, 1991; Lumpkin & Dess, 1996; Miller, 1983; Naman & Slevin, 1993) of the organization. Entrepreneurial orientation incorporates such characteristics as competitiveness, innovativeness, autonomy, proactiveness and risk-taking (Lumpkin & Dess, 1996). Organizations at the leading edge of change most likely assume risks, take action in advance of crises and exhibit creativity and Innovativeness in solving organizational or operational problems. Organizations facing institutional or technical-commercial pressure or competing

pressures may respond with an entrepreneurial orientation to find creative responses that lead to successful performance. Such organizations may take risks and develop innovative procedures in order to optimize their relationships with both the institutional pressures and the technical-commercial pressures in their environments.

Perlmutter and Cnaan (1995) provide an interesting example of the use of entrepreneurial behavior within a highly institutionalized environment. In a case study, Perlmutter and Cnaan documented the entrepreneurial management activities of a commissioner of recreation in Philadelphia. The commissioner was faced with declining budgets, increased demand for services and his personal commitment to provide continued access to recreational facilities. Rather than accept the external consultants' recommendation to cut services in order to meet the budget, the commissioner developed creative strategies to raise money and improve services. The commissioner implemented a new strategic planning process and developed on-going fundraising and revenue generating programs. He secured corporate and individual sponsors, generated revenues from advertising, involved the local sports franchises, gathered in-kind donations of equipment and services, and negotiated with the city to allow the recreation department to use fees from facilities use to directly support the facilities. According to Perlmutter and Cnaan, the commissioner acted in an entrepreneurial manner using creativity, innovation, and risk-taking to achieve the goals of the recreation department.

In much the same way, entrepreneurial orientation could describe the set of characteristics found in organizations that are able to successfully move from

institutional sources of support to multiple sources of support. Hospitals, social service organizations, arts organizations, universities and colleges are examples of organizations often faced with securing new support relationships.

Entrepreneurial Orientation Definition

Entrepreneurial orientation is an organizational-level, multidimensional construct. The origins of the entrepreneurial orientation construct are attributed to Miller (1983) who tested a one-dimensional construct of entrepreneurship consisting of three firm-level characteristics (innovation, proactiveness, and risk taking) associated with entrepreneurial firms. The construct is considered one-dimensional because, according to Miller's (1983) scale, a firm was considered to be entrepreneurial if it exhibited a high score based on the combined average of the three measures.

Entrepreneurial orientation as used in most current research is based at least in part on Miller's (1983) study (e.g., Covin & Slevin, 1991; Naman & Slevin, 1993; Merz & Sauber, 1995; Lumpkin, 1995; Lumpkin & Dess, 1996). Lumpkin (1995) and Lumpkin and Dess (1996) expanded the construct to include five independent dimensions. According to Lumpkin and Dess, "the key dimensions that characterize an entrepreneurial orientation include "a propensity to act autonomously, a willingness to innovate and take risks, and a tendency to be aggressive toward competitors and proactive relative to marketplace opportunities (1996:137)." Because Lumpkin and Dess consider the five dimensions to be independent, an organization may exhibit an

entrepreneurial orientation along some dimensions but not on others. The next section highlights recent research exploring the construct of entrepreneurial orientation.

Entrepreneurial Orientation Research

Several recent studies build on Miller's (1983) construct and highlight the importance of the entrepreneurial orientation. Covin and Slevin (1991) developed a conceptual argument linking firm-level entrepreneurial orientation and performance. Lumpkin (1995) and Lumpkin and Dess (1996) clarified the construct, defined measures, summarized key contingencies and proposed a variety of relationships between entrepreneurial orientation and performance. Naman and Slevin (1993) developed and tested a model that includes entrepreneurial style, mission strategy, organizational structure and environmental fit. Merz and Sauber (1995) profiled activities of managers in small firms using entrepreneurial orientation, environmental turbulence, and managerial activities of planning, organizing and controlling. Brown and Davidsson (1998) and Wiklund (1998) explored the relationship between entrepreneurial orientation and firm performance in Sweden. For reviews of the background and evolution of the entrepreneurial orientation construct refer to Lumpkin and Dess (1996) and Wiklund (1998).

Naman and Slevin (1993) offer several important insights for the present study. First, Naman and Slevin suggest that "organizational-level entrepreneurial style is not restricted to new ventures or small business (1993:138)." University technology transfer centers clearly do not fall into the categories of new ventures or small business,

but such organizations can still operate in an entrepreneurial manner. Naman and Slevin further explain: "The entrepreneurial firm is generally distinguished in its ability to innovate, initiate change and rapidly react to change flexibly and adroitly (1993:137)." Second, Naman and Slevin tested and found that entrepreneurial style as part of an organization's fit with its environment had a positive relationship with performance. Misfit was associated with lower performance. The Naman and Slevin results lend support for using entrepreneurial orientation as a characteristic associated with responses to environmental pressures and organizational performance.

Merz and Sauber (1995) applied the entrepreneurial orientation construct as used by Miller (1983) to classify managerial activities of small firms. They used proactiveness and innovativeness in terms of the products and markets of the organizations. Merz and Sauber collected data from existing firms ranging from three years old to 97 years old. Firms in turbulent environments displayed highly entrepreneurial styles with great importance placed on innovativeness and proactiveness. These findings suggest that technology transfer organizations operating in changing, dynamic environments would be likely to exhibit an entrepreneurial orientation.

Covin and Slevin (1991) emphasized the characteristics of risk-taking, innovativeness, and proactiveness in their model of firm-level entrepreneurial posture and performance. In addition, they suggested that entrepreneurial posture should not be limited to new or small firms, but large or existing organizations can also exhibit an entrepreneurial posture. Covin and Slevin's comprehensive model proposes relationships among entrepreneurial posture and individual, environmental and

organizational variables predicting firm performance. Several of their propositions suggest relationships for the present study. For example, Covin and Slevin predict:

> Entrepreneurial posture is positively related to a firm's proficiency at identifying opportunities for product-market opportunities (1991:16).
>
> Entrepreneurial posture is positively related to a firm's ability to create new product applications from generic technologies (1991:16).
>
> Entrepreneurial posture is positively related to revenue generated by the firm (1991:20).

While the propositions developed by Covin and Slevin (1991) may not apply to all types and sizes of organizations, the applicability to technology transfer organizations seems clear. Their propositions predict that technology transfer centers having an entrepreneurial orientation will identify more product applications and market opportunities, as well as generate more revenues than organizations lacking an entrepreneurial orientation.

Lumpkin and Dess (1996) and Lumpkin (1995) built on previous entrepreneurial orientation research and developed a rationale for five independent dimensions to the entrepreneurial orientation construct. The dimensions are: risk-taking, innovativeness, proactiveness, autonomy and competitive-aggressiveness. In addition to extending the construct, they proposed relationships between entrepreneurial orientation, organizational characteristics, environmental conditions, and performance.

Lumpkin (1995) attempted to isolate the five dimensions of entrepreneurial orientation in his unpublished dissertation. Results of the factor analysis of the dimensions were mixed, suggesting that further study using a larger sample size would

be needed to confirm the existence of independent aspects of entrepreneurial orientation. Based on the inconclusive results about the independence of the dimensions, Lumpkin (1995) followed earlier research and aggregated the dimensions into a single construct of entrepreneurial orientation.

The Lumpkin (1995) scale attempts to develop a relatively fine-grained assessment of the important components of the entrepreneurial orientation construct. Such an assessment tool would be likely to reveal more minute differences than a measure of the combined or averaged three dimensions of entrepreneurial orientation. A finer grained measure could be important especially when trying to assess characteristics of organizations that may have more similarities than differences. University-affiliated research units and technology transfer centers may be the types of organizations that are more alike than different. Therefore, the five dimensions could be provide additional insight for the present study, if they prove to be independent as evaluated in larger samples.

Brown and Davidsson (1998) and Wiklund (1998) test the link between entrepreneurial orientation and performance using data from small to medium sized enterprises in Sweden. Both studies found a relatively strong link between entrepreneurial orientation and firm performance. The one-year performance relationship examined by Brown and Davidsson (1998) was robust over the longitudinal data studied by Brown (1998). These are the first two empirical studies to examine and conclusively find relationships between entrepreneurial orientation and firm

performance. The findings suggest that entrepreneurial orientation may be a useful construct for predicting organizational performance.

Related Concepts

Two related concepts merit consideration. Bird, Hayward and Allen (1993) assessed academic-entrepreneurial value conflicts among university researchers in the top fifteen US research universities. Van de Ven (1993) presented a process of institutionalization as a method of building support for new technology ventures and for commercializing technology. Each is briefly discussed below.

Individual Values Conflict. Bird, Hayward and Allen (1993) developed and applied a scale to assess conflicts between academic values and commercialization values of individual researchers. Their scale revealed four factors: role conflicts, academic values, economic competition for resources and entrepreneurial values. Two major contributions of this work are: 1) identifying some of the perceived conflicts facing academic researchers, and 2) testing and validating the measurement items. Bird et al., (1993) delineated important academic and entrepreneurial values that confront many university researchers. For example, Bird et al., classified the following statements as items reflecting entrepreneurial values: "my work involves linking resources and opportunities to create new organizations" and "knowledge is best embodied in a finished marketable product or service (1993:67)." The Bird et al., (1993) measurement scale of individual values provides a basis for developing a

measure of organizational-level issues to compare academic-institutional and commercial values.

Infrastructure for Entrepreneurship. Van de Ven (1993) and Van de Ven and Garud (1989; 1994a & b) described and analyzed institutional support as an infrastructure that facilitates entrepreneurial activity. Rather than acting as a constraint to entrepreneurial activity, institutions create an infrastructure that support and encourage new business development. If institutions and resources are not available to support entrepreneurial activity, the technology commercialization process slows, according to Van de Ven (1993). However, the researchers acknowledged that institutional support can become a hindrance to commercialization or applications of later technological developments. Their framework includes institutional arrangements, resource endowments and proprietary functions working together to create an "industrial infrastructure for entrepreneurship (Van de Ven, 1993:215)." In a case study of "institutional and technical events in the development" (1994b:425) of the cochlear implant technology, Van de Ven and Garud provide evidence of institutional factors constraining as well as facilitating commercialization. Van de Ven and Garud (1994b) offer insights that can apply to the conflicting roles of university institutional support and constraints. For example, university licensing and patenting may have been designed with the intent to provide opportunities for technology commercialization, but due to the institutional processes, the procedures may ultimately constrain technology commercialization.

Summary of Entrepreneurial Orientation Research

DiMaggio and Powell (1991) suggested a connection between entrepreneurship and institutional change, but the connection has not been empirically tested to date. The construct of entrepreneurial orientation embodies the organizational characteristics of entrepreneurship. As such, it offers a means of evaluating the role of entrepreneurship within institutional environments. Organizational-level entrepreneurial orientation has been examined as a one-dimensional construct (Miller, 1983) and proposed as a multi-dimensional construct of five independent characteristics (Lumpkin & Dess, 1996). Risk-taking, innovativeness, competitive aggressiveness, autonomy and proactiveness comprise the multidimensional entrepreneurial orientation construct. As a unidimensional construct, entrepreneurial orientation has been associated with organizational performance, especially under conditions of environmental uncertainty and turbulence. Brown and Davidsson (1998) and Wiklund (1998) conclusively linked entrepreneurial orientation with firm performance in Sweden.

Entrepreneurial actions may facilitate change within institutional environments as suggested by DiMaggio and Powell (1991); however, institutional infrastructure in other cases may support entrepreneurial success (Van de Ven, 1993; Van de Ven and Garud, 1989; 1994a & b). The differing relationships between institutional environments and entrepreneurship described by DiMaggio and Powell (1991) and Van de Ven (1993) along with Van de Ven and Garud (1989 & 1994a&b) suggest that organizations could respond optimally to both institutional pressures and technical-commercial pressures. Rather than being opposing ends of a continuum, positive responses to both types of

pressure could benefit research units or technology transfer centers in complementary ways.

Technology Commercialization Performance

Performance measures used by research units and technology transfer centers vary widely from counting discoveries to counting dollars. The performance of a research university may be evaluated based on the level of its research funding, the number of members in honorary research academies, or the number of publications appearing in refereed journals. A technology transfer office may track the number of patent disclosures, patent applications filed, patents received, or the total dollars in royalties or licensing fees (Muir, 1993; Goslin & Trune, 1996; Trune & Goslin, 1998).

A number of recent publications provide relevant information about university technology transfer and commercialization measures. Autio and Laamanen (1995) reviewed and summarized research that examined university technology transfer or commercialization measures. Spann, Adams and Souder (1995) studied dimensions and constituents of technology transfer effectiveness in US Federal technology transfer programs. Goslin and Trune (1996) and Trune and Goslin (1998) ranked different types of university-affiliated research programs based on seven measures of performance. The Association of University Technology Managers (1997) Licensing Survey provides an extensive listing of performance measures used by university technology transfer centers, as well as data about the performance of participating universities. Muir (1993; 1997) proposed a composite index to evaluate the performance of university technology

licensing offices. Each of these studies provides insight about the variety of ways of measuring technology transfer and commercialization. The studies also share many common measures indicating a wide acceptance of indicators such as the number of patents, patent applications, the number of licenses and the dollar value of royalty agreements.

University Technology Transfer Measures

Autio and Laamanen (1995) developed a classification of technology transfer measures derived from an extensive review of research literature. The output of technology measures are classified into three major categories: research and technology outputs; commercial outputs and monetary and resource outputs. Autio and Laamanen's review covers studies reporting university-industry technology transfer, Federal agencies and laboratories transferring technology to industry, public energy utility to industry technology transfer and one study of US institutes to Japanese companies technology transfer. They categorized the measures used in twelve studies reported between 1987 and 1991 which used from two to 17 technology transfer mechanisms and measures. Measures from Autio and Laamanen (1995) can be classified to fit into the two categories of interest for the present study: institutional and technical-commercial performance indicators.

Federal Research Technology Commercialization

Spann, Adams and Souder (1995) empirically analyzed technology transfer metrics and created a taxonomy of the measures. Their study focused on Federal-government

research affiliates in the Southeastern United States. Spann, Adams and Souder ranked the measures according to respondent-perceived frequency of use and type of respondent. The types of respondents correspond with their relationship with the technology: *sponsor*, *developer*, and *adopter*. Notably absent from the list of transfer measures are *patents* and *patent disclosures* as indicators of technology transfer. Spann, Adams and Souder (1995) factor analyzed the types of transfer measures used in their sample. Two of the factors are applicable to the present study: 1) *transfer efforts*, and 2) *commercial successes*.

Annual Technology Licensing Survey

Each year the Association of University Technology Managers (AUTM) conducts a licensing survey of approximately 250 US and Canadian technology transfer offices. The most recently available survey report covers the fiscal years from 1991 through 1996. According to the AUTM Licensing survey summary (AUTM,1996), 85% of the top 100 research universities participated in the survey. Data reported include university-specific as well as aggregated information about technology transfer. Measures reported include: royalties; personnel; sponsored research expenditures categorized as industrial, governmental and private; licenses; legal fees; invention disclosures; patent applications filed; patents issued; and start-up companies. Most of the measures reported by AUTM fit into the technical-commercial category of the present study.

Muir (1993; 1997), Goslin and Trune (1996), and Trune and Goslin (1998) closely relate to the Association of University Technology Managers Survey data. Muir (1993)

developed an index of technology transfer office performance which closely follows categories of information collected for the AUTM survey. Goslin and Trune (1996) and Trune and Goslin (1998) used the AUTM survey data as their primary data source to evaluate technology commercialization performance of different types of research universities.

Muir (1993; 1997) used frequencies of the following measures to develop a technology transfer office (TTO) performance index: invention disclosures; evaluations conducted by potential licensees; income generating and industrial support agreements; patentability opinions, patent applications and issued patents; and institutional support for the TTO. The indicators are averaged to create an annual index of the performance of a technology transfer office. The indicators can be standardized based on the number of personnel, the size of the university and the budget of the office which allows comparisons among different sizes and types of university programs.

Goslin and Trune (1996) and Trune and Goslin (1998) analyzed the technology transfer activities reported by AUTM survey respondents. Their analyses ranked technology transfer performance of universities using the following categories: technological institute; medical school; university with medical school; and university without medical school. Data used to develop the average rankings included: faculty number; grants; royalties; licenses generating royalties; licenses active; disclosure received; licenses executed; and new patents filed. Goslin and Trune (1996) reported that universities without medical schools ranked number one in performance per million dollars in grant support, fourth overall, fourth using raw data, and fourth average

performance per one hundred faculty. Medical schools and universities with medical schools ranked number one and two overall as well as in average performance per one hundred faculty. The summary analyses reported by Goslin and Trune (1996) suggest that the type of university has direct bearing on the technology transfer performance of the university. Trune and Goslin (1998) examined profitability estimates and community impact estimates of university technology commercialization programs. Hospitals and research centers, followed by universities with medical schools then technological institutes, were the most profitable and generated the most community benefit according to their estimates. The results of this study also suggest that the type of university relates to the technology commercialization performance.

Summary of Performance Measures

Autio and Laamanen (1995) developed a most comprehensive analysis of technology transfer measures. Spann, Adams and Souder (1995) analyzed the usage of various technology transfer performance measures. The Association of University Technology Managers (AUTM) provides an annual report of some thirty different characteristics of performance of university technology offices. Muir (1993; 1997) proposed a single number index that would incorporate a variety of specific measures. Goslin and Trune (1996) and Trune and Goslin (1998) evaluated and ranked the technology transfer performance of universities participating in the AUTM survey. Many of the measures are common to all of the studies. These recent studies and reports provide a basis for determining a variety of performance measures for the present research.

Summary of Literature Review Chapter

The literature review chapter summarized relevant research and theoretical works pertaining to institutional theory, entrepreneurial orientation and technology transfer performance measures. Institutional concepts describe the environment of university technology transfer offices. Entrepreneurial orientation concepts suggest performance may be related to innovative responses to conflicting institutional and technical-commercial pressures confronting university technology transfer organizations. A variety of performance measures from prior research has been used to indicate various aspects of technology transfer performance.

Universities generally constitute highly institutionalized environments characterized by long-standing traditions, norms and values with many professionals represented in the work force. Institutionalized values influence the reward structures, the funding levels and types, and the goals of the sub-units operating within universities. Professional standards influence activities such as publishing research findings, teaching and scholarly technical presentations to share and disseminate knowledge. Institutional pressures often are associated with organizations copying the structures and processes of successful organizations in their field. Oliver (1991) argued that organizations respond in a variety of ways to institutional pressures, ranging from compliance to active resistance.

Technical-commercial characteristics describe another dimension of organizational environments. Technical-commercial characteristics include production and market exchange activities or goals. Technology transfer organizations face both institutional

and technical-commercial pressures. According to DiMaggio and Powell (1991) organizations might successfully respond to both institutional and technical pressures. Technology transfer centers could perhaps optimize their relationships with both institutional constituents, such as grant funding sources and the university, and technical-commercial constituents, such as corporate R&D partners. Organizations that find a way to optimize their relationships can benefit from 'the best of both worlds' to maintain multiple sources of support.

Entrepreneurial orientation may be found in organizations that successfully respond to both institutional and technical-commercial pressures. Innovativeness, risk-taking, competitive aggressiveness, proactiveness, and autonomy are characteristics of an entrepreneurial orientation (Covin & Slevin, 1991;Lumpkin & Dess, 1996; Miller, 1983; Naman & Slevin, 1993). Entrepreneurial orientation has been linked with successful business performance in large scale studies in Sweden (Brown & Davidsson, 1998; Wiklund, 1998). Entrepreneurial orientation might be found in any organization that creatively meets the challenges of both institutional and technical-commercial pressures. University technology transfer centers are prime examples of organizations that could successfully respond with an entrepreneurial orientation to pressures in complex environments. In addition, many hospitals, medical practices, community arts organizations, and social service organizations, might employ an entrepreneurial orientation to effectively meet the challenges in their complex, changing environments.

Technology transfer organizations and research units charged with technology commercialization measure performance in a variety of ways (Autio & Laamanen, 1995;

Spann, et al., 1995). Some measures fit best into an institutional category, while others clearly represent technical-commercial goal achievement. Tallying the research funding, the number of members in honorary societies, or the number of publications fit with the professional norms of academic institutions. Tracking royalty revenue and the number of licensing agreements fits into the technical-commercial or market exchange category of performance measures. Both types of measures reveal different types of performance and both are important to technology transfer organizations in universities.

The next section of the dissertation proposal, Chapter Three, presents the research model and the hypotheses. In Chapter Four, I describe the population, the variables, data collection techniques, as well as the statistical analyses methods. Chapter Five presents the results of the study and the analyses. In Chapter Six I interpret the findings in light of theoretical and practical contributions, then I conclude with suggestions for future research directions.

CHAPTER THREE

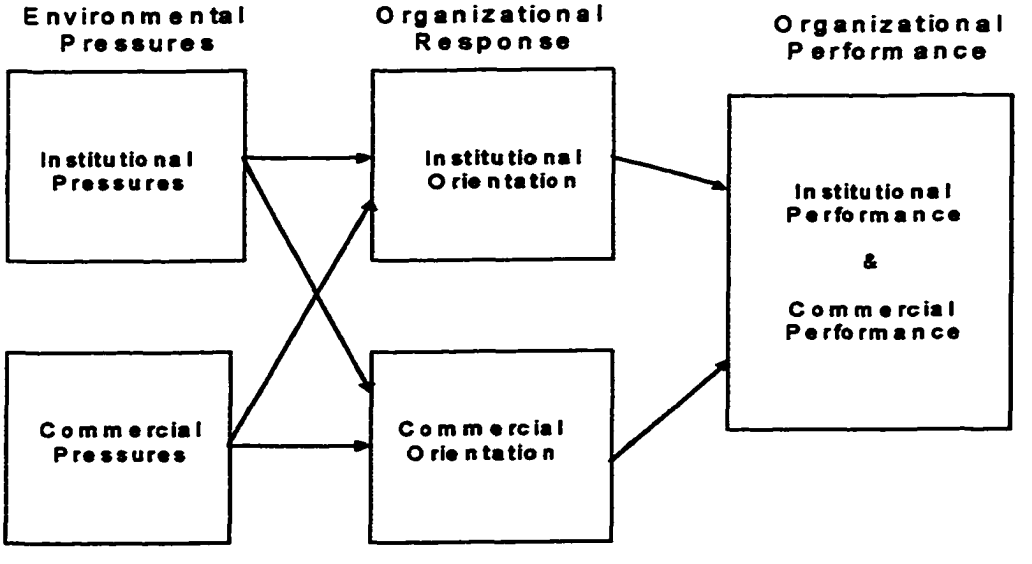
THE MODEL AND HYPOTHESES

In Chapter Three I describe the research model and list the hypotheses which I test in this dissertation study. I also briefly recap the prior research that provides bases for the model and the hypotheses.

The Model

The general research model includes three components: environmental pressures, organizational responses to the pressures; and organizational performance. Refer to Figure 2.

FIGURE 2
THE MODEL



In the model two types of environmental pressures, institutional pressures and commercial pressures, influence the organizational responses which are described as commercial orientation and institutional orientation. The model predicts that organizational orientation will influence the levels of institutional and commercial performance of the organization. The general model could be applied to many types of organizations operating in environments characterized by both institutional and technical-commercial pressures.

Following Dubin, the model suggests a number of "strategic propositions (1978:168)" from which testable hypotheses can be developed. The first two propositions derive from the institutional-technical dimensions of an environment as discussed by Scott (1987:126-142), Scott (1991) and Scott and Meyer (1991). Propositions 2 and 3 fit with Aldrich and Fiol's (1994) propositions suggesting that successful entrepreneurs must attend to both institutional and technical-commercial pressures in order for new industries to emerge. Proposition 3 also responds to Powell's (1991:190) criticism that institutional research in the past has often portrayed organizations as merely reacting with passive compliance to institutional pressures in their environment. Proposition 3, as part of commercial orientation, applies the construct of organizational-level entrepreneurial orientation (Covin & Slevin,1991; Lumpkin & Dess,1996; Miller, 1983; Naman & Slevin,1993) to assess the organization's response to the environment. Proposition 3 also applies concepts from Aldrich and Fiol (1994) to organizations confronted with conflicted environments. In addition,

Proposition 3 incorporates active organizational response to institutional pressures as theorized by Oliver (1991) and supported by Goodstein (1994) and Ingram and Simons (1995), among others.

Proposition 1. Organizations will respond to environmental pressures with responses that are isomorphic with most organizations facing the same type of pressure.

Proposition 2. Organizations attending to both institutional and technical-commercial pressures will derive benefit from both sets of constituents and demonstrate successful performance.

Proposition 3. Organizations that respond to combined pressures with a commercial orientation will demonstrate stronger commercialization performance than organizations that respond using institutional patterns.

Hypotheses

The research model (Figure 2) suggests a number of hypotheses about the relationships among institutional and technical-commercial pressures, institutional and commercial orientation and performance as applied to university technology transfer offices. Based on the previous discussion of the components of the model and a review of related research literature, the following are the hypotheses which I tested for the dissertation research in the context of university technology transfer offices.

Environmental Pressures and Organizational Responses

The first question I try to answer is: Do organizations respond to environmental pressures in ways predicted by institutional theory? That is, do they respond with orientations similar to the institutional demands of the university and does commercial orientation fit as a response to institutional and technical-commercial pressures? Hypotheses 1-3 address this question.

The foundations for Hypotheses 1 through 3 are based on institutional perspectives of organizations, as discussed at length in Chapter Two and reviewed here. The nature and extent of institutional and technical-commercial pressures were expected to affect an organization's response to those pressures. The responses to the pressures were evaluated as an organization's orientation or focus of its activities. Organizations were expected to respond to pressures with predominantly institutional or commercial orientations, or with a mixed (combined) orientation.

Recent research has examined a variety of issues related to institutional pressures and organizational responses. Organizations respond to institutional pressures in a variety of ways ranging from compliance to defiance (Edelman, 1992; Goodstein, 1994; Ingram & Simons, 1994; Oliver, 1991). Institutional pressures are related to support as well as constraints for organizational activities (Aldrich & Fiol, 1994; Baum & Oliver, 1991; Van de Ven & Garud, 1994). Conflicting institutional pressures as well as pressures from both institutional and technical-commercial sources affect organizational processes, structure and performance (e.g., D'Aunno, Sutton & Price, 1991; Slack &

Hinings, 1994; Lynn & Rao, 1995; Shanks-Meile & Dobratz, 1995; Edward, Ezzamel, Robson, & Taylor, 1995; Pettersen, 1995; Elsbach, 1994).

Commercial orientation (or its entrepreneurial component) has been reported in organizations that face both institutional and technical-commercial pressures. For example, in a case study, Perlmutter and Cnaan (1995) described the use of entrepreneurial strategies to counteract declining funding from city agencies and expand services of a public sector organization that operated in a highly institutionalized setting. Van de Ven and Garud (1994) described the institutional and commercial pressures as well as entrepreneurial activities in the development of a new biomedical device industry. Organizations responding to environmental pressures with an entrepreneurial orientation may be found to successfully cope with varied environmental pressures and exhibit strong technology transfer performance.

The following hypotheses are based on the model, the literature review, and the propositions presented earlier. As a group of related hypotheses, H1-H3 first assess the pressures facing organizations and second, assess the organizational responses to the environmental pressures.

H1: Technology transfer organizations faced with predominantly institutional pressures will exhibit a stronger institutional orientation than other organizations.

H1a: High institutional orientation, indicated by scores on self-reported *importance* of institutional performance evaluation measures; organizational values as evidenced by questionnaire items adapted from Bird, et al., (1993), will be positively related to environments having

strong institutional pressures, indicated by high institutional research expenditure *proportion*; high institutional rating on evaluation of intellectual property policy; and high institutional rating of mission statement.

H1b: Organizations in environments characterized by high institutional pressures will exhibit stronger institutional orientation when compared with organizations in environments characterized by lower institutional pressure.

H2: Technology transfer centers faced with predominantly technical-commercial pressures will exhibit a stronger entrepreneurial orientation than other organizations.

H2a: High technical-commercial and entrepreneurial orientation, indicated by self-reported *importance* of technical-commercial performance evaluation measures and scores on the self-report measures of entrepreneurial orientation (Covin & Slevin, 1991; Lumpkin & Dess, 1996; Miller, 1983), will be positively related to environments having strong technical commercial pressures, indicated by high industrial research expenditure *proportion*; high technical-commercial rating of intellectual property policy; and high technical-commercial rating of mission statement.

H2b: Organizations in environments characterized by high technical commercial pressures will exhibit stronger entrepreneurial orientation when compared with organizations in environments characterized by lower technical commercial pressures.

H3: Technology transfer centers faced with both strong institutional and strong technical-commercial pressures will exhibit high levels of both institutional and commercial orientations to take advantage of support and benefits from both aspects of their environments.

H3a: High levels of both institutional orientation and commercial orientation (indicated by scores on self-reported *importance* of institutional and

technical-commercial performance evaluation measures; organizational-level institutional values as evidenced by questionnaire items adapted from Bird, et al., 1993; and by self-report measures of entrepreneurial orientation (Covin & Slevin, 1991; Lumpkin & Dess, 1996; Miller, 1983), will be positively related to environments having strong institutional and strong technical-commercial pressures (indicated by high institutional research *proportion*, high industrial research expenditure proportion, and high institutional and technical-commercial ratings on mission statements and intellectual property policies).

Organizational Responses and Performance

The second question I seek to answer is: Do the orientations of the organization affect technology transfer and commercialization performance?

Recent research supports the notion that organizational responses to pressures in the environment affect the performance outcomes of organizations (Gupta, Dirsmith & Fogarty, 1994; Judge & Zeithmal, 1992). Multidimensional responses that accommodate both institutional and technical-commercial pressures may contribute to an organization's successful performance (Elsbach, 1994; Pettersen, 1995; Scott, 1987; Scott & Myer, 1991). Commercial performance measures have been found to be associated with entrepreneurial orientation (one component of commercial orientation) in recent large scale and longitudinal studies in Sweden (Brown & Davidsson, 1998; Wiklund, 1998). Performance of organizations will be described as predominantly institutional, predominantly technical-commercial or mixed institutional and technical-

commercial, using indicators derived from Autio and Laamanen (1994), Spann, Adams, and Souder (1994) and the AUTM Full Report Survey (1997).

The following are hypotheses describing the predicted relationships between organizational responses to institutional and technical-commercial pressures and performance.

H4: Organizations revealing a strong institutional orientation will exhibit stronger institutional-type performance.

H4a: Technology transfer centers revealing strong institutional orientation are predicted to exhibit stronger institutional-type performance as indicated by higher *levels* of Federal and non-industrial research funding and a higher number of members in national honorary academies when compared with organizations revealing entrepreneurial or mixed orientations.

H5: Organizations revealing a strong commercial orientation will exhibit stronger commercialization performance than organizations exhibiting predominantly institutional orientation.

H5a: Technology transfer centers revealing higher levels of commercial orientation will have more licenses granted, start-up companies, patents, and higher royalties and license fees, than organizations exhibiting predominantly institutional orientation.

H6: Organizations revealing both strong institutional and strong commercial orientations will be more successful in technology commercialization performance measures than organizations showing only strong commercial orientations or only strong institutional orientations because they capitalize on their relationships with both institutional and technical-commercial stakeholders.

H6a: Technology transfer centers revealing *both* strong institutional and strong commercial orientations will have higher royalties/revenues, more start-up companies, more patents, and more licenses granted than technology transfer centers exhibiting predominantly commercial or institutional orientation.

Summary of Hypotheses

The hypotheses suggest relationships between types of institutional or technical-commercial pressures and organizational orientations within those environments. The hypotheses also predict relationships between organizational orientations and the organization's performance. The hypotheses derive from the model and two established research streams. Institutional researchers suggest that organizations respond in a variety of ways to institutional-type pressures in their environment. Entrepreneurship researchers have assessed firm-level entrepreneurial behavior and its relationship to performance using the construct of entrepreneurial orientation. Examining entrepreneurship within institutional environments may provide an understanding of some differences in performance among organizations operating within institutional settings.

Chapter Four presents the research methods. Chapter Four first a discusses the population and data collection methods. Next I discuss the variables. Finally, I discuss the methods used to analyze the data and test the hypotheses.

CHAPTER FOUR

RESEARCH METHODS

Chapter four presents the research methods. Chapter Four is organized into six main sections: 1) Population and Sample; 2) Independent Variables; 3) Control Variables; 4) Dependent Variables; 5) Analyses Methods; 6) Summary of Research Methods. For each section related to variables, I describe the operational measures, the data collection methods, and data sources. I also report measurement characteristics where appropriate.

Population and Sample

In this section, I describe the population, the sample and the survey data collection methods. I include the survey data collection in this section because survey response defines the sample. To establish that the sample represents the population, I compare the sample to other technology transfer offices.

Technology transfer organizations affiliated with US universities comprise the population for this study. There are three reasons for selecting the population of university technology transfer offices. First, universities can be characterized as highly institutionalized environments. Second, the goals and purposes for the existence of technology commercialization offices suggest the presence of technical-commercial pressures. Third, operating in an entrepreneurial manner may allow the organization to execute activities necessary to successfully commercialize university research

technologies. For these three reasons, technology commercialization organizations are likely to face pressures exerted by institutional demands and entrepreneurial goals. Because of the complex demands, university-affiliated technology transfer offices operate in combined institutional and technical-commercial environments. The population for the dissertation research includes all US university technology transfer offices, centers or job functions having responsibility for commercializing the results of university research.

My sample consists of 77 university technology transfer offices that completed the technology commercialization survey. The sample was representative of the pool of accessible technology transfer offices as determined by frequency counts and ANOVA analyses described in the following sections. Fifty-three (68.8%) of the responding offices also reported data in the Fiscal Year 1996 Association of University Technology Transfer Mangers Annual Survey (AUTM, 1997).

Association of University Technology Managers

In 1997, 262 US universities or university campuses were represented by at least one person as a member in the Association of University Technology Managers (AUTM, 1997). AUTM is one of several organizations in the US with members involved in technology commercialization or licensing. It is the only organization emphasizing university technology transfer in the US. AUTM members are "employee[s] of an institution of higher education or a teaching hospital, who [are] engaged either directly or indirectly in activities relating to the administration of the institution's intellectual property..." (AUTM Bylaws, Effective 1994).

AUTM Licensing Survey Respondents

Universities reporting results in AUTM's annual licensing surveys were the primary target subjects because I planned to use data from the licensing surveys for several dependent variables. For the two most recent AUTM licensing surveys, 127 and 128 universities reported data in the AUTM Licensing Surveys for Fiscal Year 1995 and 1996, respectively. However, I wanted to be able to compare study subjects to non-subjects. Therefore, I collected data from as many university technology transfer offices as possible.

Identifying and Locating Potential Study Subjects

I located 245 university technology transfer offices or functions. I was able to collect at least some data for 189 of the 245 university technology transfer offices. I followed the organization's structural convention established by the university's report to the AUTM Licensing Survey. That is, I included only main university campuses unless other campuses were separately reported in the AUTM Annual Licensing Survey reports.

The 1997 Membership Directory of the Association of University Technology Managers (AUTM, 1997) served as the starting point for collecting contact information. I applied the following decision rules to select names for the database when searching the AUTM membership directory:

- Type of Organization: US university, medical school affiliated with a US university, US medical university.
- Title: dean, director, vice president, other title indicating head of organization, or the only person listed for a qualifying organization.

I also searched the AUTM web site links to university technology transfer offices for missing address data, especially e-mail addresses (AUTM, 1998). Finally, I used the Yahoo Search Engine (YAHOO!, 1998) to locate e-mail addresses or other missing information for those university technology transfer offices which were not linked to the AUTM web site.

Table 1 summarizes selected characteristics of the technology transfer universities. I used research funding data from the National Science Foundation (NSF,1998) unless it was not available in which case I used the research funding sums from the AUTM Licensing Survey Reports for FY1991-1996 (AUTM, 1997). Peterson's 1997 Guide to Graduate and Professional Programs was the data source for the type of university, the number of graduate students, and number of graduate faculty (Peterson's, 1997).

The universities are predominantly public (67.7%). The technology transfer offices reported founding dates from 1925 through 1997 (AUTM, 1997). Most are classified as Research I universities (58%) by Carnegie Foundation for the Advancement of Teaching as shown in refer to Table 2 (Carnegie Foundation, 1998). Slightly more than 53% of the universities have medical schools and universities without medical schools comprise the next largest group representing 35% of the technology transfer universities (see Table 3).

TABLE 1
Selected Characteristics of Technology Transfer Universities

Characteristic	N	Minimum	Maximum	Mean
Research Funding[a]				
Six-Year Total ($000s)	153[b]	10,691	8,514,122	748,084
	79[c]	11,161	8,514,122	785,555
Year TTO[d] Formed	121	1925	1997	1985
	52	1925	1997	1985
Size-Graduate Students	120	760	125,838	20,491
	55	1075	125,838	22,258
Size-Graduate Faculty	118	102	10,865	1,376
	53	103	10,865	1,499
Total NAS[e]	167	0	443	19
	75	0	443	22
Public Universities	84	—	—	—
	42			
Private Universities/Colleges	40	—	—	—
	15			

[a] Sum of 1991 - 1996 Research Funding, National Science Foundation (1998)
[b] Technology Transfer Universities in Database
[c] Technology Transfer Offices Responding to the Survey
[d] Technology Transfer Office
[e] Sum of the number of members in any of the National Academy of Sciences groups (National Academy of Science; National Academy of Engineers; Institute of Medicine).

Sample: Survey Respondents

The final sample of 77 university technology transfer offices is defined by having completed the entire technology transfer survey. There were no significant differences between the 77 respondents and 76 non-respondents in the database. Note that 79 university technology transfer offices completed at least fourteen items (one sub-scale) in the survey, thus in some tables the number of respondents total 79 because I used pairwise exclusion to maximize the data available for comparison. Tables 1 through 3 also present frequencies comparing respondents to total technology transfer universities in the database. All frequencies are roughly equal for type of university (Table 3),

Carnegie Research Classification (Table 2), and for selected descriptive characteristics (Table 1).

TABLE 2
Carnegie Classifications of Technology Transfer Universities

Carnegie Classification[a]	Number	Percent
Research I	71[b]	58%
	33[c]	58%
Research II	19	15%
	8	14%
Doctoral I	6	5%
	2	3.5%
Doctoral II	11	9%
	6	10.5%
Master I	4	3%
	2	3.5%
Master II	0	—
	0	
Speicalized - Medical	12	10%
	6	10.5%
Total	123	100%
	57	

[a] Source: Carnegie Foundation for the Advancement of Teaching, 1998
[b] Technology Transfer Universities in Database
[c] Technology Transfer Offices Responding to the Survey

To test the representativeness of the sample, I conducted ANOVAs comparing respondents to non-respondents using available characteristics of the universities and performance measures. There were no significant differences in the characteristics of faculty size, Carnegie classification, university type, public or private status, or in the year of founding of the technology transfer office, as shown in Table 4.

TABLE 3

Type of University

Type of University	Number	Percent
Technical Institute (2) [a]	5 [b]	4.1
	2 [c]	3.6
University -- No Medical School (3)	43	35.2
	20	35.7
University -- With Medical School (4)	65	53.3
	32	57.1
Medical University or School (5)	9	7.4
	2	3.6
Total	122	100
	56	100

[a] Categorical code for each type of university.
[b] Technology Transfer Universities in Database
[c] Technology Transfer Offices Responding to the Survey

There were no significant performance differences between the respondents and non-respondents. Table 5 shows the ANOVA results testing the respondents versus non-respondents in terms of the number of patents awarded, royalties and licensing income, total research funding, institutional research funding, and industrial research funding. In addition, there were no differences in the size-controlled number of patents or institutional research funding measures, also shown in Table 5.

Table 4

Characteristics
Comparison between Survey Respondents and Non-Respondents

Characteristic	Survey	N	ANOVA				
				Sum of Squares	df	Mean Square	F	Sig.
Faculty Size Log	NR[a]	66	Between	.06	1	.06	.10	.76
	SR[b]	51	Within	70.70	115	.62		
	Total	117	Total	70.76	116			
Carnegie Classification	NR	68	Between	.13	1	.13	.03	.86
	SR	55	Within	508.13	121	4.20		
	Total	123	Total	508.26	122			
University Type	NR	68	Between	.16	1	.16	.25	.62
	SR	55	Within	75.70	121	.63		
	Total	123	Total	75.85	122			
Public or Private University	NR	68	Between	.50	1	.50	2.69	.14
	SR	55	Within	26.50	121	.22		
	Total	123	Total	26.99	122			
Year TTO[c] Founded	NR	68	Between	14.45	1	14.45	.10	.75
	SR	52	Within	16897.00	118	143.20		
	Total	120	Total	16911.59	119			

[a] Non-respondents
[b] Survey respondents
[c] Technology transfer organization

Pre-Test. I conducted a pre-test of the survey with ten subjects to test the procedures of the survey and to clarify wording of modified or new items. Thirty-seven of the 52 construct-related items had had been previously used although I modified some items to better fit the subject pool of technology transfer offices. I created 15 original content items (items measuring specific constructs) and eight items to assess stability of the organization's performance and funding levels. Following Dillman (1978) I classified the pre-test participants as colleagues (n=6), potential users of the

results (n=2), and potential subjects (n=2). The pre-test subjects provided feedback in terms of the ease of use of the on-line survey, ease of access, the clarity of the items, the legibility of the internet web site on various systems, and the length of time required to complete the survey. I made modifications based on the pre-test subjects' suggestions.

TABLE 5
Selected Performance Measures
Comparison Between Survey Respondents and Non-Respondents

			ANOVA					
Measure	Survey	N		Sum of Squares	df	Mean Square	F	Sig.
Patents Awarded Log	NR[a]	69	Between	.53	1	.53	.50	.48
	SR[b]	53	Within	128.51	120	1.07		
	Total	122	Total	129.04	121			
Royalties & Licensing Income Log	NR	73	Between	2.70	1	2.70	.68	.42
	SR	55	Within	518.18	126	4.11		
	Total	128	Total	520.89	127			
Total Research Funding Log	NR	76	Between	.13	1	.13	.09	.77
	SR	77	Within	215.95	151	1.43		
	Total	153	Total	216.08	152			
Industrial Research $ Proportion[c]	NR	76	Between	.003	1	.003	.57	.45
	SR	77	Within	.66	151	.004		
	Total	153	Total	.67	152			
NAS Total Members Log	NR	70	Between	.54	1	.54	.26	.61
	SR	61	Within	267.10	129	2.07		
	Total	131	Total	267.64	130			
Patents per 1000 Faculty Log	NR	60	Between	.04	1	.04	.04	.83
	SR	48	Within	87.78	106	.83		
	Total	108	Total	87.81	107			
Institutional RF per Faculty Log	NR	59	Between	.02	1	.02	.03	.88
	SR	51	Within	90.17	108	.84		
	Total	110	Total	90.19	109			

[a] Non-respondent to survey.
[b] Survey respondent.
[c] Transformed using arcsine transformation (Cohen & Cohen, 1983).

Solicitation & Collection of Survey Responses. I distributed the survey via an internet web site which required a researcher-provided password for access. I solicited participation by sending a series of three e-mail messages and one regular mail letter addressed by name to the head of the technology transfer office. The survey could be completed entirely on-line. I also offered paper copies to be delivered via regular mail, fax or e-mail. The survey contains 60 items using a five point Likert-type response choice plus 17 fill-in-the-blank items. It required approximately 25 to 35 minutes to complete on-line.

Respondents submitted their completed or partial surveys directly to a database stored on the server computer at Globalport, Inc., in League City, Texas. Globalport is the company that designed and hosted the survey web site. The survey responses were stored on the Globaport computer and periodically sent via e-mail as a Microsoft Access database attachment to the researcher in Santiago, Chile. See Appendix A for a copy of the survey. Table 6 lists the descriptive statistics for the survey items.

Table 6

Survey Items: Descriptive Statistics

Table 6 continues on the following page.

Item	N		Mean	Standard Deviation	Skewness
	Valid Statistic	Missing Statistic	Statistic	Statistic	Statistic
ID	84	–	–	–	–
Q1	84	0	4.17	1.12	-1.505
Q2	83	1	3.65	1.23	-0.975
Q3	83	1	3.43	1.13	-0.405
Q4	82	2	3.23	1.30	-0.341
Q5	82	2	3.55	1.17	-0.431
Q6	82	2	3.82	0.96	-0.919
Q7	82	2	4.01	1.08	-1.161
Q8	82	2	3.39	1.11	-0.384

Continuation of Table 6

Q9	82	2	2.88	1.14	-0.013
Q10	82	2	3.39	1.09	-0.244
Q11	79	5	3.04	1.23	-0.116
Q12	79	5	3.49	1.13	-0.475
Q13	79	5	3.23	1.17	-0.310
Q14	79	5	2.46	1.06	0.318
Q15	78	6	2.29	1.11	0.331
Q16	78	6	2.29	0.91	-0.207
Q17	78	6	2.94	1.20	-0.060
Q18	78	6	2.29	1.07	0.358
Q19	78	6	2.21	1.06	0.579
Q20	78	6	3.00	1.06	-0.136
Q21	78	6	3.56	1.09	-0.913
Q22	78	6	3.19	1.16	-0.387
Q23	78	6	2.94	1.14	-0.353
Q24	78	6	2.83	1.11	-0.246
Q25	78	6	3.53	1.08	-0.675
Q26	78	6	3.42	1.08	-0.792
Q27	78	6	3.86	1.12	-1.344
Q28	78	6	3.88	1.03	-1.074
Q29	78	6	4.00	1.01	-1.412
Q30	78	6	3.46	1.28	-0.547
Q31	78	6	4.06	0.92	-0.856
Q32	78	6	3.54	1.18	-0.726
Q33	78	6	2.73	1.31	-0.343
Q34	78	6	3.14	1.60	-0.411
Q35	78	6	4.00	1.37	-1.470
Q36	78	6	3.03	1.19	-0.660
Q37	78	6	3.17	1.42	-0.555
Q38	78	6	3.58	1.16	-1.122
Q39	78	6	3.21	1.48	-0.536
Q40	77	7	3.94	1.25	-1.536
Q41	77	7	3.55	1.29	-1.152
Q42	77	7	3.84	1.30	-1.369
Q43	77	7	4.05	1.23	-1.825
Q44	77	7	2.55	1.18	0.412
Q45	77	7	3.45	1.36	-0.911
Q46	77	7	2.52	1.15	0.241
Q47	77	7	3.97	1.14	-1.444
Q48	77	7	4.00	1.20	-1.815
Q49	77	7	2.90	1.29	-0.439
Q50	77	7	4.08	1.20	-1.793
Q51	77	7	2.47	1.06	-0.015
Q52	77	7	3.61	1.19	-0.960
Q53	77	7	3.75	1.05	-1.843
Q54	77	7	3.58	1.16	-1.500
Q55	77	7	3.88	0.96	-1.780
Q56	77	7	2.99	1.32	-1.306
Q57	77	7	3.22	1.18	-1.588
Q58	77	7	2.90	1.39	-1.133
Q59	77	7	3.09	1.52	-1.029
Q60	77	7	2.83	1.58	-0.693

Measurement statistics for each scale within the survey are presented in sections discussing specific variables and measures. The three major scales in the survey are: 1) entrepreneurial orientation (Covin & Slevin, 1991; Lumpkin & Dess, 1996; Miller, 1983; Naman & Slevin, 1993); 2) academic and commercial values (Bird, Hayward, & Allen, 1993); and 3) importance of academic and commercial performance measures (based on Autio & Laamanen, 1995; Spann, Adams & Souder, 1995).

Appendix B contains copies of five messages I attempted to send requesting participation. I sent Request 1 via e-mail between December 1-3, 1997 to 211 technology transfer offices. Request 2, also via e-mail, was intended to go to the same 211 offices, however, a technical difficulty resulted in only some of the messages being sent. I was not able to determine the number delivered. Request 1 and 2 resulted in 29 usable surveys with six messages not deliverable.

I waited until after the year-end holidays and after the start of school to send Request 3 (February 10-12, 1998). Request 3, sent via e-mail , yielded an additional 23 usable surveys. On March 31, 1998 I sent 84 regular US mail service letters (Request 4) requesting participation, advising of the web site, and offering a paper copy of the survey. I sent the letters to the 84 non-respondent university technology transfer offices for which data was also available in the AUTM Licensing Survey Reports. I attempted to send Request 5 via posting on a technology transfer e-mail discussion list (TECHNO-L), however the message was never posted as it was deemed inappropriate for the forum. In sum, with three delivered requests, I received 77 completed surveys plus seven partial surveys.

Response Rate. The various requests for participation yielded a net response rate of 41.2 percent. This response rate compares with AUTM's annual licensing survey response rate of 58% (AUTM, 1997). I calculated the overall response rate using the base of 211 technology transfer offices identified with addresses in my database. I subtracted the seven non-deliverable addresses to reach a net of 204 university technology transfer offices. A total of 84 university technology transfer offices responded as indicated by registering at the web site with their unique password and completing at least one item, or by sending a completed survey via mail.

Summary of Population and Sample

The population for this research consists of all university-affiliated technology transfer offices in the US. The sample is defined by response to a survey requesting organizational-level data about the technology transfer office practices and norms. A total of 77 university technology transfer offices completed the survey between December 2, 1997 and May 5, 1998. The overall response rate was 41.2% of the accessible university technology transfer offices.

I concluded that the sample was representative of the population of university technology transfer offices. ANOVA tests revealed no significant differences between respondents (n=77) and non-respondents (n=79) in descriptive characteristics such as size, age of technology transfer office, type of university, or Carnegie classification. I also found no differences in performance measures of universities with technology licensing offices. I compared respondents and non-respondents based on five different performance measures: the number of patents, total research funding, industrial

research funding proportion; memberships in the National Academies of Science, and royalties and licensing income.

The next section presents the independent variables. As with the present section, I describe the data collection methods and the characteristics of the measures.

Independent Variables

I used two broad categories of independent variables. The first set of independent variables I categorize as environmental pressures: institutional pressures and technical-commercial pressures. The second category of independent variables are the organizational response to environmental pressures. I evaluated organizational response as organizational orientation which includes: institutional orientation, commercial orientation or some combination of the two. I describe the independent variables in two sections: 2.1. Environmental Pressures and, 2.2. Organizational Response. For each type of independent variable I describe the construct, its theoretical foundations, the operational measure, the characteristics of the measure, the source of the data, and the data collection methods. Refer to Figure 3 for an overview of the model, the variables and the measures used in this research.

Environmental Pressures

In this section, I first present an overview of the theoretical foundations of environmental pressures, as used in this research. Next, I describe each variable, its operational measures, measurement characteristics and data collection methods. I

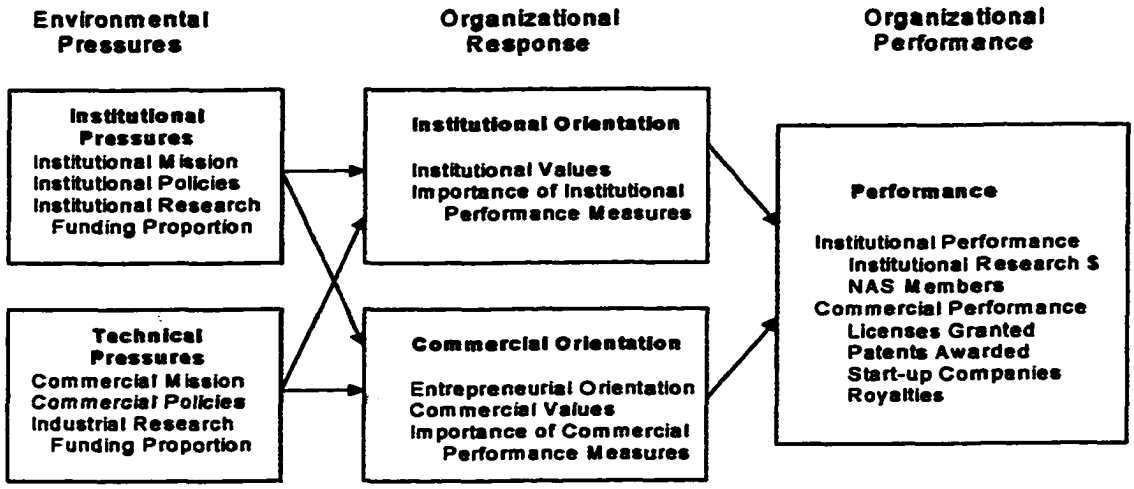
conclude this section by discussing the classification of technology transfer offices into environmental pressure groups.

Institutional pressures derive from sources such as rules, policies, procedures and government regulations. Institutional pressures also are embedded in values, norms and taken-for-granted patterns and practices. Sources of financial and personnel resources as well as legitimacy support also reveal institutional pressure. Technical-commercial pressures are those associated with market exchange, producing a product or service, or effectively and efficiently achieving goals. Institutional pressures and technical-commercial pressures can co-exist and are not ends of a continuum (Scott 1987;1991; Scott & Meyer,1991).

I used three measures to assess institutional pressures and technical-commercial environmental pressures. I evaluated mission statements, intellectual property (IP) policies and industrial research funding proportion to measure and classify the environmental pressures confronting technology transfer offices. I collected mission statements and intellectual property policies from world-wide web sites of technology transfer offices affiliated with US universities. To calculate the industrial research funding proportion variable, I used the National Science Foundation Science & Engineering Indicators (1996) research funding data for the years 1987 through 1996. I coded all data into a Microsoft Access97 database. I keyed all data files to a unique identification number for each university technology transfer office.

FIGURE 3

Constructs and Measures



After coding all of the data, I used cluster analysis to classify the technology transfer offices based on their institutional and commercial scores of their mission statements, intellectual property policies, and industrial research funding proportion. The technology transfer offices could be classified as having institutional pressures; commercial pressures; mixed pressures; or as not having data posted on the Internet. I used the environmental pressure classification as a variable to test whether the environmental pressures were associated with different types of organizational orientation.

Mission Statements. The mission of an organization reveals its publicly intended strategy. By explicitly stating the planned direction of the organization's activities, the charter or mission reveals institutional and/or technical-commercial pressures facing organizations (D'Aunno, Sutton, & Price, 1991). Missions offer a glimpse of the norms or values of an organization (e.g., Elsbach & Sutton, 1992; Elsbach, 1994).

To collect mission statements I searched the world-wide web for university technology transfer or commercialization offices. I started with the web site links of the Association of University Technology Managers (AUTM, 1998). I also created a database file of the names of all university members of AUTM then searched for web sites affiliated with the members' universities. In addition, I used the YAHOO search engine (YAHOO!, 1998) to locate university web sites and the affiliated technology transfer offices. See Appendix C for a listing of the Internet world wide web URLs accessed to collect mission statements, intellectual property policies and addresses.

I collected and analyzed mission statements or statements of purpose from 158 university technology transfer organizations. To code the mission statement I looked for specific wording in the document. I coded each phrase as yes or no indicating its presence or absence in the mission statement. D'Aunno, Sutton and Price (1991) used similar coding to classify environmental pressures in drug abuse treatment programs.

Operational Measure of Mission Statement. The mission statement could be both institutional and commercial. Each phrase could be coded yes or no for a total of four points for an institutional mission statement and four points for a commercial

mission statement. I looked for the following words in each mission statement. I defined these phrases *a priori* in the dissertation proposal.

Institutional Statements

- Benefits to university
- Educational and student benefits
- Acquiring research funding
- Avoid conflict of interest

Commercial Statements

- Patent protection
- Sales, commercialization, technology transfer
- Inventor participation
- Industry relationships

Next I discuss the evaluation of intellectual property policies, the second indicator of environmental pressures.

Intellectual Property Policies. Intellectual property policies provide an indication of the types of pressures in an organization's environment (e.g., Oliver, 1991; Slack & Hinings, 1994; D'Aunno, Sutton & Price, 1991). Policies differ from practices. Policies refer to the guidelines or stated procedures that an organization is supposed to follow. Policies are normative. Policies are part of the pressures of the environment. In contrast, practices refer to what the organization does, that is the actual behavior of the organization, or how it executes the policies. Practices may or may not conform with policies. In this study, practices reveal the organization's response to policies in its environment.

To collect intellectual property policies I searched the world-wide web for US universities. Refer to Appendix C for a listing of WWW sites accessed to collect mission statements, intellectual property policies and addresses. I started with the web site links of the Association of University Technology Managers (AUTM, 1998). I also created a database file of the names of all university members of AUTM then searched for web sites affiliated with the members' universities. In addition, I used the Yahoo search engine to locate university web sites (YAHOO!, 1998). I searched university web sites using a variety of key word searches and departmental searches. Policies were often linked to WWW sites of university offices such as offices of sponsored research, technology transfer, administration or vice president of academic affairs. I also used key word searches when office links failed to link to university policies. Some of the key word searches I used were: patent policies, intellectual property policies, faculty manuals, faculty handbooks, and university policies.

I collected and analyzed intellectual property policies from 159 universities. To code the policy I looked for specific wording in the document. I coded each phrase as yes or no indicating its presence or absence in the intellectual property policy. D'Aunno, Sutton and Price (1991) used similar coding to classify environmental pressures in drug abuse treatment programs.

Operational Measures of the Intellectual Property (IP) Policies. The IP policy could be both institutional and commercial. Each phrase could be coded yes or no for a total of five points for an institutional policy and five points for a commercial policy. I defined the phrases *a priori* in the dissertation proposal with the exception of "public

interest" and "royalty to inventor defined." Early in the process of reviewing IP policies I decided to add the two phrases. However, the two new phrases did not affect the analysis because nearly all universities used both phrases. I looked for the following words in each intellectual property policy.

Institutional Policy Statements

- Patent policies favor university (university owns patent)
- Basic research over commercialization
- Tenure is a stated goal
- Scholarly publications are key
- Public interest

Commercial Policy Statements

- Include inventor or inventor's organization in ownership
- Quick patent review process (< 90 days)
- New business guidelines
- Reward industry affiliations or commercialization
- Royalty to inventor defined

The next section describes the operational measure and data collection procedure for industrial research funding proportion. Industrial research funding proportion is the third and last indicator of environmental pressure.

Industrial Research Funding Proportion. I measured resources support using the proportion of research funding from industrial sources and the proportion of research funding from institutional sources. In statistical analyses and calculations I used only the industrial proportion because it would be redundant to use both

proportions. I transformed the research funding proportion using logit transformation to achieve a more normal distribution (Cohen & Cohen, 1983).

In research testing various aspects of institutional theory, resource dependence (Pfeffer & Salancik 1978) has been used as an indicator of pressures on organizations. Oliver (1991) suggested that institutional sources of funding and dependence on those sources would be an indicator of pressures on an organization. Slack and Hinings (1994), D'Aunno, Sutton and Price (1991), and Greening and Gray (1994) employed measures of sources of financial resources to indicate the types of pressures facing organizations. Covaleski and Dirsmith (1988) associated resources support with institutional coercion and control. Oliver (1991) suggested using budget proportions to indicate pressures on an organization. Both the number of different sources and the concentration of resources from each source have been be used to indicate pressures on an organization. Following Oliver (1991) I used the funding proportion as one part of the measure of environmental pressure.

Industrial Research Expenditure Proportion Data. Industrial research expenditures are defined as: "...expenditures made by the institution in support of its research activities funded by corporations, but not expenditures supported by other sources such as foundations and other nonprofit organizations (AUTM, 1995:13)." Industrial research expenditures as a proportion of total research expenditures provide an indicator of technical-commercial pressures.

I downloaded university research funding data for the years 1987 through 1996 from the National Science Foundation Science & Engineering Indicators (National

Science Foundation,1998) report posted on the world-wide web. I used the Carnegie Classification as the sort key to capture research funding details for 238 US universities. The report provides access to research funding data from more than 3,000 US colleges and universities. The categories of research funding are listed below:

- Research & development total expenditures
- Federal funding sources
- State and local sources
- Industrial sources
- University's own sources
- Other

To calculate the industrial research funding proportion first I created a six-year sum of the total R&D funding and a six-year sum of the industrial funding. I summed the data to smooth any funding levels that seemed unusual. (Clearly, I could have also used the average.) I used the six-year time period to match data available from the AUTM Licensing Surveys. In the event of missing data I then could use AUTM data to substitute for the missing NFS data. Using the six-year sums, I divided the industrial sources amount by the total research and development amount. The industrial research funding proportions ranged from 0.00 to .40 for the 150 universities for which I also had database entries coded for mission statements and intellectual property policies.

In the next section I discuss the procedure for creating the environmental pressure group variable. The environmental pressure groups were necessary to test the hypotheses and the model.

Environmental Pressures Groups. The technology transfer offices had to be classified into environmental pressure groups in order to test the hypotheses. The

environmental pressure groups were the final variable needed to test the hypotheses related to environmental pressures. I classified the technology transfer offices into groups based on similarities in the environmental pressures measured by mission statements, intellectual property policies, and proportion research funding from industrial sources.

I created a new variable, which I labeled *Environmental Pressure Group,* by identifying technology transfer offices which operated under conditions of similar environmental pressures. Environmental pressures define group membership. To discover the groupings, I conducted cluster analysis using three measures of the environmental pressure construct: mission statements; intellectual property policies; and industrial proportion of total research funding. I analyzed the 77 technology transfer offices that responded to the survey.

The Quick-Cluster procedure (SPSS, 1997) using a three-group cluster command classified the cases into three identifiable environmental pressure groups. The final cluster centers in Table 7 show the mix of items for each cluster classification. Based on the cluster center information, I labeled the clusters as follows: Cluster 1) Commercial Pressures; Cluster 2) Mixed Pressures; and Cluster 3) Institutional Pressures. The Commercial Pressures Cluster has 23 cases. The Mixed Pressures cluster includes 15 cases. The Institutional Pressures cluster includes 27 cases.

TABLE 7
Environmental Pressures: Final Cluster Centers

Construct	Measure	Cluster 1 Commercial Pressure	Cluster 2 Mixed Pressure	Cluster 3[a] Institutional Pressure
Institutional Mission	Benefits to university	2[b]	3[c]	3
	Student/education benefit	2	2	2
	Acquire research funding	2	3	3
	Avoid conflict of interest	2	2	2
Commercial Mission	Patent protection	3	3	3
	Sales/commercialization	3	3	2
	Inventor participation	3	2	2
	Industry relationships	3	3	2
Institutional Intellectual Property Policy	Patent policies favor university	3	3	3
	Basic research over commercialization	2	2	2
	Tenure a goal	2	2	2
	Scholarly publications are key	2	3	3
	Public interest	3	3	3
Commercial Intellectual Property Policies	Inventor/organization are owners	2	2	2
	Quick patent review	2	2	2
	New business guidelines	2	2	2
	Industry affiliation rewarded	2	2	2
	Royalty share to inventor	3	3	3
Funding	Proportion of research funding from industry sources (transformed)	-2.41	-3.46	-2.49
N[d]		23	15	27

[a] Cluster 4 (Not Posted on Internet) is not shown because there are no missions and/or policies to code. Cluster 4 N=14.
[b] Coded 2 = absence of statement in the mission or policy.
[c] Coded 3 = presence of statement in the mission or policy.
[d] N Total = 79 cases including Cluster 4.

Fourteen of the survey-respondent university technology transfer offices did not post mission statements and/or policies on the internet. I attempted to collect policies and mission statements by contacting a sample of the targeted university technology transfer offices. I received no response even when requesting the information through colleagues at the targeted universities. The missing data of mission statements and/or

intellectual policies would have reduced the usable survey responses in all analyses that relied on data from both sources. Therefore, I formed a separate cluster of the cases in the "Not Posted Internet" category. According to Hair, et al. (1995) this is an appropriate technique for dealing with missing data.

I excluded the "Not Posted Internet" category in the cluster analysis process to better observe the differences among the cases having all data available. The "Not Posted Internet" category of cases dominated earlier attempts to classify the technology transfer offices and hid other critical differences among the environments of the technology transfer offices.

I conducted a one-way ANOVA with four contrasts to test whether the fourth cluster, NPI - Not Posted on the Internet, differs from the three clusters identified by the cluster analysis procedures. The Levene test of homogeneity of variances indicated that I could not conclude that the variances were homogeneous therefore I examined the significance of the contrasts using tests that do not assume equal variances. The group defined as "NPI" differed significantly from the combined set of other groups on all variables. The NPI group also differed significantly from each pairwise comparison except when compared with the Commercial Pressure group ($p < 0.56$) or the Institutional Pressure Group ($p < .29$) in the proportion of research funding from industrial sources.

Because the cluster analysis procedure maximizes the differences between groups, the ANOVA procedure only tested whether the fourth group, the group defined

by the researcher, differed from the three groups defined by cluster analysis. Refer to Table 8 for details of the contrasts.

TABLE 8
Contrasts Among the Environmental Pressure Groups
Not Posted Internet Group vs. Each Other Group

Variable of Contrast	Not Posted Internet Cluster vs.	Value of Contrast	Std. Error	t	df	sig.
Institutional Mission	Commercial	-.34	.16	-2.05[a]	13.43	.06
	Mixed	-.49	.17	-2.94	14.48	.01
	Institutional	-.55	.17	-3.31	13.87	.01
Institutional Intellectual Property Policy	Commercial	-.74	.10	-7.55[a]	13.84	.00
	Mixed	-.77	.10	-7.82	13.87	.00
	Institutional	-.75	.10	-7.69	13.67	.00
Commercial Mission	Commercial	-.93	.14	-6.74[a]	13.32	.00
	Mixed	-.83	.14	-5.85	14.67	.00
	Institutional	-.57	.14	-3.99	14.63	.00
Commercial Intellectual Property Policy	Commercial	-.74	.11	-7.03[a]	15.16	.00
	Mixed	-.72	.10	-6.62	14.33	.00
	Institutional	-.78	.10	-7.43	14.65	.00
Proportion Industrial Research Funding	Commercial	.11	.19	.59	74	.56
	Mixed	1.16	.21	5.57	74	.00
	Institutional	.20	.19	1.06	74	.29

[a] Contrasts were examined using tests that do not assume equal variance because the Levene test of the homogeneity of variance indicated significantly different variances in the contrast variable.

I used four groups for all tests requiring the grouping of technology transfer offices according to their environmental pressure characteristics. The four groups are: Cluster 1) Institutional Pressures; Cluster 2) Mixed Pressures; Cluster 3) Commercial Pressures; and Cluster 4) Not Posted on the Internet (NPI).

Summary of Environmental Pressure Measures. To assess institutional pressures and commercial pressures in the environments of the university technology transfer offices I evaluated: 1) mission statements, 2) intellectual property policies, and 3) industrial research funding proportions. I collected the mission statements and intellectual property policies from university internet web sites. I coded the mission statements and intellectual property policies using *a priori* defined lists of phrases. The National Science Foundation Science and Engineering Report (1998) provided data to calculate the industrial research proportion. I used the data from the three measures to classify the technology transfer offices into environmental pressure groups using cluster analysis statistical techniques (SPSS, 1997). The four clusters were: Commercial Pressure Group (n=23); Mixed Pressure Group (n=15); Institutional Pressure Group (n=27); and the Not-Posted-Internet Group (n=14).

The next section discusses the organizational orientation constructs, commercial orientation and institutional orientation, and the operational measures of the constructs. I describe three self-report measures used to assess organizational orientation: 1) entrepreneurial orientation, 2) institutional and commercial values, and 3) importance of institutional and commercial performance measures.

Organizational Orientation

I used organizational orientation to label the organization's responses to pressures in its environment. The variables measure two different types of organizational orientation: institutional orientation and commercial orientation. Scott (1987) suggested that organizations operate in institutional and technical-commercial

environments which exert pressures on organizations to conform the demands of the environment. Following Scott and Meyer (1991) and Powell and DiMaggio (1991), organizations can operate in ways that are consistent with the demands of both dimensions of their environments. Organizations may choose to emphasize one dimension or a combination of dimensions of their environments. Refer to Figure 4 which uses a two-by-two matrix to depict various combinations of responses to environmental pressures.

FIGURE 4

Institutional & Commercial Orientation

Descriptive Characteristics

Institutional Environments

Technical Environments	Weaker	Stronger
Stronger	**Strong Commercial Orientation** • Commercial performance valued • Strong commercial values • Entrepreneurial orientation	**Strong Institutional Orientation** **Strong Commercial Orientation**
Weaker	**Weak Institutional and Commercial Orientations**	**Strong Institutional Orientation** • Institutional performance valued • Emphasis on institutional values

Adapted from Scott, W.R. 1987. Table 6.1. p. 126.

This section is divided into three subsections to present the operational measures used to assess organizational orientation. First , I describe measures of institutional orientation. Next, I describe measures of commercial orientation. Third, I discuss how I assessed the perceived importance of two categories of organizational performance, institutional and commercial performance.

Institutional Orientation. Institutional orientation can be evaluated by examining the actual practices of an organization and by assessing what factors in the environment are perceived to be important. Hiring practices, performance evaluation measures, practices involved with dissemination of knowledge through teaching, publication and participation in professional conferences, could all be examples of institutionally-oriented practices. For example, to assess hiring practices and to determine the orientation of drug-abuse treatment organizations, D'Aunno, Sutton and Price (1991) classified organizational licenses and the backgrounds of individuals hired by organizations. Tolbert (1985) used the existence of an organizational office or position as evidence of institutional response to institutional environmental pressures.

Self-report measures have also been used to capture information about organizational responses to institutional pressures (e.g., Gupta, Dirsmith, & Fogarty, 1994; Elsbach, 1994; D'Aunno, Sutton & Price, 1991). D'Aunno, Sutton and Price (1991) used survey items asking the importance of various activities to assess the organizations' orientations. Elsbach (1994) employed a series of twelve questions relating to a fictional vignette to assess institutional and technical orientation content in messages about a business crisis. Bird, Hayward and Allen (1993) developed and

tested survey items assessing individual-level values of the importance of commercial and academic activities.

I assessed institutional orientation using Likert-scaled survey items in two categories. The two categories were: importance of institutional performance measures and institutional values. I created an index of the institutional orientation construct by summing the responses from the two sets of survey items (Nunnally, 1978).

I wrote seven survey items which asked technology transfer center directors to evaluate the *importance* of institutional-type performance measures. The selection of institutional performance measures was based on analyses reported by Autio and Laamanen (1995) and Spann, Adams and Souder (1995). The Cronbach's alpha for the seven original items was α=0.89 with 78 valid responses. Refer to Table 9 for a summary of the characteristics of the Importance of Organizational Performance Evaluation Measures Scale. Using a scale of 1= Very Unimportant through 5=Very Important, participants rated the following institutional performance measures in response to the question: *How important is each of the following for evaluating your technology transfer organization?*

- Honorary appointments (such as National Academy of Sciences and the National Academy of Engineers) held by your organization.
- Number of refereed journal articles published by members of your organization.
- The amount of Federal funding attracted and received by your organization.
- Number and quality of technical problems solved.
- Technical briefs/papers presented.

- Number of innovations developed.
- Number of graduate students participating in your organization.

TABLE 9
Importance of Organizational Performance Evaluation Measures
Academic Institutional Performance and Commercial Performance
Measurement Summary

Scale/ Construct	Description	Adapted From	Number of Items	N Valid Responses	Coefficient Alpha
Importance of Performance Measures	Items: Q25 - Q39 Five-point Likert Scaled; Rate importance of specific performance measures. Traditional academic measures and commercial measures.	Autio & Laamanen, 1995; Spann, Adams, & Souder, 1995	15	78	0.85[a]
Institutional Performance Measures: Part of Institutional Orientation Construct	Items: Q33 - Q39 Five-point Likert Scaled; Rate importance of examples of performance measures from academia.	Autio & Laamanen, 1995; Spann, Adams, & Souder, 1995	7	78	0.89[b]
Commercial Performance Measures: Part of Commercial Orientation Construct	Items: Q25 - Q32 Five-point Likert Scaled. Rate importance of examples of performance measures used to assess commercial enterprises.	Autio & Laamanen, 1995; Spann, Adams, & Souder, 1995	8	78	0.90[b]

[a] Cronbach alpha for all 15 items of the Importance of Performance Evaluation Measures Scale.
[b] Cronbach alpha for the sub-scale construct.

I measured *institutional organizational values* using survey items adapted from a scale created and reported by Bird, Hayward and Allen (1993). The Cronbach alpha for the seven adapted items was α=0.88 with 77 valid responses. Refer to Table 10 for a summary of the characteristics of the Organizational Values Scale.

TABLE 10
Organizational Values
Traditional Academic Institutional Values and Commercial Values
Measurement Summary

Scale/Construct	Description	Adapted From	Number of Items	N Valid Responses	Coefficient Alpha
Organizational Values Scale	Items: Q40-Q52 Five-point Likert Scaled; Assessing organizational-level values. Traditional academic institutional values and commercial values.	Bird, Hayward, & Allen, 1993	13	77	0.86[a]
Institutional Values: Part of Institutional Orientation Construct	Items: Q40 - Q43, Q48, Q50, Q52 Five-point Likert Scaled; Assessing organizational-level values. Traditional academic values.	Bird, Hayward, & Allen, 1993	7	77	0.88[b]
Commercial Values: Part of Entrepreneurial/ Commercial Orientation Construct	Items: Q44 - Q47, Q49, Q51 Five-point Likert Scaled. Assessing organizational-level values. Commercial values.	Bird, Hayward, & Allen, 1993	6	77	0.77[b]

[a] Overall Cronbach alpha for all 13 items of the Organizational Values construct.
[b] Cronbach alpha for the sub-scale construct.

The items assess academic institutional values using a five-point Likert scale ranging from 1=Strongly Disagree to 5=Strongly Agree. Respondents were asked to: *Consider the following statements in terms of the organization as a whole, not in terms of your own personal values.*

- The work of our organization emphasizes knowledge creation.
- Knowledge creation is best measured by scholarly publications and presentations.
- Our organization values and rewards acceptance in scholarly circles.

- Research with students is important to our organization.
- Collegiality is important in our work organization.
- Free exchange of ideas is important.
- Most people in our organization prefer the reflective thinking environment of academe to industry.

Commercial Orientation. I assessed commercial orientation using Likert-scaled survey items in three categories. The three categories were: *entrepreneurial orientation*, *importance of commercial performance measures* and *commercial values*. I created an index of the commercial orientation construct by summing the responses from the three sets of survey items (Nunnally, 1978).

I first discuss the entrepreneurial orientation scale and its five sub-scales. Next I present the commercial values items. Finally, I describe the items assessing the importance of commercial performance measures. I conclude this section with a brief summary of the commercial orientation measures.

I adapted the 24-item *entrepreneurial orientation* scale (Lumpkin, 1995; Lumpkin & Dess, 1996). The overall Cronbach's alpha for the entrepreneurial orientation scale in my study was $\alpha = 0.91$ with 78 valid responses. The entrepreneurial orientation scale consisted of 24 items which included five sub-scales. The five sub-scales in the entrepreneurial orientation set are: entrepreneurial style; technological innovation; administrative innovation; risk-taking propensity; and competitiveness. Refer to Table 11 for a summary of the measurement characteristics the entrepreneurial orientation scale and the five related sub-scales.

TABLE 11
Entrepreneurial Orientation
Measurement Summary

Scale/Construct	Description	Adapted From	Number of Items	N Valid Responses	Coefficient Alpha
Entrepreneurial Orientation/ Part of Commercial Orientation Construct	Items: Q1-Q24 Five-point Likert Scaled; Multi-dimensional: Competitiveness; Innovation; Risk-taking; Entrepreneurial Style	Covin & Slevin, 1991; Lumpkin, 1995; Lumpkin & Dess, 1996; Miller, 1983	24	78	.91[a]
Entrepreneurial Style	Items: Q1, Q9, Q10, Q13, Q16, Q20, Q21, Q23, Q24. Five-point Likert Scaled	Covin & Slevin, 1991; Lumpkin, 1995; Miller, 1983	9	78	.86[b]
Administrative Innovation	Items: Q3, Q6, Q7, Q8 Five-point Likert Scaled	Lumpkin, 1995; Lumpkin & Dess, 1996	4	81	.45[b]
Technological Innovation	Items: Q2, Q4, Q5 Five-point Likert Scaled	Lumpkin, 1995: Lumpkin & Dess, 1996	3	82	.73[b]
Risk-Taking Propensity	Items: Q11, Q12, 14, Q15 Five -point Likert Scaled	Lumpkin, 1995; Lumpkin & Dess, 1996	4	78	.43[b]
Competitiveness	Items: Q17, Q18, Q19 Five-point Likert Scaled	Lumpkin, 1995: Lumpkin & Dess, 1996	3	77	.44[b]

[a] Overall Cronbach alpha for all 24 items of the Entrepreneurial Orientation scale.
[b] Cronbach alpha for the sub-scale/sub-construct.

The sub-scale of *entrepreneurial style* (Miller,1983; Naman & Slevin, 1993) is the most critical sub-scale because of its prior use and validation. The Cronbach alpha of $\alpha = 0.89$ for the nine items from the entrepreneurial style scale suggest that I could have used these nine-items independent of the remaining 15 items from the entrepreneurial

orientation scale. The other four sub-scales were developed by Lumpkin (1995) to attempt to measure distinct dimensions of entrepreneurial orientation.

In the questionnaire I asked respondents to evaluate each entrepreneurial orientation statement by considering the following question: *Do the following statements describe your technology transfer organization?* The response mode used a five-point Likert-type scale having the anchors of 1 = strongly disagree and 5 = strongly agree. Survey items for the entrepreneurial orientation, organized by the five sub-scales, are listed below.

Entrepreneurial Style Items (Covin & Slevin, 1991; Lumpkin, 1995; Miller, 1983; Naman & Slevin, 1993)

- Places a strong emphasis on R&D, technological leadership, and innovations.
- Exhibits a strong proclivity for high-risk projects.
- Takes bold, wide-ranging actions to achieve the organization's objectives.
- When confronted with decision-making situations involving uncertainty, typically adopts a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities.
- Typically adopts a very competitive 'undo-the-competitors' posture.
- Monitors technological or scientific developments that potentially offer competing approaches to the research pursued by the organization.
- Encourages researchers and engineers to pay attention to competing technological solutions or developments.
- Typically initiates actions that other organizations later adopt or copy.

- Is very often the first organization to introduce new product/services, administrative techniques, operating technologies, etc.

I adapted items from Lumpkin (1995) to assess *technological innovativeness, administrative innovativeness, competitiveness* and *risk-taking propensity* as potentially distinct components of entrepreneurial orientation.

Technological Innovation

- Designs its own unique new processes and methods to achieve success in research applications.
- Announced (or published articles or made technical presentations about) a large number of research breakthroughs in the past five years.
- Is considered a leader in new developments in its field by other organizations operating in the same field.

Administrative Innovation

- Develops alternative procedures when necessary to work around university policies that hinder or slow progress in any area.
- Finds creative solutions to administrative problems such as funding, staffing, space, budgets, equipment acquisitions, or patent procedures.
- Has helped the university develop new processes, policies or procedures that facilitate commercial endeavors by research units or faculty.
- Nearly always adheres to established university policies even when the policies might hinder organizational progress. (Reverse scored.)

Risk-Taking Propensity

- Readily spends money on potential solutions if problems are holding us back.

- Quickly seizes new opportunities.
- Circumvents policies that are perceived to get in the way of commercial developments.
- Is exposed to potential administrative censure by selectively following university policies that relate to commercializing technologies.

Competitiveness

- Is very aggressive and intensely competitive.
- Formally monitors competitors' actions.
- Does not have competitors in its field of endeavor.

To assess *commercial values* I used six survey items from a scale developed by Bird, Hayward, and Allen (1993). The Cronbach alpha for the six items was α=0.77 with 77 valid responses. Refer to Table 10 (presented earlier) for a summary of the characteristics of the Organizational Values Scale. The items assess commercial values in an academic setting using a five-point Likert scale ranging from 1=Strongly Disagree to 5=Strongly Agree. Respondents were asked to: *Consider the following statements in terms of the organization as a whole, not in terms of your own personal values.* The statements are:

- Most people working here prefer the faster feedback of the industrial world over academe.
- Our work emphasizes linking resources and opportunities to create new organizations or products.
- Knowledge is best embodied in a finished, marketable product or service.
- In our work, protecting proprietary information is important.

- Our organization encourages competition with others.
- Most people in our organization consider personal wealth as an important measure of success.

I wrote eight survey items which asked technology transfer center directors to evaluate the *importance of commercial-type performance measures*. I based the selection of commercial performance measures on analyses reported by Autio and Laamanen (1995) and Spann, Adams and Souder (1995). The Cronbach's alpha for the eight original items was α=0.90 with 78 valid responses. Refer to Table 9 (presented earlier) for a summary of the measurement characteristics of the Importance of Organizational Performance Evaluation Measures Scale. Using a scale of 1= Very Unimportant through 5=Very Important, participants rated the following commercial performance measures in response to the question: *How important is each of the following for evaluating the performance of your technology transfer organization?*

- The number of patent disclosures issued.
- The number of patents filed.
- The number of commercial customers.
- Amount of income from royalties or patents.
- Licenses granted or sold.
- New businesses started.
- Financial or in-kind support from industry partners.
- Number of new products developed.

Summary of Commercial Orientation. Commercial orientation is an organizational level construct. I measured commercial orientation using a total of 38

Likert-scaled self-report survey items asking respondents to consider the statements in relation to their technology transfer organization. Three separate sets of items comprise the commercial orientation construct: 24-items for entrepreneurial orientation ($n=78$, $\alpha= 0.91$); six-items for commercial values ($n=77$, $\alpha=0.77$); and eight items for importance of commercial performance measures($n=78$, $\alpha=0.90$).

Organizational Orientation Group Variable. I used data from organizational orientation measures to form a new variable, the organizational orientation group. In order to test the hypotheses, I needed to form groups based on the results of the organizational orientation mesas.

Using Quick-Cluster (SPSS, 1997) I formed three groups based on the summated scales for institutional orientation and commercial orientation. Scores from the institutional values and importance of institutional performance measures comprise the summated scale for institutional orientation. Commercial orientation includes the summed scores of survey responses on items measuring entrepreneurial orientation, importance of commercial-type performance measures, and commercial values. The commercial orientation summed scale was transformed by multiplying the ratio of total possible score for the items in each scale (70 institutional points/160 commercial points) times the original sum of the commercial orientation variable to create comparably scaled measures. I transformed the scores because cluster analysis is very sensitive to the scale of the measures (Hair, et al., 1995).

Table 12 presents the final cluster centers for the organizational orientation group variable. Based on an analysis of the scores in each category of the cluster centers, I

labeled the three groups as: institutional orientation (n=18); mixed orientation(n=46); and commercial orientation (n=13).

Summary of Organizational Orientation Measures. Organizational orientation measures attempt to capture the organization's response to environmental pressures. I sought to examine two types of organizational orientation: institutional orientation and commercial orientation. In this research I collected survey responses from heads of university technology transfer to assess institutional and commercial orientation. A total of 52 survey items addressed institutional and commercial values, entrepreneurial orientation and the importance of performance measures. Seventy-seven university technology transfer offices submitted responses to the organizational orientation questions.

TABLE 12
Organizational Orientation: Final Cluster Centers

Classification Variable	Cluster Label: Type of Orientation		
	Institutional	Mixed	Commercial
Institutional Orientation	51[a]	55	29
Commercial Orientation	40[b]	57	54
N Total = 77 N per Group	18	46	13

[a] Summed scores of survey responses on items measuring institutional values and the importance of institutional-type performance measures.

[b] Summed scores of survey responses on items measuring entrepreneurial orientation, importance of commercial-type performance measures, and commercial values. This commercial orientation summed scale was transformed by multiplying the ratio of total possible score for items in each scale (70/160) times the original sum of the commercial orientation variable to create comparably scaled measures. Cluster analysis is very sensitive to the scale of the measures (Hair, et al., 1995).

Summary of Independent Variables

I used two broad categories of independent variables in this research. First, environmental pressure variables indicated whether the technology transfer organization operates in an environment with commercial pressures, institutional pressures or mixed pressures. I used the environmental pressure measures to classify the technology transfer offices into three groups of environmental pressures and one group consisting of organizations that did not post mission statements and/or policies. The environmental pressure group was used as the classification variable to assess the relationship between pressures and organizational response. The second category of variables, organizational orientation, captured the response of the technology transfer office to the environmental pressures. The technology transfer organizations were expected to respond to environmental pressures with predominantly commercial orientation, institutional orientation or a mixed orientation. I formed an organizational orientation group variable to classify the technology transfer offices according to their scores on the organizational orientation measures. I used the organizational orientation group variable to examine how organizational orientation might relate to the performance of the technology transfer organization.

Control Variables

I collected demographic data for descriptive as well as control purposes. The demographic data are: the Carnegie Classification, faculty size, student size, location by zip code, type of institution, and public or private status. Below I briefly describe each characteristic and its source. In the final analysis, for a control variable, I used

only university size as indicated by the number of full-time or full-time equivalent faculty teaching at the graduate level, following the example of Goslin and Trune, 1996. I selected faculty size for three reasons. First, it was used by Goslin and Trune (1996). Second, with the exception of public versus private university status, all the control variables were significantly correlated. Third, faculty size had the highest correlations with the dependent variables. To look for possible effects of public versus private university status, I used ANOVA to test for performance differences between private and public universities. I found no significant performance differences in contrasting public versus private universities. I used the other demographic data for descriptive purposes and to compare survey respondents to non-respondents.

Carnegie Classification

The Carnegie Classification provides an indication of the focus of the college or university (Carnegie Foundation, 1998). The latest classification completed by the Carnegie Foundation was done in 1994. The classifications are based on the variety and types of degrees offered, the number of doctoral graduates, and the amount of Federal research funding for research universities. The classification includes all degree granting, accredited higher education institutions in the US. The technology transfer universities in my database and sample were primarily Research I and Research II universities as shown in Table 2 presented earlier. Table 4, also reported previously, shows that there are no significant Carnegie classification differences ($p < .86$) between survey-responding (n=57) and non-responding (n=68) universities.

Size: Graduate Faculty and Students

I collected total student enrollment and total number of graduate faculty data from Peterson's Graduate and Professional Programs 1997 Guide (Peterson's, 1997). The guide reported only the number of faculty teaching at the graduate level. It also reported the total student enrollment. Some universities did not supply student enrollment and/or faculty numbers. I was able to locate faculty size for 117 technology transfer universities. As indicated earlier in Table 4, there were no differences in faculty size ($p<.76$) between responding ($n=51$) and non-responding ($n=66$) universities. I did not compare respondents to non-respondents in terms of number of students, however the number of students significantly correlates with the number of faculty ($r = .90$, $p < .01$).

Type of University

I collected and coded university type for 123 technology transfer universities using Peterson's Graduate and Professional Programs 1997 Guide (Peterson's, 1997). I classified the university types as: technical institute; university with no medical school; university with medical school; and medical school. I followed the classification scheme used by Goslin and Trune (1996) and Trune and Goslin (1998). As indicated in Table 4 (presented earlier) there were no differences ($p<.62$) between respondents' university type ($n=55$) and non-respondent's university type ($n=68$).

Public or Private University

I collected and coded the public or private status for 123 technology transfer universities using Peterson's Graduate and Professional Programs 1997 Guide (Peterson's, 1997). As indicated in Table 4 (presented earlier) there were no significant differences ($p<.14$) in the number of public/private university between respondents' (n=55) and non-respondent's (n=68).

Year of Founding Technology Transfer Organization

The Fiscal Year 1996 Licensing Survey (AUTM,1997) defined the year of founding the technology transfer office as the first year for which one-half full-time equivalent professional worked on the technology transfer activities for the university. Using the Fiscal Year 1996 AUTM Licensing Survey, I collected and coded the founding dates for 117 technology transfer offices affiliated with US universities or medical schools. As indicated in Table 4 (presented earlier) there were no differences ($p<.75$) in the founding dates of the technology transfer offices between respondents' (n=52) and non-respondent's (n=68).

The technology transfer office founding dates ranged from 1925 to 1997, as shown on Table 1 presented earlier. Of the total, 11.1% were founded before 1980; 64.8% between 1980 and 1990; and 24.1% between 1991 and 1997. I chose 1980 as the cut date for the year-of-founding comparisons based on the passage of the Bayh-Dole Act. The Bayh-Dole Act, passed in 1980, marks a regulatory gate-opening for university technology transfer in that it permitted the pursuit of commercialization of federally-funded university technologies (GAO, 1998).

The next section presents the dependent variables, including the data collection methods and sources. The dependent variables are performance measures of university technology transfer offices.

Dependent Variables

I collected and coded performance data from four sources:

1. National Science Foundation's (NSF) WebCASPAR Database System (NSF, 1998);
2. University Patents Summary from Intellectual Property Education Coalition (Schneider, 1998);
3. National Academy of Sciences (NAS) listing of members by organizational affiliation (NAS, 1998); and,
4. The Association of University Technology Managers (AUTM) Annual Surveys for Fiscal Years 1994, 1995 and 1996 (AUTM, 1997).

Two studies provided guidance in selecting the performance measures for the present research. Autio and Laamanen (1995) and Spann, Adams, and Souder (1995) classified technology transfer and commercialization performance measures.

Autio and Laamanen (1995) developed a classification of technology transfer measures derived from an extensive review of published research literature. They classified technology output measures into three major categories: research and technology outputs; commercial outputs and monetary and resource outputs. The studies reviewed by Autio and Laamanen were predominantly related to university-industry technology transfer.

Spann, Adams, and Souder (1995) surveyed managers responsible for technology development and transfer in Federal government-affiliated organizations in the Southeast United States. Spann, Adams and Souder (1995) empirically analyzed technology transfer metrics and created a taxonomy of the measures.

Following the examples from prior research I categorized the performance measures in this study. First, I hypothesized that institutional performance measures would be indicative of institutional outcomes of university technology transfer offices. I used a measure of institutional research funding and a measure of the memberships in the three branches of the National Academy of Sciences as indicators of institutional performance. Second, I hypothesized that commercial performance measures would be indicative of commercial outcomes of the work of university technology transfer offices. I used four measures to indicate commercial performance: the number of licenses granted; the number of patents awarded; the royalties and fees related to technology licenses; and the number of start-up companies. Table 13 summarizes the descriptive statistics for the performance measures used in the current analyses. I describe each measure and the data sources below.

Institutional Performance Measures

I defined institutional performance measures as those which could be associated with a traditional academic environment. The two measures or indicators that I used were: 1) number of memberships in the organizations of the National Academy of Sciences, and 2) institutional research funding.

TABLE 13

Organizational Orientation and Performance Measures: Descriptive Statistics

Measure	N	Minimum	Maximum	Mean	s.d.
Institutional Orientation Sum	77	0	68	49.90	12.27
Commercial Orientation Sum	77	52	159	120.74	21.10
Licenses Granted: 1996	129	0	137	17.62	24.92
Royalties Received: 1996[a]	132	0	63,200	2,783	7,817
Patents Awarded: 1996	132	0	159	13.73	19.47
Start-Up Companies: 1996	130	0	14	1.43	2.28
NAS[b] Members Total	167	0	443	18.93	46.10
Institutional Research Funding: 1991 - 1996[c]	153	8,180	7,987,589	695,787	805,991

[a] US Dollars in Thousands ($000s)
[b] Total of three types of National Academy of Sciences memberships: National Academy of Sciences; National Academy of Engineers; and National Intitute of Medicine.
[c] Sum of 1991 -1996 institutional research funding.

Memberships in the National Academy of Sciences (NAS). I summed the number of people listed as affiliated with each university in the membership directories of the three honorary organizations of the National Academy of Sciences: the National Academy of Sciences (NAS, 1998), National Academy of Engineers (NAE, 1998), and the Institute of Medicine (IOM, 1998). The mean number of memberships was about 19, with a range from 0 to 443 members in the three organizations. As shown in Table

5 (presented earlier) there were no differences ($p < .61$) between survey respondents ($n=61$) and non-respondents ($n=70$) in terms of the number of memberships in the organizations of the National Academy of Sciences.

Next I discuss the second measure of institutional performance, the amount of institutional research funding. First, I explain the reasons for selecting research funding as a measure. Then I discuss the data source and calculation method for the institutional research funding variable. Finally, I explain the rationale for use of prior years' funding level as an indicator of current performance.

Institutional Research Funding. I selected institutional research funding as a performance indicator for a number of reasons. Research funding by source are reported by offices of sponsored research of many universities as an indicator of the office's performance in service to the university. The Carnegie Foundation uses the levels of Federal research funding as a criteria for classifying universities in their Research I and Research II categories. Finally, universities often publicize their levels of research funding as an indicator of the quality of the faculty and the programs of the university.

I collected the research funding data from the National Science Foundation (NSF) WebCASPAR System (NSF, 1998). The data in the NSF database were collected by surveying of the population of institutions of higher education"...that perform separately budgeted R&D expenditures in [science and engineering] for which at least $50,000 has been expended in any 1 of the last 6 fiscal years... The data are believed to

account for 99 percent of all R&D at colleges and universities...The FY 96 response rate was 97.3 percent (National Science Foundation, 1998)."

I used a six-year sum (1991-1996) of research funding levels to calculate the *institutional research funding* amount for the universities in my database. I selected the time period because the AUTM data was available for the same years and could be substituted if data were missing for the AUTM survey participants.

The 153 technology transfer universities in my database reported a mean of $748,084,000 for six years of all categories of research funding. This high average is influenced by the system-wide reporting of a number of university organizations, such as the University of California System. The minimum for the six year period was $10,691,000 and the maximum was $8,514,122,000. (Refer to Table 1, presented earlier.) Using ANOVA, I found no differences ($p<.77$) between survey respondents ($n=77$) and non-respondents ($n=76$) in terms of the total six-year research funding levels.

I calculated the *institutional* research funding amount by subtracting from the six-year total the six-year sum of industrial research funding. Table 5 (presented earlier) shows that there were no differences ($p<.88$) between the respondents ($n=51$) and non-respondents ($n=59$) in terms of institutional research funding per faculty member. Table 5 also shows no differences ($p<.45$) between respondents ($n=77$) and non-respondents ($n=76$) in terms of the proportion of industrial research funding by university. Both of these contrasts indicate that there would also be no differences in the amount of institutional research funding between respondents and non-respondents.

Data for 1997 or 1998 research funding levels were not available or accessible at the time of the data collection for this research. I examined research funding patterns to determine if prior year data would be indicative of the 1997 and 1998 funding levels. Table 14 shows the descriptive statistics of *total* research funding for 219 US technology transfer universities for the years 1987 through 1996.

The research dollars steadily increase each year, however, as indicated in Table 15 there are high, significant correlations among the total research funding levels each year. The correlations for total research funding levels in 1996 and the 1991-1995 levels range from r= .984 to r = .998. I concluded that research funding levels from prior years would be indicative of future years' research funding levels.

TABLE 14
Ten-Year Total Research Funding
Descriptive Statistics

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Mean	50586[a]	56030	62092	67827	73241	78220	82613	86990	91827	94961
s.d.	57873	63042	69016	75184	80672	85450	89476	93415	97683	101045

[a]US $000s
N = 219

TABLE 15
Ten-Year Total Research Funding
Correlation Matrix[a]

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1987	1.00									
1988	.997[b]	1.00								
1989	.994	.998	1.00							
1990	.992	.995	.998	1.00						
1991	.988	.991	.995	.998	1.00					
1992	.985	.989	.993	.994	.997	1.00				
1993	.981	.985	.989	.991	.995	.996	1.00			
1994	.978	.982	.987	.989	.991	.993	.997	1.00		
1995	.974	.978	.984	.985	.988	.990	.993	.997	1.00	
1996	.972	.977	.982	.984	.986	.989	.992	.995	.998	1.00

[a] N = 231
[b] All correlations are significant at the p < .001 level (two-tailed).

To further evaluate the usefulness of prior year data, I examined descriptive statistics and correlations for ten years for *institutional* research funding levels. Table 16 shows the descriptive statistics for the institutional research funding over 10 years.

TABLE 16
Ten-Year Total Institutional Research Funding
Descriptive Statistics

Year	Mean	s.d.
1987	47,259[a]	54,475
1988	52,359	59,534
1989	57,926	64,857
1990	63,109	70,528
1991	68,205	75,813
1992	72,848	80,329
1993	76,913	83,939
1994	81,022	87,761
1995	85,551	91,639
1996	88,320	94,484

N = 219 [a]US $000s

Table 17 presents the correlation matrix for the ten-year institutional research funding levels. The correlations for institutional research funding levels in 1996 and the 1991-1995 levels range from r= .984 to r = .998. These correlations are the same as for the total research funding levels. I concluded that institutional research funding from prior years would be indicative of future years' institutional research funding levels.

TABLE 17
Ten-Year Institutional Research Funding
Correlation Matrix[a]

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1987	1.00									
1988	.997[b]	1.00								
1989	.994	.997	1.00							
1990	.991	.995	.998	1.00						
1991	.988	.991	.995	.997	1.00					
1992	.985	.989	.992	.993	.997	1.00				
1993	.981	.985	.988	.990	.994	.996	1.00			
1994	.978	.982	.986	.988	.990	.993	.997	1.00		
1995	.974	.978	.983	.985	.987	.989	.993	.997	1.00	
1996	.972	.976	.981	.982	.984	.987	.991	.994	.998	1.00

[a] N = 219
[b] All correlations are significant at the $p < .001$ level (two-tailed).

Commercial Performance Measures

I used four measures as indicators of commercial performance: the number of licenses granted; the royalties and fees received; the number of patents awarded; and the number of start-up companies. I first describe each variable and its source, then I provide evidence to support the use of prior year data as a proxy for current year data.

Licenses Granted. I collected data for the number of licenses executed or granted from the Association of University Technology Managers (AUTM) Licensing Survey, Fiscal Year 1994, Fiscal Year 1995 and Fiscal Year 1996 Full Reports. Data were available from 1991 - 1996 fiscal years. In its survey instructions, AUTM defines licenses/options executed as: "the number of license or option agreements that were

executed in the year for all technologies. Each agreement, exclusive or non-exclusive, should be counted separately (AUTM, 1997:37)."

In the analyses, I used the number of licenses granted in 1996. I used the 1996 data because it was the most recent licensing data available. As indicated in Table 18, there was a high, significant correlation (r = .94) with the prior year number of licenses granted.

TABLE 18
Licenses Granted: 1991 - 1996
Correlation Matrix

Year	1996	1995	1994	1993	1992	1991
1996	1.00	101[a]	101	91	75	72
1995	.94[b]	1.00	103	93	76	73
1994	.93	.91	1.00	93	76	73
1993	.85	.79	.92	1.00	73	70
1992	.91	.87	.94	.95	1.00	73
1991	.91	.85	.92	.94	.97	1.00

[a] Number for each bivariate correlation.
[b] All correlations are significant at the $p < .001$ level (two-tailed).

Royalties and Licensing Income. I collected data for the royalties and licensing income from the Association of University Technology Managers (AUTM) Licensing Survey, Fiscal Year 1994, Fiscal Year 1995 and Fiscal Year 1996 Full Reports. Data were available from 1991 - 1996 fiscal years. According to AUTM's 1996 Survey Summary, royalties and licensing income...

> " includes: license issue fees, payments under options, annual minimums, running royalties, termination payments, the amount of equity received when cashed-in, and

> software end-user license fees equal to $1,000 or more, but not research funding, patent expense reimbursement, a valuation of equity not cashed-in, software end-user fees less than $1,000, or trademark licensing royalties from university insignia (AUTM, 1997:36)."

In the analyses, I used the amount of royalties and fees received in 1996. I used the 1996 data because it was the most recent data available. As indicated in Table 19, there was a high, significant correlation (r = .98) with the prior year royalties and licensing fees.

TABLE 19
Royalties and Licensing Fees: 1991 -1996
Correlation Matrix

Year	1996	1995	1994	1993	1992	1991
1996	1.00	104[a]	104	90	74	73
1995	.98[b]	1.00	104	90	74	73
1994	.97	.99	1.00	90	74	73
1993	.95	.96	.98	1.00	71	70
1992	.94	.94	.94	.96	1.00	73
1991	.90	.91	.92	.93	.96	1.00

[a] Number for each bivariate correlation.
[b] All correlations are significant at the p < .001 level (two-tailed).

Patents Awarded. I collected data for the number of patents issued to universities from the Association of University Technology Managers (AUTM) Licensing Survey, Fiscal Year 1994, Fiscal Year 1995 and Fiscal Year 1996 Full Reports. Data were available from 1991 - 1996 fiscal years. I also collected and evaluated patent data from the National Science Foundation (National Science Board, 1998) and Intellectual

Property Management, Inc. (Schneider, 1998). I examined the relationships among the three patent sources and found high, significant correlations. Because the data from AUTM matched more universities in my subject pool, I decided to use the 1996 AUTM patent data.

Table 20 presents the correlation matrix of patents awarded by year from 1993 through 1996 (AUTM, 1997). There were high, significant correlations between years, with 1995 and 1996 having a correlation of r = .95. I concluded that I could use prior year data as a proxy for current year patent data.

TABLE 20
Patents Awarded 1993 - 1996
Correlation Matrix

Year	1996	1995	1994	1993
1996	1.00	115[a]	104	98
1995	.95[b]	1.00	111	101
1994	.95	.96	1.00	101
1993	.92	.92	.94	1.00

[a] Number for each bivariate correlation.
[b] All correlations are significant at the p < .001 level (two-tailed).

I found no differences between the number of patents awarded between respondents and non-respondents. The number of patents awarded per university were not significantly different (p< .48) between survey respondents (n=53) and non-respondents (n=69). The number of patents adjusted for size of the university, that is, patents per faculty, also showed no difference (p< .83) between respondents (n=48) and non-respondents (n=60). Comparisons between respondents and non-respondents were presented earlier in Table 5.

Start-up Companies. I collected data for the number of start-up companies from the Association of University Technology Managers (AUTM) Annual Licensing Surveys, Fiscal Year 1994, Fiscal Year 1995 and Fiscal Year 1996 Full Reports. Data were available from 1994 - 1996 fiscal years. According to AUTM's 1996 Survey instructions...

> "...start-up companies are companies that were dependent upon licensing the institution's technology for initiation. If a technology was licensed to an existing start-up company, but not to a start-up that was dependent upon your technology for initiation, this company should be counted as a small company when responding...as opposed to a start-up company (AUTM, 1997:38)."

In the analyses, I used the 1996 data because it was the most recently available data. Table 21 shows the correlations in the number of start-up companies for the years 1994 through 1996. The correlations are all significant ($p < .001$) however they are not as high as with the other performance measures. Lacking another source for the number of start-up companies I decided to use the 1996 data as a proxy for current year data.

TABLE 21
Start-Up Companies 1994- 1996
Correlation Matrix

Year	1996	1995	1994
1996	1.00	102[a]	102
1995	.56[b]	1.00	104
1994	.46	.71	1.00

[a] Number for each bivariate correlation.
[b] All correlations are significant at the $p < .001$ level (two-tailed).

Summary of Dependent Variables

I selected the performance measures for dependent variables based on two previous studies (Autio & Laamanen, 1995; Spann, Adams, & Souder, 1995). In the analyses I defined two categories of performance measures, institutional measures and commercial measures. Institutional measures are those associated with traditional academic activities. Commercial measures are those associated with a commercial business rather than a traditional academic setting. The institutional measures used in this research are institutional research funding and the number of members in the organizations of the National Academy of Sciences. The four commercial measures I used in the analyses are: the number of licenses granted; royalties and licensing fees; the number of patents awarded; and the number of start-up companies. Because of data availability constraints, I used 1996 data as proxies for current year data. For all measures except the number of start-up companies, the correlations among data from prior years and 1996 were very high and significant.

Analyses Methods

In this section I present an overview of the data analyses methods used to test the hypotheses. As presented earlier, I used cluster analysis to create new variables of groups based on the environmental pressure measures. I examined the relationships between environmental pressures and organizational orientation using correlation analysis among the variables. I used ANOVA to test for group differences based on the environmental pressure groups. As presented previously, I also used cluster analysis to create the group variable based on the organizational orientation measures. Finally,

using ANOVA, I tested the relationships between organizational orientation and two types of performance, institutional and commercial performance. In addition, I used ANOVA to examine the relationships between organizational orientation and size-controlled performance measures. Finally, and post-hoc, I examined the overall performance relationships in the model using multiple regression techniques (SPSS, 1997).

Correlation Analysis

Based on the wording of Hypotheses 1a and 2a, I used bivariate correlations to evaluate the predicted relationships between environmental pressure measures and measures of organizational orientation. In the hypotheses I predicted positive, significant relationships among the measures for institutional environmental pressures and institutional orientation, as well as among measures for commercial environmental pressures and commercial orientation. For each of the predicted relationships I examined bivariate, Pearson correlation coefficients among the measures of the variables.

ANOVA: Planned Multiple Comparisons

I used ANOVA with planned (a priori) multiple comparisons to evaluate the relationships among the environmental pressure groups and organizational orientation measures, then among the organizational orientation groups and the performance measures. I had originally proposed using MANOVA, following examples in related research (Chen & Hambrick, 1995; Greening & Gray, 1994). However the group sizes

based on the number of survey respondents were too small to detect differences among the groups. In order to have sufficient power to detect medium effects, with three groups and six dependent variables, I would need to have 66 cases in each group (Hair, et al., 1995).

I used ANOVAs and controlled for the overall alpha level using planned multiple comparison calculations for the critical values to evaluate significance of the between-group contrasts (Maxwell & Delaney, 1990). I tested for homogeneity of variance using the Levene statistic (SPSS, 1997). In contrasts where I could assume that the variances assumed were equal, I examined the data using Tukey's method (Maxwell & Delaney, 1990). In contrasts where the variances could not be assumed to be equal, I used the Dunnett T3 method because it is appropriate for small group sizes with unequal variances (Maxwell & Delaney, 1990). Dunnett's T3 differs from the Dunnett contrast test used for situations involving control groups.

Multiple Regression Analysis

I had not planned to assess the overall contribution of the independent variables to changes in the performance measures. However, the question seemed to be an important one to address, therefore I conducted analyses to assess the overall relationships among the variables in the model. I used multiple regression analysis and backward elimination techniques to evaluate the best predictive model. I tested the model using two performance measures, patents and institutional research funding, as well as the size-controlled measures of patents and institutional research funding.

Summary of Research Methods

Chapter Four described the variables, the data sources, and data collection methods. In Chapter Four I also introduced the statistical analyses methods employed to test the hypotheses and answer a *post hoc* question. Figure 3, presented earlier, provides an overview of the variables and their relationships within the model.

I used two sets of independent variables which I classify as environmental pressures and organizational orientation. The dependent variables are measures of university performance related to the work of technology transfer offices.

I collected data from a variety of sources. To collect technology transfer office mission statements and university intellectual property policies, I searched the world-wide web sites of universities for copies of the original documents. I coded the documents according the presence of *a priori* defined lists of phrases. Organizational orientation measures were collected from surveys completed by university technology transfer offices directors or their designees. For research funding data and proportions, I used data published by the National Science Foundation. For commercial performance measures of patents, licenses, royalties, and start-up companies, I used data from the AUTM Annual Licensing Surveys. For the institutional performance measure of membership in the National Academy of Sciences (NAS), I searched and coded data from the membership records of the National Academy of Science, National Academy of Engineers, and the Institute of Medicine.

Where possible I cross-checked data from different sources to verify accuracy of the data. I compared patent data from three sources and found high, significant

correlations among all three sources. I also found high, significant correlations between two sources of Carnegie Classification data. I evaluated research funding levels and categories by comparing data reported by the Association of University Technology Managers and the National Science Foundation. I found high and significant correlations between the two sources of research funding data.

I used four types of statistical analyses in this research. To test the hypotheses, I used correlations and ANOVAs. I used correlations to examine the relationships between environmental pressures and organizational orientation. I examined the correlations using the three measures of environmental pressures, two measures of institutional organizational orientation, and three measures of commercial orientation. Second, I compared groups using ANOVA. To form the group variables, I used cluster analysis statistical techniques. I compared environmental pressure groups using measures of organizational orientation. I also compared organizational orientation groups in terms of their performance measures. Finally, using multiple regression, I explored the relationships among the independent variables and two dependent variables, in an exploratory test to consider what characteristics of technology transfer offices might contribute to levels of research funding and the number of patents awarded.

The next section, Chapter Five, discusses the results of the analyses conducted for this research. I present each hypothesis followed by a description of the data analysis results.

CHAPTER FIVE

RESULTS

In Chapter Five I present the results of the analyses testing the hypotheses. For each hypothesis I explain the statistical tests, the results, and interpret the findings. Because the hypotheses are related, I first present the analyses of Hypotheses 1 - 3, then the analyses of Hypotheses 4 - 6. The first three hypotheses predict patterns of relationships between environmental pressures and organizational orientation. The last three hypotheses predict relationships between organizational orientation and organizational performance. Following the reports of the hypotheses tests, I present results of post hoc tests which examine the variables contributing to technology transfer center performance.

Environmental Pressures and Organizational Orientation

The first set of hypotheses, H1 through H3, predict that organizations operating in different environmental pressure settings will differ in their responses to their environments. The results discussed below for Hypotheses 1 - 3 show that technology transfer offices in commercial pressure environments differ in their level of commercial orientation when compared with technology transfer offices operating in institutional pressure environments. The results also indicate that technology

transfer offices do not differ in terms of their institutional orientation, that is in traditional academic values and importance of such performance measures. Refer to Figure 3 (presented earlier) which shows the model and the variables associated with each segment of the model.

I repeat the hypotheses for ease of reference in this section. The sub-hypotheses are also repeated. Following each sub-hypothesis, I present the results and a brief interpretation of the results.

Hypothesis 1

Hypothesis 1 predicts that technology transfer organizations faced with institutional pressures will exhibit institutional orientations that differ from the orientations of organizations in commercial pressure or mixed pressure environments. The results suggest that all university technology transfer organizations exhibit similar characteristics of institutional orientation in terms of institutional values and importance of institutional performance measures.

H1: Technology transfer centers faced with predominantly institutional pressures will exhibit a stronger institutional orientation than other organizations.

H1a: High institutional orientation, indicated by scores on self-reported *importance* of institutional performance evaluation measures; organizational values as evidenced by questionnaire items adapted from Bird, et al., (1993), will be positively related to environments having strong institutional pressures, indicated by high institutional research expenditure *proportion*; high institutional rating on evaluation of

intellectual property policy; and high institutional rating of mission statement.

Analyses of Hypothesis 1a. Hypothesis 1a predicted a positive relationship between the measures of institutional environmental pressures and the measures of institutional orientation. I analyzed the relationship using Pearson correlations of three measures of institutional environmental pressure and two measures of institutional organization orientation. The measures of institutional environmental pressures were: institutional mission scores; institutional policy scores; and institutional research funding proportion. I transformed the variables to achieve more normal distributions (Cohen & Cohen, 1983). The measures of institutional orientation were: institutional values summed score of survey responses and the summed score for survey items asking the importance of institutional performance measures. Refer to Table 22 for the correlation matrix and levels of significance.

Results of Tests of Hypothesis 1a. The data did not follow the predicted pattern between the measures of institutional pressure and institutional orientation. Contrary to the predicted relationship, one component of the institutional orientation construct, the importance of institutional performance measures, was negatively related ($r = -.27$, $p<.05$) to institutional intellectual property policies, a component of the environmental pressure.

TABLE 22
Pearson Correlations of
Institutional Pressures and Institutional Orientation

Construct	Variable	1	2	3	4	5
Institutional Environmental Pressures	1. Institutional IP Policies	1.00				
	2. Institutional Mission	.29**	1.00			
	3. Institutional Research Funding Proportion	.05	.10	1.00		
Institutional Orientation	4. Institutional Values	-.07	.11	-.02	1.00	
	5. Importance of Institutional Performance Measures	-.27*	-.06	.02	.58***	1.00

*** Correlation significant at p < .001 level (2-tailed).
** Correlation significant at p < .01 level (2-tailed).
* Correlation significant at p < .05 level (2-tailed).
[a] N = 77 (listwise exclusion)

The interpretation of this unexpected result may be found in the comments of several survey participants. Several technology transfer office directors sent e-mail messages advising that the series of items related to institutional performance applied to their university but not to the technology transfer office. The directors who communicated also reported that they could not appropriately respond to the items as the items relate to the technology transfer activities. It is possible that the survey items created confusion for most of the respondents.

The two other significant correlations were within the constructs. Institutional missions correlated positively with institutional intellectual property policies (r = .29,

$p < .01$) as would be expected for component measures of the institutional environmental pressures construct. Thus the missions of the university technology transfer offices and the intellectual property policies of the universities are in alignment or agreement. The scores for institutional values and the importance of institutional performance measures were positively correlated ($r = .58$, $p < .001$) also as would be expected for components of the same construct, institutional orientation.

Analyses of Hypothesis 1b. Next I discuss the analysis and results of tests of Hypothesis 1b. The results did not support the predicted relationship between institutional orientation and the organizations in the commercial, mixed or institutional environments. Hypothesis 1b follows:

H1b: Organizations in environments characterized by high institutional pressures will exhibit stronger institutional orientation when compared with organizations in environments characterized by lower institutional pressure.

Environmental Pressure Groups & Institutional Orientation. Table 23 presents a summary of the institutional orientation data for each environmental pressure group. I used SPSS Quick-cluster (1997) statistical classification to form the groups, as discussed in the section describing the variables.

TABLE 23
Institutional Orientation Measures and Environmental Pressure Groups
Descriptive Statistics

Measure	Cluster Name	N	Mean	s.d.	Std. Error
Institutional Values	Commercial	22	4.82	1.62	.34
	Mixed	15	5.22	.68	.18
	Institutional	26	5.27	.44	.09
	Not Posted Internet	14	5.16	.50	.13
	Total	77	5.11	.98	.11
Importance of Institutional Performance Measures	Commercial	23	4.74	1.25	.26
	Mixed	15	4.34	1.08	.28
	Institutional	26	4.61	.66	.13
	Not Posted Internet	14	5.09	.62	.17
	Total	78	4.68	.96	.11

I used the Levene Test of homogeneity of variances (SPSS, 1997) to evaluate the equality of variance assumption. Results indicated that one cannot conclude that the variances are equal within the institutional values measures ($p < .05$). For the measure of *the importance of institutional performance measures* results indicate that I could assume homogeneity of variance. Refer to Table 24 for details of the test of homogeneity of variances.

TABLE 24
Institutional Orientation Measures
Levene Test of Homogeneity of Variances

Measure	Levene Statistic	df1	df2	sig.
Institutional Values	2.79	3	73	.05
Importance of Institutional Performance Measures	1.89	3	74	.14

Table 25 summarizes the ANOVA results comparing overall environmental pressure group differences on the measures of institutional orientation. I found no

evidence of differences in institutional values ($p < .42$) nor in the importance of institutional performance ($p < .20$) between the four environmental pressure groups.

TABLE 25
Institutional Orientation Measures and Environmental Pressure Groups
ANOVA

Measure	Contrast	Sum of Squares	df	Mean Square	F	sig.
Institutional Values	Between Groups	2.71	3	.90	.95	.422
	Within Groups	69.57	73	.95		
	Total	72.28	76			
Importance of Institutional Performance Measures	Between Groups	4.24	3	1.41	1.57	.20
	Within Groups	66.62	74	.90		
	Total	70.86	77			

Table 26 presents the pairwise contrasts using planned multiple comparison techniques for the two measures of institutional orientation. For the contrasts between groups in terms of institutional values I used the Dunnett T3 test for planned multiple comparisons with unequal variances because this test is appropriate for group sizes of less than 50 per group (Maxwell & Delaney, 1990). Dunnett's T3 differs from the Dunnett's C test for contrasts involving control groups (Maxwell & Delaney, 1990). Because I could assume equal variances, I used Tukey's method (Cook & Campbell, 1979) for the planned, multiple contrasts of the groups' differences in scores on the importance of institutional performance measures. Both Tukey's method and Dunnett's T3 test control for overall (experiment-wide) alpha levels for planned multiple contrasts (Maxwell & Delaney, 1990).

TABLE 26
Institutional Orientation Measures and Environmental Pressure Groups
Planned Multiple Contrasts

Dependent Variable	Type of Test	Contrast Group A (Environmental Pressure Group)	Contrast Group B	Mean Difference (A-B)	Std. Error	sig.
Institutional Values	Dunnett T3	Commercial	Mixed	-.40	.33	.87
			Institutional	-.45	.28	.75
			NPI	-.34	.33	.93
		Mixed	Institutional	-.04	.32	1.00
			NPI	.07	.36	1.00
		Institutional	NPI	.11	.32	.98
Importance of Institutional Performance Measures	Tukey HSD	Commercial	Mixed	.40	.32	.58
			Institutional	.13	.27	.96
			NPI	-.34	.32	.72
		Mixed	Institutional	-.27	.31	.81
			NPI	-.74	.35	.16
		Institutional	NPI	-.47	.32	.44

Interpretation of the Results of Tests of Hypothesis 1b. The predictions in Hypothesis 1b were not supported by the data. There were no differences in institutional orientation among the technology transfer organizations in different environmental pressure settings. I concluded that all university technology transfer offices exhibit similar levels of institutional orientation. One reason that could be inferred is that they do not differ in terms of institutional orientation because they are integral parts of a larger, highly institutionalized organization, a university or medical school. An alternative explanation would be that problems with the survey items created confusion among the respondents, as discussed above.

Institutional theory would support the conclusion that the technology transfer offices all reveal institutional orientation because they exist within the institutional setting of a university. The lack of differences in institutional orientation does not preclude the possibility of the organizations also being commercially oriented (Scott, 1987 & 1991; Scott & Meyer, 1991).

Hypothesis 2

Hypothesis 2 and its two sub-hypotheses predict relationships between commercial environmental pressures and commercial orientation of technology transfer organizations.

H2. Technology transfer organizations faced with predominantly technical-commercial pressures will exhibit a stronger commercial orientation than other organizations.

H2a: High technical-commercial and entrepreneurial orientation, indicated by self-reported *importance* of technical-commercial performance evaluation measures and scores on the self-report measures of entrepreneurial orientation (Covin and Slevin, 1991; Lumpkin and Dess, 1996; Miller, 1983), will be positively related to environments having strong technical commercial pressures, indicated by high industrial research expenditure *proportion*; high technical-commercial rating of intellectual property policy; and high technical-commercial rating of mission statement.

Analysis of Hypothesis 2a. I analyzed the predictions of H2a using Pearson bivariate correlations of the three measures of commercial environmental pressure and three measures of commercial orientation. The environmental pressure measures were: commercial mission scores; commercial scores of intellectual property

policies; and industrial research funding proportion. The commercial orientation measures were scores of survey items for: entrepreneurial orientation; commercial values; and the importance of commercial performance measures. Prior to conducting the correlation analysis, where needed, I transformed the variables to achieve a more normal distribution (Cohen & Cohen, 1983).

Results for H2a. Hypothesis 2a predicted a positive correlation between the measures of commercial environmental pressures and the measures of commercial orientation. Refer to Table 27 for the correlation matrix and levels of significance. The data suggest that some components of commercial environmental pressure and commercial orientation are positively correlated as predicted in H2a. The strongest relationship between commercial environmental pressure and commercial orientation appeared between the commercial mission statement scores and entrepreneurial orientation.

Two components of commercial environmental pressures were positively correlated with components of commercial orientation. The measure of commercial mission statement correlated positively with entrepreneurial orientation ($r=.45$, $p<.001$) and with the importance of commercial performance ($r=.33$, $p<.01$). The measure of commercial intellectual property policies correlated positively with entrepreneurial orientation ($r=.21$, $p<.10$) and with measures of the importance of commercial performance measures ($r = .20$, $p< .10$). Table 27 also shows several positive correlations within the commercial orientation construct, as would be expected for indicators of the same construct. The importance of commercial

performance was significantly correlated with entrepreneurial orientation (r=.64, p<.001) and with commercial values (r=.21, p<.10). Commercial values correlated positively with entrepreneurial orientation (r=.23, p<.05).

TABLE 27
Pearson Correlations of
Commercial Pressures and Commercial Orientation

Construct	Variable	1	2	3	4	5	6
Commercial Orientation	1. Entrepreneurial Orientation	1.00					
	2. Commercial Values	.23*	1.00				
	3. Importance: Commercial Performance	.64***	.21†	1.00			
Commercial Environmental Pressures	4. Commercial Mission	.45***	-.00	.33**	1.00		
	5. Commercial Intellectual Property Policies	.21†	-.03	.20†	.43***	1.00	
	6.Industrial Research Funding Proportion	.06	.07	-.03	-.15	-.12	1.00

*** Correlation is significant at p < .001 (2-tailed).
** Correlation is significant at p < .01 (2-tailed).
* Correlation is significant at p < .05 (2-tailed).
† Correlation is significant at p < .10 (2-tailed).
N = 76 (listwise exclusion.)

Within the commercial environmental pressures construct, commercial intellectual property policies correlated significantly with commercial mission statements (r=.43, p<.001) suggesting that the technology transfer office missions are aligned with the university intellectual property policies. Also, within the same construct, industrial research funding proportion correlated negatively (but not

significantly) with the measure of commercial mission statement contrary to what would be expected for components of the same construct.

Interpretation of Results of H2a. The strong relationship between the commercial mission statement and the entrepreneurial orientation measures suggest that the organization's perception of its activities fit with its mission or goals. It is not possible to conclude a causal relationship, however the alignment of the commercial mission and entrepreneurial orientation may indicate that commercial actions reflect commercial goals of the technology transfer offices.

It is important to note that the researcher's analyses and coding of the internet-posted mission statements were conducted entirely independently from the self-report responses to the survey items measuring entrepreneurial orientation. The mission statements and policies were coded before accessing the survey results. Survey results were sent directly from respondents to a database stored on a separate computer which was not accessible to the coder. The coder did not review the database of survey responses until after the completing the coding of the mission statements and policies. The independence of the data collection methods lends support to the conclusion of well-aligned goals/missions and organizational perceptions of its activities by avoiding the threat to validity of mono-method bias (Cook &Campbell,1979).

Analyses of Hypothesis 2b. Hypothesis 2b predicts a relationship between the environmental pressure classification and the commercial orientation of technology transfer offices.

H2b: **Organizations in environments characterized by high technical commercial pressures will exhibit stronger commercial orientation when compared with organizations in environments characterized by lower technical commercial pressures.**

Environmental Pressure Groups. Table 28 presents a summary of the commercial orientation data for each environmental pressure group. Examining and ranking the means of the measures of entrepreneurial orientation and commercial values suggest that the technology transfer offices in commercial pressure environments yielded the highest scores followed by those in mixed pressure environments, followed by those in institutional pressure environments, and finally the organizations in the Not Posted Internet group. The direction of the scores follows the predictions in Hypothesis 2 and its related sub-hypotheses.

The Levene test of homogeneity of variances results (Table 29) indicated that one could not conclude that the variances were homogeneous. Thus, when examining contrasts in analysis of variance (ANOVA) procedures I examined both the contrasts using techniques that do not require compliance with the assumption of homogeneity of variance.

TABLE 28
Commercial Orientation Measures and Environmental Pressure Groups
Descriptive Statistics

Measure	Environmental Pressure Cluster	N	Mean	s.d.	Std. Error
Entrepreneurial Orientation	Commercial	23	8.94	.55	.11
	Mixed	15	8.72	.58	.15
	Institutional	27	8.22	.89	.17
	NPI	14	8.03	1.12	.30
	Total	79	8.49	.87	.10
Commercial Values	Commercial	22	3.97	1.34	.29
	Mixed	15	4.17	.50	.13
	Institutional	26	4.19	.45	.09
	NPI	14	4.30	.58	.16
	Total	77	4.15	.83	.09
Importance of Commercial Performance Measures	Commercial	23	5.55	.41	.09
	Mixed	15	5.54	.40	.10
	Institutional	26	5.29	.92	.18
	NPI	14	5.27	.85	.23
	Total	78	5.41	.70	.08

TABLE 29
Commercial Orientation Measures
Levene Test of Homogeneity of Variances

Measure	Levene Statistic	df1	df2	sig.
Entrepreneurial Orientation	3.41	3	75	.02
Commercial Values	2.66	3	73	.06
Importance of Commercial Performance	3.30	3	74	.03

Table 30 summarizes the ANOVA results comparing overall environmental pressure group differences on the measures of organizational orientation. I found evidence suggesting that differences in entrepreneurial orientation exist between the four environmental pressure groups ($p < .002$). There was no evidence of differences

between the groups in terms of commercial values ($p < .68$) or the importance of commercial performance measures ($p < .45$).

TABLE 30
Commercial Orientation Measures and Environmental Pressure Groups
ANOVA

Measure	Contrast	Sum of Squares	df	Mean Square	F	sig.
Entrepreneurial Orientation	Between	10.47	3	3.49	5.39	.002
	Within	48.56	75	.65		
	Total	59.03	78			
Commercial Values	Between	1.06	3	.35	.51	.68
	Within	50.94	73	.70		
	Total	52.00	76			
Importance of Commercial Performance	Between	1.33	3	.45	.90	.45
	Within	36.66	74	.50		
	Total	37.99	77			

Table 31 displays the results of the planned multiple contrasts comparing each environmental pressure group on the measure of entrepreneurial orientation. I conducted planned multiple contrasts between the groups to examine the differences in the entrepreneurial orientation measures among technology transfer organizations in the four environmental pressure groups. I did not examine contrasts between groups in terms of commercial values nor the importance of commercial performance measures among the groups because the overall ANOVA indicated that I could not conclude there were differences. The tests for the planned multiple contrasts control for overall alpha level (Maxwell & Delaney, 1990).

TABLE 31
Entrepreneurial Orientation Measure and Environmental Pressure Groups
Planned Multiple Contrasts
Assume Unequal Variances

Test	Environmental Pressure Cluster A	Environmental Pressure Cluster B	Mean Difference A - B	Std. Error	sig.
Dunnett T3	Commercial	Mixed	.22	.27	.78
		Institutional	.72	.23	.01
		NPI	.92	.27	.06
	Mixed	Institutional	.50	.26	.19
		NPI	.69	.30	.26
	Institutional	NPI	.20	.27	.99
Games-Howell	Commercial	Mixed	.22	.27	.64
		Institutional	.72	.23	.01
		NPI	.92	.27	.05
	Mixed	Institutional	.50	.26	.15
		NPI	.69	.30	.20
	Institutional	NPI	.20	.27	.94

The technology transfer offices in the commercial pressure group revealed higher scores on the entrepreneurial orientation scale when compared with each other group. The differences were significant as predicted between the technology transfer offices in the commercial pressure group and the institutional pressure groups ($p < .01$). The organizations in the commercial pressure group were also significantly higher in entrepreneurial orientation when compared with the Not-Posted-Internet group ($p < .06$). I report two different calculations of significance, the Dunnett T3 method and the Games-Howell method. Both approaches are appropriate for planned multiple contrasts with unequal variances although the Dunnett T3 method is slightly more conservative for contrasts involving group sizes of less than 50 cases (Maxwell & Delaney, 1990).

Interpretation of the Results of H2b. The results of the tests support the prediction of Hypothesis 2b. I found higher levels of commercial orientation in technology transfer offices in the commercial environmental pressure group when compared with those in the institutional and Not-Posted-Internet groups. These findings indicate that a relationship appears to exist between commercial pressures and commercial orientation, at least as indicated by the measure of entrepreneurial orientation. Again, it is not possible to determine direction of causality, but the results indicate an alignment between organizational goals and perceived organizational actions.

Next I discuss the analysis and results of statistical tests evaluating the predictions of Hypothesis 3.

Hypothesis 3

Hypothesis 3 and its sub-hypothesis, H3a, predict a relationship between mixed environments and strong institutional plus strong commercial organizational responses. I found no evidence to support the predicted relationships between mixed environments and high levels of both institutional and commercial orientation.

H3. Technology transfer centers faced with both strong institutional and strong technical-commercial pressures will exhibit high levels of both institutional and entrepreneurial orientations to take advantage of support and benefits from both aspects of their environments.

H3a: High levels of both institutional orientation and entrepreneurial orientation (indicated by scores on self-reported *importance* of institutional and technical-commercial performance evaluation measures; organizational-level institutional values as

> evidenced by questionnaire items adapted from Bird, et al., 1993; and by self-report measures of entrepreneurial orientation Covin & Slevin, 1991; Lumpkin & Dess, 1996; Miller, 1983), will be positively related to environments having strong institutional and strong technical-commercial pressures (indicated by high institutional research *proportion*, high industrial research expenditure proportion, and high institutional and technical-commercial ratings on mission statements and intellectual property policies).

Contrasts between Environmental Pressure Groups. Table 31 displays the results of planned multiple contrasts comparing each environmental pressure group on the measures of commercial orientation. (All relevant tables were presented earlier in this chapter.) The mixed pressure group yielded higher commercial orientation scores when compared with the institutional pressure group and the not posted internet group, as shown in Table 28. However, the differences were not statistically significant as evidenced by the ANOVA tests presented in Table 31 based on the planned multiple contrasts between groups. Table 26 shows the results of the planned multiple contrasts comparing each environmental pressure group on the measures of institutional orientation. I found no significant organizational orientation differences between the technology transfer offices in mixed environments and those in other environments.

Interpretation of the Results of H3a. The data did not support the prediction that organizations operating in mixed environmental pressure situations would respond with strong institutional and commercial orientations. Thus, there appears to be no relationship between mixed environments and organizational responses.

Summary of Results of H1 through H3

Results of the analyses of the predicted relationships show that university technology transfer offices in different environments differ in terms of one measure of commercial orientation but not in terms of institutional orientation. Institutional theory supports the finding that all university technology transfer offices have similar levels of institutional orientation. The finding of significant differences in levels of entrepreneurial orientation for technology transfer offices in commercial environments when compared to those in other environments suggests an alignment between the environmental pressures and entrepreneurial orientation, one of three components of commercial organizational response measured in this research.

Organizational Orientation and Performance Results

Hypotheses 4 through 6 predict relationships between the organizational orientation of technology transfer offices and their performance. First, I present an overview of the relationships between the organizational orientation measures and the performance measures. Next, I present the analysis and results for the tests of each hypothesis. I conclude the section with a summary of the results of tests for Hypotheses 4 through 6.

Relationships between Organizational Orientation & Performance

Prior to testing the hypotheses related specifying performance contrasts between organizational orientation groups, I first examined the overall relationships between the organizational orientation variables and the measures of performance. Table 32 summarizes the correlations among the variables institutional orientation,

commercial orientation, and six performance measures: institutional research funding; NAS memberships; patents awarded; license granted; royalties and license fees; and the number of start-up companies. Institutional orientation does not correlate significantly with any of the other variables, including those attempting to measure institutional performance. The institutional performance variables do however correlate with commercial orientation. The National Academy of Sciences membership variable (log transformed) correlated with commercial orientation ($r = .27$, $p < .05$). Institutional research funding (log transformed) also correlated with commercial orientation ($r = .53$, $p < .001$). The number of start-up companies, a commercial performance measure, did not correlate with institutional orientation or with commercial orientation. All of the other commercial performance variables correlated significantly and in the expected positive direction with commercial orientation. The commercial performance variables also correlated strongly with the institutional performance measures.

TABLE 32
Organizational Orientation and Performance Measures:
Correlation Matrix

	Measure	1	2	3	4	5	6	7	8
Pearson Correlation Coefficient	1. Institutional Orientation	1.00							
	2. Commercial Orientation	.11	1.00						
	3. Institutional Research Funding Log[a]	-.05	.53***	1.00					
	4. NAS Total Log	-.18	.27*	.68***	1.00				
	5. Patents Awarded 1996 Log	-.10	.41**	.69***	.67***	1.00			
	6. Royalties 1996 Log	-.01	.57***	.70***	.66***	.69***	1.00		
	7. Licenses 1996 Log	-.14	.36**	.74***	.74***	.75***	.68***	1.00	
	8. Start-up Companies 1996	-.01	.16	.49***	.56***	.53***	.44***	.62***	1.00
Number for each measure (pairwise exclusion)	1. Institutional Orientation	77							
	2. Commercial Orientation	77	77						
	3. Institutional Research Funding Log	77	77	153					
	4. NAS Total Log	61	61	119	132				
	5. Patents Awarded 1996 Log	53	53	111	98	123			
	6. Royalties 1996 Log	55	55	115	101	123	129		
	7. Licenses 1996 Log	55	55	111	98	119	123	123	
	8. Start-up Companies 1996	56	56	115	101	121	127	123	130

[a] The log transformed variables are used in the analyses.

Tests for Homogeneity of Variance. I used the Levene test of homogeneity of variances in order to determine which significance testing criteria to use in the analyses for all the performance measures. Refer to Table 33. I could not assume homogeneity of variances for the institutional research funding variable ($p < .01$). The results for the number of start-up companies variable also suggested that I could not assume equal variances ($p < .07$). For both of these variables I examined the contrast significance tests reported for unequal variances. For all other measures I used tests that assume homogeneity of variance.

TABLE 33
Institutional and Commercial Performance Measures
Levene Test of Homogeneity of Variance

Measure	Levene Statistic	df1	df2	sig.
NAS Memberships Log	.70	2	58	.50
Institutional Research Funding Log	5.53	2	74	.01
Patents Awarded 1996 Log	1.07	2	50	.35
Royalties & License Fees 1996 Log	.08	2	52	.93
Licenses Granted 1996 Log	.35	2	52	.71
Start-Up Companies 1996	2.44	2	53	.07

Hypothesis 4

Hypothesis 4a predicts that technology transfer offices having strong institutional orientations will also have stronger institutional performance.

H4: Organizations revealing a strong institutional orientation will exhibit stronger institutional-type performance.

H4a: Technology transfer centers revealing strong institutional orientation are predicted to exhibit stronger institutional-type performance as indicated by higher *levels* of Federal and non-industrial research funding and a higher number of members in national honorary academies when compared with organizations revealing entrepreneurial or mixed orientations.

Table 34 summarizes the National Academy of Science membership (NAS) and institutional research funding data for each organizational orientation group. The table suggests that commercial orientation and mixed orientation technology transfer

offices have higher levels of both institutional performance measures. The technology transfer offices reporting mixed orientations (determined by high institutional and high commercial orientation scores) appear to also have higher levels of institutional research funding than the other groups.

TABLE 34
Institutional Performance Measures:
Descriptive Statistics by Organizational Orientation Group

Variable	Organizational Orientation Group	N	Mean	s.d.	Std. Error
NAS Total Log	Institutional Orientation	10	1.44	.99	.31
	Mixed Orientation	40	2.25	1.43	.23
	Commercial Orientation	11	2.77	1.35	.41
	Total	61	2.21	1.39	.18
Institutional Research Funding Log	Institutional Orientation	18	11.67	1.56	.37
	Mixed Orientation	46	13.24	.91	.13
	Commercial Orientation	13	13.21	1.06	.29
	Total	77	13.87	1.29	.15

To test Hypothesis 4a and to assess if the performance differences were significant, I conducted an ANOVA comparison between the organizational orientation groups to examine the differences based on the two institutional performance variables. Based on the ANOVA comparisons and contrasts discussed below, I concluded that both the mixed orientation group and the commercial orientation group have higher institutional research funding performance than the institutional orientation technology transfer offices, contrary to the prediction in H4a.

The technology transfer organizations in the commercial orientation group also had more NAS members ($p<.10$) than the offices in the institutional orientation group.

Table 35 presents the overall ANOVA comparisons for institutional performance among the organizational orientation groups. The groups differ in terms of the institutional research funding variable ($p < .001$). The groups may also differ in terms of the number of members in the National Academy of Sciences ($p < .09$).

TABLE 35
Institutional Performance
ANOVA Comparisons

Performance Measure	Comparison	Sum of Squares	df	Mean Square	F	sig.
NAS Total Log	Between Groups	9.45	2	4.72	2.57	.09
	Within Groups	106.42	58	1.84		
	Total	115.87	60			
Institutional Research Funding Log	Between Groups	33.78	2	16.89	13.62	.00
	Within Groups	91.73	74	1.24		
	Total	125.50	76			

I conducted planned multiple comparisons to control for overall alpha levels (Maxwell & Delaney, 1990) between organizational orientation groups and the two institutional performance measures. I used the Tukey's method to evaluate NAS performance and Dunnett's T3 method for institutional research funding. Refer to Table 36 for details.

The institutional orientation group when compared with the commercial orientation group had lower NAS membership ($p < .07$) and lower institutional funding levels ($p<.01$). The institutional orientation group also had lower institutional research funding than the mixed orientation group ($p< .001$). The

analysis revealed no significant institutional performance differences between the mixed orientation group and the commercial orientation group.

TABLE 36
Institutional Performance:
Planned Multiple Contrasts Between Organizational Orientation Groups

Performance Measure	Organizational Orientation Group Contrast		Mean Difference	Standard Error	sig. (2-tailed)
NAS Total Log	Institutional vs.	Mixed	-.81	.48	.22[a]
		Commercial	-1.33	.59	.07
	Mixed vs.	Commercial	-.52	.46	.50
Institutional Research Funding Log	Institutional vs.	Mixed	-1.57	.31	.00[b]
		Commercial	-1.54	.41	.01
	Mixed vs.	Commercial	.04	.35	.99

[a] Calculated using Tukey's HSD method.
[b] Calculated using Dunnett T3 method.

The weak institutional performance of the institutional orientation group compared with the commercial orientation group is contrary to the predicted relationships. The ranking (high to low) in terms of scores on institutional orientation measures of the three groups was: 1) mixed orientation group; 2) institutional orientation group; and 3) commercial orientation group. The strong institutional performance of the mixed orientation group follows the predictions of the hypothesis because the mixed group also had higher scores on institutional orientation measures. Following the prediction in the hypothesis, the mixed orientation group should also have higher institutional performance than the commercial orientation group. However, the data did not show significant differences between the mixed and commercial orientation groups. Because of the mixed results, I could not conclude

that differences in institutional performance relate to differences in organizational orientation.

Hypothesis 5

H5: Organizations revealing a strong commercial orientation will exhibit stronger commercialization performance than organizations exhibiting predominantly institutional orientation.

H5a: Technology transfer centers revealing higher levels of commercial orientation will have more licenses granted, start-up companies, patents, and higher royalties and license fees than organizations exhibiting predominantly institutional orientation.

Table 37 shows the commercial performance data organized by organizational orientation group. I used the log transformation for the number of patents, the amount of royalties and the number of licenses granted to achieve more normal distributions (Cohen & Cohen, 1983). The total number of technology transfer offices in the analysis varies from 53 to 56. The reduced number of cases reflects the availability of data from the AUTM licensing survey reports. Small group sizes for both the institutional orientation (from n=8 to n=11) and commercial orientation groups (n=11) may make it difficult to detect differences due to low power for the analyses.

TABLE 37
Commercial Performance Measures
Descriptive Statistics by Organizational Orientation

Performance Measure	Organizational Orientation Group	N	Mean	s.d.	std. error
Patents Awarded 1996 Log	Institutional Orientation Group	8	1.12	1.17	.42
	Mixed Orientation Group	34	2.44	.85	.15
	Commercial Orientation Group	11	2.50	1.05	.32
	Total	53	2.25	1.04	.14
Royalties Earned 1996 Log	Institutional Orientation Group	10	11.09	2.07	.65
	Mixed Orientation Group	34	13.92	1.72	.30
	Commercial Orientation Group	11	13.63	2.00	.60
	Total	55	13.35	2.11	.28
Licenses Granted 1996 Log	Institutional Orientation Group	10	.83	1.13	.36
	Mixed Orientation Group	34	2.30	1.25	.21
	Commercial Orientation Group	11	2.52	1.42	.43
	Total	55	2.07	1.37	.19
Start-Up Companies 1996	Institutional Orientation Group	11	.27	.90	.27
	Mixed Orientation Group	34	1.68	2.64	.45
	Commercial Orientation Group	11	1.91	2.30	.69
	Total	56	1.45	2.37	.32

The overall ANOVA comparisons based on commercial performance measures revealed significant differences between organizational orientation groups on all measures except the number of start-up companies. Refer to Table 38 for details of the comparisons. The groups differed in terms of the number of patents awarded in 1996 ($p < .01$); the amount of royalties received in 1996 ($p < .001$); and in terms of the number of licenses granted in 1996 ($p < .01$). I cannot conclude that differences exist between groups in terms of the number of start-up companies in 1996 ($p < .18$).

Table 38
Commercial Performance
ANOVA Overall Comparisons of Organizational Orientation Groups

Performance Measure	Comparison	Sum of Squares	df	Mean Square	F	sig.
Patents Awarded in 1996 Log	Between Groups	12.51	2	6.08	6.87	.002
	Within Groups	44.24	50	.89		
	Total	56.39	52			
Royalties Received in 1996 Log	Between Groups	63.24	2	31.62	9.32	.000
	Within Groups	176.39	52	3.39		
	Total	239.63	54			
Licenses Granted in 1996 Log	Between Groups	19.44	2	9.72	6.12	.004
	Within Groups	82.64	52	1.59		
	Total	102.09	54			
Start-up Companies in 1996	Between Groups	19.31	2	9.65	1.76	.18
	Within Groups	290.53	53	5.48		
	Total	309.84	55			

Table 39 presents the results of planned multiple contrasts between the organizational orientation groups for each commercial performance measure. I used Tukey's method for all contrasts except the number of start-up companies for which I examined both Tukey's method and the Dunnett T3 method (Maxwell & Delaney, 1990).

The hypothesis predicted that groups having higher commercial orientation scores would also have higher commercial performance results. The groups ranked from high to low according to their scores on commercial orientation are: 1) mixed orientation group; 2) commercial orientation group; and 3) institutional orientation group. When contrasted with the institutional orientation group, the mixed and

commercial orientation groups each had more patents, licenses, start-up companies and higher royalties. This finding follows the prediction of the hypothesis.

TABLE 39

Commercial Performance Measures:
Planned Multiple Contrasts Between Organizational Orientation Groups

Performance Measure	Organizational Orientation Group Contrast		Mean Difference	std. error	sig. (2-tailed)
Patents Awarded 1996 Log	Institutional vs.	Mixed	-1.32	.37	.00[a]
		Commercial	-1.38	.44	.01
	Mixed vs.	Commercial	-.06	.33	.98
Royalties 1996 Log	Institutional vs.	Mixed	-2.84	.66	.00[a]
		Commercial	-2.54	.81	.01
	Mixed vs.	Commercial	.30	.64	.89
Licenses Granted 1996 Log	Institutional vs.	Mixed	-1.47	.45	.01[a]
		Commercial	-1.70	.55	.01
	Mixed vs.	Commercial	-.23	.44	.86
Start-up Companies 1996	Institutional vs.	Mixed	-1.40	.81	.20[a] .03[b]
		Commercial	-1.64	1.00	.24 .13
	Mixed vs.	Commercial	-.23	.81	.96 .99

[a] Calculated using Tukey's HSD method, assuming homogeneity of variances, to control for overall alpha level with multiple planned comparisons (Maxwell & Delaney, 1990).
[b] Calculated using Dunnett T3 method, assuming unequal variances, to control for overall alpha level with multiple planned comparisons (Maxwell & Delaney, 1990).

Hypothesis 6

H6: Organizations revealing both strong institutional and strong entrepreneurial orientations will be more successful in technology commercialization performance measures than organizations showing only strong commercial or only strong institutional orientations because

they capitalize on their relationships with both institutional and technical-commercial stakeholders.

H6a: Technology transfer centers revealing *both* strong institutional and strong entrepreneurial orientations will have higher royalties/revenues, more start-up companies, more patents, and more licenses granted than technology transfer centers exhibiting predominantly commercial or predominantly institutional orientation.

I conducted planned multiple contrasts between the organizational orientation groups for each commercial performance measure. I used Tukey's method for all contrasts except the number of start-up companies. Based on the Levene test of homogeneity of variance, it is possible that the variances might not be homogeneous for the number of start-up companies. Therefore, for these contrasts I used both Tukey's method and the Dunnett T3 method (Maxwell & Delaney, 1990).

Technology transfer offices revealing mixed orientations had higher levels of commercial performance than offices having institutional orientations. Refer to Table 39 presented earlier. I found no evidence of commercial performance differences between technology transfer offices having mixed orientations compared with those having commercial orientations. The prediction of Hypothesis 6a is supported by the results between mixed and institutional orientations, but not between mixed and commercial orientations.

Additional Analyses

I conducted two additional tests to evaluate technology transfer office performance relationships. First, I used ANOVA tests with planned multiple contrasts to assess

the relationship between organizational orientation and technology transfer office performance when controlling for the effects of university size. Second, I used multiple regression analyses to examine the relationship among all the variables in the model and two performance measures, institutional research funding and patents. In the multiple regression analyses, I also examined the results when controlling for the size of the university.

Organizational Orientation and Size-Controlled Performance

To control for the effects of university size I divided the dependent variable by the total number of graduate faculty. Table 40 presents descriptive statistics for the size-controlled measures: National Academy of Sciences memberships; institutional research funding; patents; royalties and licensing income; and licenses granted.

I also conducted a test of the homogeneity of variances prior to the ANOVA contrasts. I could assume that each variable had homogeneity of variances as indicated by the Levene test results shown in Table 41.

TABLE 40
Performance Controlled for Size of University
Descriptive Statistics[a]

Performance Measure	Organizational Orientation	N	Mean	s.d.	Std. Error	Minimum	Maximum
NAS Total per 100 Faculty	Institutional	13	.3	.5	.1	0	1.5
	Mixed	33	2	4	.8	0	23.3
	Commercial	8	2	3	1	0	9.3
	Total	54	2	4	.5	0	23.3
Institutional RF $ per Faculty[b]	Institutional	13	79.62	98.52	31.16	8	337
	Mixed	33	142.87	269.27	46.87	14	1584
	Commercial	8	68.53	33.52	11.85	12	120
	Total	51	118.81	222.26	31.12	8	1584
Patents per 1000 Faculty	Institutional	10	4.3	5.10	1.61	.000	14.93
	Mixed	33	17.37	29.44	5.12	2.57	165.05
	Commercial	8	10.05	7.08	2.50	2.52	25.91
	Total	51	13.66	24.39	3.42	.000	165.05
Royalties & Fees per Faculty Member[c]	Institutional	10	189.21	236.97	74.94	0	761
	Mixed	33	3403.65	6535.77	1137.73	86	34,434
	Commercial	8	1709.06	2673.60	945.26	44	7629
	Total	51	2507.55	5482.35	767.68	0	34,434
Licenses per 100 Faculty	Institutional	10	.4	.5	.2	0	1.5
	Mixed	33	3	7	1	.1	4.1
	Commercial	8	1	.9	.3	.3	2.7
	Total	51	2	6	.8	0	4.1

[a] Descriptive statistics show raw data for ease of interpretation.
[b] Average yearly institutional RD funding divided by the total number of graduate faculty ($00s).
[c] Total 1996 royalties and fees divided by the total number of graduate faculty.

TABLE 41
Performance Measures Controlled for Size of University
Levene Test of Homogeneity of Variance

Measure	Levene Statistic	df1	df2	sig.
NAS per Faculty Member	.49	2	39	.61
Institutional RF $ per Faculty Member	1.00	2	48	.38
Patents per 1000 Faculty	1.06	2	45	.36
Royalties & Fees per Faculty Member	.03	2	47	.97
Licenses per Faculty Member	.76	2	47	.46

Next, I conducted planned multiple comparisons using ANOVA and Tukey's method to evaluate significance. The multiple comparison results presented in Table 42 show no differences between groups in terms of per faculty institutional research funding or NAS memberships. Technology transfer offices having mixed orientations had higher per faculty numbers of patents ($p < .06$), royalties ($p<.00$), and licenses ($p<.04$) than those having institutional orientations. I found higher royalties per faculty with organizations having commercial orientations ($p<.09$) when compared with those in the institutional orientation group.

TABLE 42
Performance Controlled for Size of University
Planned Multiple Comparisons[a]

Dependent Variable	Organizational Orientation		Mean Difference	Std.	
	Contrast A	Contrast B	A - B	Error	sig.
NAS Membership per Faculty[c]	Institutional	Mixed	-.63	.64	.60 (.22)[b]
		Commercial	-.75	.83	.64 (.07)
	Mixed	Commercial	-.12	.64	.98 (.50)
Institutional Research Funding per Faculty	Institutional	Mixed	-.63	.31	.12 (.00)
		Commercial	-.23	.41	.84 (.01)
	Mixed	Commercial	.40	.34	.46 (.99)
Patents per 1000 Faculty	Institutional	Mixed	-.87	.37	.06 (.00)
		Commercial	-.67	.46	.32 (.01)
	Mixed	Commercial	.20	.35	.84 (.98)
Royalties per Faculty	Institutional	Mixed	-2.48	.64	.00 (.00)
		Commercial	-1.76	.82	.09 (.01)
	Mixed	Commercial	.72	.67	.53 (.98)
Licenses per Faculty	Institutional	Mixed	-1.10	.44	.04 (.01)
		Commercial	-.96	.57	.22 (.01)
	Mixed	Commercial	.14	.46	.95 (.86)

[a] All contrasts assume equal variance and use Tukey's HSD method to control for overall alpha level for multiple comparisons (Maxwell & Delaney, 1990).
[b] Significance in parentheses shows significance for contrasts using the original dependent variables that did not control for size of university taken from Tables 36 and 39.
[c] Variables transformed using logit transformation (Cohen & Cohen, 1983).

I concluded that when compared with institutional TTOs, organizations having relatively strong levels of both institutional and commercial orientations have better commercial performance after controlling for the effects of university size. There were no significant performance differences between mixed orientation TTOs and commercial orientation TTOs.

Multiple Regression: Patents and Institutional Research Funding

I used multiple regression analyses to examine how well the variables in the model predict two types of performance, the amount of institutional research funding and the number of patents. I also examined size-controlled institutional research funding and size-controlled patents. For both types of dependent variables my goal was to determine the model with the best predictive capability. I used backward elimination multiple regression techniques (Pedhazur, 1982; Hair, et al., 1995).

The ten independent variables were the summed scales or scores (Nunnally, 1978) for each of measures reported in previous analyses. The independent variables were: entrepreneurial orientation; importance of institutional performance measures; industrial research funding proportion; commercial intellectual property policies; institutional values; institutional mission; importance of commercial performance measures; commercial values; commercial mission; and institutional intellectual property policies. For each of the models, the independent variables were transformed to achieve more normal distributions (Cohen & Cohen, 1983). I entered the variables without any planned sequence and examined the full model and the models produced by backward elimination techniques (Pedhazur, 1982).

First, I present the results of the analyses of the models predicting levels of institutional research funding and institutional research funding per faculty. Next, I discuss the results of the multiple regression analyses of the models predicting the number of patents and number of patents per faculty.

Institutional Research Funding Multiple Regression

Table 43 presents the full model and parsimonious model for the dependent variable measures of institutional research funding. First, I discuss the full model and the parsimonious model for institutional research funding. I then present the full model and the parsimonious model for institutional research funding per faculty to control for possible effects related to university size.

Institutional Research Funding Full Model. The full model (n=75) using all ten independent variables yielded an $R^2 = .492$. This result suggests that the full model explains nearly half of the variance of the six-year total of institutional research funding The more conservative adjusted R^2 for the full model was adjusted $R^2 = .413$.

TABLE 43

Institutional Research Funding (RF) & Size-Controlled Institutional RF Multiple Regression Full Models & Parsimonious Models: Backward Elimination Method

Variables	Institutional RF Full Model	Institutional RF Parsimonious Model	Institutional RF Per Faculty Full Model	RF/Faculty Parsimonious Model
Entrepreneurial Orientation	.036[a]		.373[*]	.379[**]
Importance of Institutional Performance	-.027		.074	
Industrial RF Proportion	-.288[**]	-.284[**]	-.165	-.160
Commercial IP Policies	.155		.482	.505[†]
Institutional Values	-.194	-.226[†]	-.041	
Institutional Mission	-.601		.001	
Importance of Commercial Performance	.420[***]	.453[***]	.018	
Commercial Values	.200	.214	.163	.158
Commercial Mission	.253[†]	.222[**]	-.017	
Institutional IP Policies	-.144		-.430	-.470
R^2	.492	.485	.239	.235
Adjusted R^2	.413	.448	.049	.150
F (Significance)	6.286 (.000)	13.176 (.000)	1.257 (.287)	2.758 (.029)
N	75	75	50	50

[a] Standardized beta coefficients.

[***] $p<.001$ [**] $p<.01$ [*] $p<.05$ [†] $p<.10$

The institutional predictors were in the opposite direction of the hypothesized relationships. Institutional values, importance of institutional performance measures, and institutional intellectual property policies had negative signs in the overall equation. In addition, the predictor of industrial research funding proportion was negatively and significantly ($p < .05$) associated with the level of institutional research funding. Two other variables were significant in the full model, the importance of commercial performance ($p < .001$) and commercial mission statement ($p < .10$).

Parsimonious Model Institutional Research Funding. I used backward elimination techniques (Pedhazur, 1982) to evaluate more parsimonious models of predicting institutional research funding. I selected the model having the highest adjusted R^2 as the model to report as the parsimonious model. The more parsimonious model predicting institutional research funding was:

> IRF = Constant - Industrial RF Prop - Institutional Values + Importance of Commercial Performance Measures + Commercial Mission.

The institutional research funding parsimonious model yielded $R^2 = .485$ and adjusted $R^2 = .448$. The significant variables in the parsimonious model were: Commercial mission ($p < .01$), importance of commercial performance ($p < .001$), institutional values ($p < .10$), and industrial research funding proportion ($p < .01$). Commercial values, commercial mission, and the importance of commercial performance were all positively associated with institutional research funding levels.

Institutional Research Funding per Faculty Full Model. When using the size-adjusted institutional research funding levels (n=50), the model's performance decreases as indicated by the $R^2 = .239$ and adjusted $R^2 = .049$. Only the entrepreneurial orientation variable was significant ($p<.01$) in the full model predicting institutional research funding per faculty.

Institutional Research Funding per Faculty Parsimonious Model. I selected the model having five independent variables as the more parsimonious model based on having the highest adjusted R^2 of all the models in the backward elimination process. The selected model resulted in $R^2 = .235$ and adjusted $R^2 = .150$. The model selected was:

> IRF/Faculty = Constant + Entrepreneurial Orientation - Industrial RF Proportion + Commercial IP Policies + Commercial Values - Institutional IP Policies.

The parsimonious model of size-adjusted institutional research funding included two significant variables: entrepreneurial orientation ($p<.01$) and commercial IP policies ($p<.10$). These results suggest that entrepreneurial orientation may be an important factor contributing to institutional performance in technology transfer universities.

Patents Awarded Multiple Regression

I examined multiple regression results of the full model and parsimonious models predicting the number of patents awarded for the university and the number of patents awarded per faculty to adjust for the possible effects of size. I again used the criteria of the highest adjusted R^2 to select the more parsimonious model from the

backward elimination process. Table 44 presents the results of the multiple regression analyses of the patents awarded dependent variables.

TABLE 44
Patents Awarded & Patents Awarded per Faculty
Multiple Regression Full Models & Parsimonious Models: Backward Elimination Method

Variables	Patents Awarded Full Model	Patents Parsimonious Model	Patents/Faculty Full Model	Patents /Faculty Parsimonious Model
Entrepreneurial Orientation	.104[a]		.340[†]	.319[*]
Importance. of Institutional Performance	-.114		.042	
Industrial RF Proportion	-.287[*]	-.264[*]	-.171	-.174
Commercial IP Policies	.281		.241	
Institutional Values	-.128	-.213	-.018	
Institutional Mission	-.102		.115	
Importance of Commercial Performance	.258[†]	.341[**]	-.016	
Commercial Values	.229	.259	.083	
Commercial Mission	.372[†]	.306[*]	-.102	
Institutional IP Policies	-.292		-.133	
R^2	.381	.348	.168	.133
Adjusted R^2	.234	.278	-.057	.094
F (Significance)	2.589 (.015)	5.012 (.001)	.747 (.677)	3.444 (.041)
N	52	52	47	47

[a] Standardized beta coefficients.
[***] p<.001 [**] p<.01 [*] p<.05 [†] p<.10

Patents Awarded Full Model. The full model using ten independent variables resulted in $R^2 = .381$ and an adjusted $R^2 = .234$ in predicting patents awarded (n=52) at the university level. Three variables were significant: industrial RF proportion ($p<.05$); importance of commercial performance measures ($p<.10$); and commercial mission ($p<.10$). Variables with negative coefficients were: importance of institutional performance; industrial research funding proportion; institutional values; institutional mission; and institutional IP policies.

Patents Awarded Parsimonious Model. The parsimonious model included five independent variables and resulted in $R^2 = .348$ and an adjusted $R^2 = .278$. The significant variables were: industrial RF proportion ($p<.05$); importance of commercial performance measures ($p<.01$); and commercial mission statements ($p<.05$). The parsimonious model was:

> Patents = Constant - Industrial RF Proportion - Institutional Values + Importance of Commercial Performance Measures + Commercial Values + Commercial Mission.

Patents per Faculty Full Model. The full model using ten independent variables resulted in $R^2 = .168$ and an adjusted $R^2 = -.057$ in predicting patents awarded per faculty (n=47). The entrepreneurial orientation variable was the only significant ($p<.10$) variable in the model. The full model does not function well as a predictive model for the number of patents when controlling for university size.

Patents per Faculty Parsimonious Model. Using backward elimination and selecting the model having the highest adjusted R^2 I selected a model having only two predictor variables. The parsimonious model resulted in $R^2 = .133$ and an

adjusted $R^2 = .094$ in predicting patents awarded per faculty (n=47). The parsimonious model was:

Patents/Faculty = Constant + Entrepreneurial Orientation - Industrial RF Proportion.

The entrepreneurial orientation variable was significant ($p<.05$) and in the direction expected. Industrial research funding proportion was again negatively related to the performance in terms of number of patents. A high proportion of industrial research funding seems to be found in universities with lower overall research funding levels. Thus, rather than indicating commercial orientation, industrial research funding proportion seems to indicate low levels of other types of research funding.

Summary of Additional Analyses

I conducted two types of additional post hoc statistical analyses. First, I used ANOVA to examine the relationship between organizational orientation group membership and performance controlled for size of university. Second, I used multiple regression analysis to examine the overall model.

Results of the ANOVA contrasts partially supported the predictions of Hypothesis 6. Compared with institutional orientation TTOs, technology transfer offices having mixed orientation were higher performing as measured by the number of licenses, royalties and patents. There were no performance differences between mixed and commercial orientation TTOs.

For the multiple regression analyses, I used summated measures for each of the ten independent variables. Institutional research funding and institutional RF per faculty were the two institutional performance dependent variables used in the

multiple regression analyses. I also used two commercial performance dependent variables, the number of patents awarded and the number of patents per faculty member.

The full model explained nearly 50% of the variance of institutional research funding and nearly 40% of the variance in the number of patents awarded. The predictive capabilities of the models (full and parsimonious) were dramatically lower for the size-controlled institutional research funding and size-controlled number of patents. For the size-controlled patents and institutional research funding performance measures, entrepreneurial orientation was a significant predictor in both the full and parsimonious models. This finding suggests that entrepreneurial orientation may be a good predictor of technology transfer success. The data also suggest that university size is likely to be an important predictor of the number of patents and the amount of research funding. Next I present a summary of the results discussed throughout Chapter Five.

Summary of Results

The intent of this research was to test two types of relationships suggested by institutional theory. The first set of relationships tested were between environmental pressures and organizational responses of university technology transfer offices. The second set of relationships examined were between categories of organizational response and organizational performance. I based my hypotheses on institutional theory and recent research dealing with organizational response to changes in institutional environments. In general, the hypotheses predicted that 1) technology

transfer offices would respond in accordance with environmental conditions and 2) their performance would correspond with the organization's orientation. I used correlation analysis, ANOVA, cluster analysis and multiple regression analysis to examine the data from and about the 77 US university technology transfer offices in my sample. The results were mixed.

In my analysis, I found that all university technology transfer offices have similar levels of institutional orientation, regardless of the kinds of environmental pressures. There was a strong relationship between commercial mission statements and commercial orientation, suggesting an alignment between goals and perceived actions. Commercial orientation, in general, was related to strong institutional as well as strong commercial performance. Institutional orientation was associated with lower rather than higher institutional performance. I also uncovered entrepreneurial orientation as factor related to strong commercial performance.

Environmental Pressures and Organizational Orientation: Summary

In terms of environmental pressures and organizational orientation, I found relationships in the commercial measures (H2) but not in the institutional measures (H1). The data revealed no significant correlations between indicators of institutional environmental pressure and institutional orientation. I also found no differences in levels of institutional orientation regardless of the type of environmental pressure facing the technology transfer offices. However, the data supported the predictions in Hypotheses 2. Strong correlations existed between entrepreneurial orientation (an indicator of commercial orientation) and commercial

mission scores (an indicator of commercial environmental pressure) suggesting an alignment between organizational response and environmental pressures. There were also significantly higher levels of commercial orientation in technology transfer offices in mixed and commercial environmental pressure situations. I did not find the relationship predicted in Hypothesis 3 between mixed environmental pressures and the organizational responses of technology transfer offices. The predictions of Hypothesis 2 were supported while the predictions of Hypothesis 1 and 3 were not supported by the data. Refer to Table 45 for a summary of the results of the tests of the hypotheses.

Based on the analysis of the results for Hypotheses1-3, I concluded that university technology transfer offices all have similar levels of institutional orientation. I also concluded that university technology transfer offices have significantly different commercial orientations in response to differing types of environmental pressures.

Table 45

Hypotheses' Tests Results Summary

Prediction	Results
H1a: Correlation between institutional pressures and institutional orientation measures	One significant correlation. Importance of Inst. Perf. (-.27*) with Inst. Policies. See Table 22.
H1b: TTOs faced with institutional pressures will respond with higher i.o. than other TTOs	All the same. See Tables 25 and 26.
H2a: Correlation between commercial pressures and commercial orientation measures	Commercial mission & policies correlated with EO & importance of commercial performance. See Table 27.
H2b: TTOs faced with commercial pressures will respond with higher c.o. than other TTOs	CP TTOs had higher CO than IP TTOs and higher than Not-posted TTOs. See Tables 30 and 31.
H3a: TTOs faced with mixed pressures will respond with strong institutional plus strong commercial orientations.	No differences. See Tables 26 and 31.
H4a: TTOs with strong institutional orientation will have stronger institutional performance	Institutional orientation TTOs had lower NAS membership than commercial TTOs; and lower institutional RF than mixed and commercial orientation TTOs. See Tables 32, 34, 35 and 36.
H5a: TTOs with strong commercial orientation will have stronger commercial performance.	Commercial orientation TTOs had higher commercial performance than institutional orientation TTOs. See Tables 32 and 39. Start-ups same.
H6a: TTOs with mixed orientations will have stronger institutional and stronger commercial performance.	Mixed orientation TTOs had higher institutional RF, patents, royalties, & licenses than institutional orientation TTOs. No differences compared with commercial orientation TTOs. See Tables 32, 36, 37& 39.

Organizational Orientation and Performance: Summary

The second set of hypotheses (H4-H6) predicted that organizational performance would be aligned with the organizational orientations of the technology transfer office. Again, the results were mixed. Contrary to the prediction of Hypothesis 4,

technology transfer offices with mixed and commercial orientations had higher institutional performance (National Academy of Sciences memberships and institutional research funding) than offices having institutional orientations. In addition, offices with mixed or commercial orientations also generated more patents, licenses, and royalties. Technology transfer offices having mixed orientations also generated more start-up companies when compared with offices having an institutional orientation. The higher levels of commercial performance by organizations having mixed or commercial orientations were predicted in Hypothesis 5 and Hypothesis 6. Finally, contrary to the prediction of Hypothesis 6, without considering university size, technology transfer offices revealing mixed orientations did not have higher levels of commercial performance than those having commercial orientations.

I concluded that entrepreneurial orientation, commercial values and viewing commercial performance measures as important to the organization are associated with strong commercial performance and strong institutional performance. I also concluded that institutional orientation was not associated with either strong institutional or commercial performance.

Controlling for Size of University: Summary

I conducted ANOVA contrasts among organizational orientation groups using performance measures divided by the number of faculty. Results of the size-controlled ANOVA suggested that technology transfer offices having mixed orientations generated more patents, royalties and licenses than offices having

institutional orientations. I also found that technology transfer offices with commercial orientations received significantly more royalty income than offices with institutional orientation. I concluded that after controlling for the effects of university size, organizations having relatively strong commercial and institutional orientation have stronger commercial performance only when compared with organizations with institutional orientations. This conclusion partially conforms with Hypothesis 6 and may suggest that organizations attending to both the academic institutional demands and commercial demands will be more successful in commercializing technologies. See Table 46 for a summary of the findings of the post-hoc tests controlling for size of the university.

Table 46
Size-controlled Performance Contrasts
ANOVA: Post Hoc Analyses

Analysis	Results
ANOVA Organizational Orientation & Size-controlled Performance: Mixed vs. Institutional	No differences in institutional performance measures. Mixed orientation TTOs had higher per faculty patents; royalties & licenses. See Tables 40 and 42.
ANOVA Organizational Orientation & Size-controlled Performance: Commercial vs. Institutional	Commercial orientation TTOs had higher per faculty royalties. See Table 42.
ANOVA Organizational Orientation & Size-controlled Performance: Commercial vs. Mixed	No significant differences in performance measures. See Tables 40 and 42.

Multiple Regression Models: Summary

The multiple regression analysis used all ten independent variable indicators in models predicting institutional research funding levels and patents awarded. I

examined both sets of regression equations using university performance measures and performance measures controlled for the size of the university. I used backward elimination to determine the variables to include in parsimonious models.

The models predicting university-wide performance explained more of the variance in performance. In all models the proportion of industrial research funding was negatively associated with performance. It appears that a high *proportion* of industrial research funding is found in universities with lower absolute research funding levels. Thus, rather than indicating commercial orientation, industrial research funding proportion seems to indicate low levels of other types of research funding. The tests of H2a shown previously in Table 27 showed that industrial research funding proportion was not significantly correlated with entrepreneurial orientation or with commercial values and was negatively (but not significantly) correlated with commercial missions and commercial policies.

In size-controlled models, entrepreneurial orientation was a significant variable in the prediction model. I concluded that entrepreneurial orientation could be a strong predictor of both institutional research funding and patents, even when controlling for size of university. Refer to Tables 47 and 48 for a summary of the multiple regression results.

The next section, Chapter 6, presents a discussion and interpretation of the results of the research conducted and reported for this dissertation. First, I discuss the theoretical implications linking the results to institutional theory and entrepreneurship theory. Second, I present practical implications and interpretations

of the results, specifically as the data and results could be applied to technology transfer organizations.

Table 47
Institutional Research Funding Post Hoc Multiple Regression
(Data from Table 43)

Analysis	Results
Full Model Institutional RF = EO - Impt. Inst. Perf - Ind. RF Prop** + Comm IP Pols - Inst. Values - Inst. Mission + Impt. Comm. Perf.** + Comm Values + Comm Mission† - Inst. IP Pols	R^2 = .49; Adjusted R^2 = .41 F=6.29, Significance=.000 Across universities of all sizes, without controlling for size, importance of commercial performance measures is a strong predictor of institutional research funding. The negative industrial research funding proportion also is a significant predictor along with commercial mission statements.
Full Model Institutional RF per Faculty = EO* + Impt. Inst. Perf - Ind. RF Prop + Comm IP Pols - Inst. Values + Inst. Mission + Impt. Comm. Perf. + Comm Values - Comm Mission - Inst. IP Pols	R^2 = .24; Adjusted R^2 = .05 F= 1.26, Significance = .29 F-test and significance level suggest that the model is not a good predictor of the change in institutional research funding levels on a per faculty basis.
Parsimonious Model Institutional RF = -Industrial RF Prop** - Inst. Values† + Impt. Comm. Perf** + Comm Values + Comm Mission**	R^2 = .49; Adjusted R^2 = .45 F= 13.18, Significance = .000 Across universities of all sizes, without controlling for size, commercial mission and importance of commercial performance measures are strong predictors of institutional research funding.
Parsimonious Model Institutional RF per Faculty = Entrepreneurial Orientation** - Industrial RF Prop + Commercial IP Policies† + Comm Values - Inst. IP Policies	R^2 =.24; Adjusted R^2 = .15 F= 2.76, Significance = .029 After controlling for university size, entrepreneurial orientation and commercial IP policies are strong predictors of institutional research funding.

Table 48
Patents Awarded Post Hoc Multiple Regression
(Data from Table 44)

Analysis	Results
Full Model Patents Awarded = EO - Impt. Inst. Perf. - IndRF prop* + Comm IP Pols - Inst. Values - Inst. Mission + Impt. Comm.Perf.† + Comm Values + Comm Mission† - Inst. IP Policies	R^2 = .38; Adjusted R^2 = .23 F= 2.59, Significance = .015 Full Model variance explained offers important new information about university technology transfer.
Full Model Patents Awarded per Faculty = EO† + Impt. Inst. Perf. - Ind RF prop + Comm IP Pols - Inst. Values + Inst. Mission - Impt. Comm.Perf. + Comm Values - Comm Mission - Inst. IP Policies	R^2 = . 17; Adjusted R^2 = -.06 F= .75, Significance = .68 Poor model for predicting patent performance after accounting for the effects of university size.
Parsimonious Model Patents Awarded = - IndRF prop* - Inst. Values + Impt. Comm. Perf.** + Comm Values + Comm Mission*	R^2 = .35; Adjusted R^2 = .28 F= 5.12, Significance = .001 Commercial performance measures and commercial missions are important for successful university technology transfer. Industrial research funding proportion may reflect low levels of other funding, thus the negative sign.
Parsimonious Model Patents Awarded per Faculty = Entrepreneurial Orientation* - IndRF prop	R^2 = .13; Adjusted R^2 = .09 F=3.44, Significance = .041 Offers new information about university technology transfer offices and the importance of entrepreneurial orientation, even in a university-institutional setting.

CHAPTER SIX

DISCUSSION

The purpose of this research was to examine how academic institutional pressures and commercial pressures affect the performance of university technology commercialization organizations. The theoretical foundations drew on institutional theory (Lynn & Rao, 1995;Oliver,1991; Scott, 1987) and applied concepts from entrepreneurship research, specifically the construct of entrepreneurial orientation (Covin & Slevin, 1991; Lumpkin, 1995; Lumpkin & Dess, 1996; Miller, 1983). I found that successful university technology transfer offices pay attention to their institutional foundations and to the commercial demands of technology commercialization. All university technology transfer offices respond to the institutional pressures in their environments, however the offices with the most successful technology transfer programs also act as entrepreneurial organizations in alignment with commercial missions and intellectual property policies.

In Chapter Six I interpret the findings and contributions of this research. First, I recap the findings. Next, I discuss implications for research and applications to managing university technology transfer programs. I then offer suggestions for future research. I conclude the chapter with a brief summary of the contributions and directions for future research.

Summary of Results

I conducted many different analyses of the data collected for this study. All of the analyses lead to three broad conclusions. First, university technology transfer offices exhibit similar levels of academic institutional orientation in response to the generally academic institutional environments of universities. Second, technology transfer organizations revealing strong commercial orientation were found in settings having strong commercial pressures (missions and policies) which could also be viewed as goals of the organizations. This suggests an alignment between the goals and the actions of the technology transfer offices. Third, commercial orientation, and more specifically, entrepreneurial orientation was found in high performance technology transfer offices. This third major conclusion suggests that entrepreneurial actions, as indicated by entrepreneurial orientation, relate to the performance of technology transfer offices. Taken together, the conclusions of this study demonstrate that effective university technology transfer programs operate with an alignment of commercial goals, organizational actions, and performance while acknowledging or adhering to the institutional demands of their environments. The technology transfer office missions and intellectual property policies provided indications of the goals. The measure of entrepreneurial orientation and the assessment of the importance of commercial performance measures represented the organizational actions. Performance indicators included number of patents, licenses and royalties, in addition to the number of members in National Academy of Sciences organizations and the amount of institutional research funding.

The three broad conclusions are based on eight specific findings:

1. University technology transfer offices can be classified according to levels of institutional, commercial and mixed environmental pressures.
2. All university technology transfer offices reveal similar levels of institutional orientation.
3. Entrepreneurial orientation and the perceived importance of commercial performance measures correlate with two measures of commercial pressures --commercial missions and commercial policies.
4. Technology transfer offices having a commercial orientation generate higher levels of commercial performance.
5. Technology transfer offices having a commercial orientation are found in universities with higher levels of the measures of institutional performance -- the number of National Academy of Sciences memberships and institutional research funding. However, this finding was not robust when controlling for the effects of university size, suggesting that commercial orientation technology transfer offices were often in the larger universities.
6. Mixed orientation technology transfer offices (TTOs) generate higher levels of commercial performance than TTOs having an institutional orientation, even after controlling for the effects associated with university size.
7. After controlling for size, commercial orientation TTOs generate more royalties but not patents, licenses or start-up companies when compared with institutional orientation TTOs.

8. After controlling for the effects of university size entrepreneurial orientation is an important predictor of both the number of patents and the amount of institutional research funding.

Implications For Research

In analyzing the data from the present study I can draw a number of conclusions that extend or support institutional theory research, entrepreneurship research and research related to technology commercialization or technology transfer. In discussing the implications for research I organize the implications following the constructs in the research model. First, I present implications related to the institutional, commercial and mixed environmental pressures. Next, I discuss implications that evolve from the findings about environmental pressures and organizational responses. Last, I summarize research implications based on the relationships between organizational orientation and performance of university technology transfer offices.

Environmental Pressures

I uncovered differing levels of institutional pressures and technical commercial pressures facing university technology transfer offices. This finding lends support to one of the foundations for this study which was to apply the concept of complex environmental pressures as presented by Scott (1987). Scott suggested that organizations operate in settings that include both institutional pressures and technical commercial pressures, as opposed to one or the other type of pressure. Using cluster analysis procedures, I classified technology transfer offices according to dimensions of institutional pressures and technical commercial pressures. The dimensions used for the

classification were not dichotomous or opposing, rather, the technology transfer offices could and did have high scores on both the institutional and the technical commercial dimensions of their environments (Powell, 1991; Scott, 1987; 1991; 1995). The classification scheme allowing high scores on both technical commercial pressures and institutional pressures offers evidence in support of the complex nature of institutional settings. Using a complex scheme of institutional environments contrasts with the often-used one dimensional assumption of an institutional environment. The complex institutional environment also differs from the scheme of the presence or absence of institutional pressures and the classification approach which suggests mutually exclusive institutional or commercial pressures. Thus, the study responds to a need called for by Scott (1994:84) by classifying and assessing characteristics of an institutional environment. It also tests the concepts of a multidimensional institutional environment as proposed by Scott (1987).

Environmental Pressures and Organizational Response

Oliver (1991) proposed that organizations strategically respond to their environmental pressures in order to maintain legitimacy and resources support. Oliver's (1991) propositions of strategic choice in an institutional environment challenged earlier thinking that organizations simply copy similar organizations (using what has been labeled *isomorphism*) in response the demands of the institutional pressures (DiMaggio & Powell, 1983; 1991). Interestingly, I found evidence of both strategic choice responses as suggested by Oliver (1991) and organizational responses of isomorphism (DiMaggio & Powell, 1983; 1991).

When testing across environmental pressure groups, all of the technology transfer offices had similar levels of institutional orientation suggesting that they conform with the norms, values and rules of their university's institutional environment. The institutional orientation conformance offers a good example of institutional isomorphism (DiMaggio & Powell, 1983; 1991). The finding of no differences in institutional orientation also provides empirical evidence of institutional isomorphism even for organizations in environments comprised of both institutional and commercial pressures. The institutional conformance could be a result of the need to sustain organizational legitimacy for access to university resources (Friedlund & Alford, 1991; Oliver, 1991).

In support of Oliver's (1991) propositions pertaining to strategic choice responses in institutional environments, I found wide differences in commercial orientation, especially in entrepreneurial orientation, among US university technology transfer offices. This finding also extends the conclusions of strategic choices as a response to institutional pressures offered by Goodstein (1994) and Ingrams and Stevens (1995). If the technology transfer organizations were merely passively fitting in with their environments, they would likely have conformed with the broader and dominant university academic-institutional environment rather than with their unique commercial environment. Together the results indicating similar institutional orientation and widely divergent commercial orientation provide empirical evidence of Scott's (1987) suggestion that organizations do operate in multi-dimensional environments and must respond to complex demands in order to maintain legitimacy and support.

The findings of strong commercial orientation of technology transfer offices in mixed and commercial environments suggest a congruence between commercial pressures and organizational orientation. One interpretation suggests that commercial environmental pressures form part of an infrastructure that supports and encourages commercial activity, as explored by Van de Ven and Garud (1989; 1994) . The technology transfer organizations in this research responded in a commercial or entrepreneurial manner to their foundations or emerging infrastructure of commercial environmental pressures. In this way this study lends general support to the conclusions of Van de Ven (1993) and Van de Ven and Garud (1989; 1994a & b) in their works that bridge institutional and entrepreneurship research streams.

Environmental pressures as measured in this study were not necessarily imposed upon the technology transfer offices. The technology transfer offices created their own mission statements or statements of purpose. Some of the technology transfer offices influenced the content of the intellectual property policies as indicated by responses to survey items. The reciprocal relationship or perhaps evolutionary nature of the pressures and organizational responses suggests that organizations influence and are influenced by their environments. We do not know from this study which occurred first -- the commercial pressures or the commercial orientation. If the commercial or entrepreneurial orientation of the technology transfer offices existed first, then the offices defined their missions and worked with other university members to develop and refine the intellectual property policies to support commercialization and technology transfer. In this scenario, with entrepreneurial orientation leading to commercial missions and policies, the technology transfer offices having an alignment

between their missions, policies and actions may actually reflect organizations that *talk the walk* (Weick, 1995). Weick explains: "To talk the walk is to be opportunistic in the best sense of the word. It is to search for words that make sense of current walking... (1995:183)." In other words, the technology transfer organizations formalized goals and policies to be congruent with entrepreneurial or commercial actions needed to create a bridge between their academic institutions and commercial ventures of all types, from large, established corporations to small, start-up ventures.

Organizational Orientation and Performance

Commercial orientation, specifically as measured by entrepreneurial orientation, plays a significant role in successful university technology transfer programs. However, the best performing technology transfer offices demonstrate strong commercial and strong institutional orientation, which I labeled *mixed orientation* throughout the study. The relationship between organizational orientation and performance contributes to both institutional theory research and to the field of entrepreneurship research.

In terms of institutional theory contributions, the research responded Oliver's (1991) call for studies examining the performance effects of complex environmental pressures. The results extend the findings of recent studies examining performance related to institutional settings (e.g., Elsbach, 1994; Ezzamel, Robson, & Taylor, 1995; Lynn & Rao, 1995; Shanks-Meile & Dobratz, 1995). In contrast to the prior studies, the present research examined multiple measures and multiple types of performance, in addition to specifically assessing institutional and commercial environmental pressures. The present study built upon the earlier studies and extended the model to include

comparisons between types of performance, contrasts between environmental pressure groups, and tests of the alignment between environmental pressures and organizational responses.

Technology transfer offices classified as having mixed orientations had strong entrepreneurial orientations in addition to strong institutional orientations. The successful performance of the mixed orientation technology transfer offices fits with the institutional and commercial demands of the environments in which university technology transfer offices must operate. The strong performance of mixed-orientation technology transfer offices provides further evidence in support of Scott's (1987) proposed model in which organizations can successfully operate in response to complex institutional and technical commercial pressures.

The results of the study show a strong relationship between commercial orientation and institutional as well as commercial performance. The relationship between strong commercial orientation and strong institutional performance was not predicted in the hypotheses. Before controlling for university size, multiple regression analyses showed that commercial missions and perceptions of the importance of commercial performance measures were significant predictors of both institutional research funding and the number of patents awarded. The results of multiple regression analyses after controlling for university size indicated that entrepreneurial orientation (Covin & Slevin, 1991; Lumpkin & Dess, 1996; Miller, 1983) is a significant predictor of both institutional research funding and the number of patents.

The construct of entrepreneurial orientation was robust to the effects of university size and may capture an essential organizational pattern of action that leads to strong

performance of many different types. However, entrepreneurial technology transfer offices may be part of research offices which are also innovative, competitive, and proactive, in other words, entrepreneurial. I suggest this alternative because acquiring institutional research funding is not usually a function of the technology transfer office but of an affiliated or parent organization such as the office of sponsored research or the office of the vice president for research. However, the potential for an overall pattern of entrepreneurial activity within a highly institutionalized setting such as a university creates new opportunities for applying entrepreneurship research concepts to management situations beyond the new venture arena.

In the language of institutional theory, successful technology transfer offices may be in the process of creating a new institutional order of entrepreneurial or commercial orientation for the conduct of the technology commercialization business of the university. The entrepreneurial technology transfer offices may also be part of a broader pattern of entrepreneurial behavior leading change in universities. Perhaps the entrepreneurial offices are part of the process alluded to by DiMaggio's and Powell's (1991:28) question: "Under what conditions are challengers and entrepreneurs able to refashion existing rules or create new institutional orders?"

The link between entrepreneurial orientation and performance had, until recently, been assumed but not empirically tested (Brown & Davidsson, 1998). Finding a relationship between entrepreneurial orientation and performance provides a response to the various calls for empirical evaluation of this relationship (e.g., Covin & Slevin, 1991; Lumpkin & Dess, 1996). The results showing significant relationships between entrepreneurial orientation and university technology transfer office performance

provide the first US-based empirical results to demonstrate a relationship between entrepreneurial orientation and performance. Brown and Davidsson (1998) and Wiklund (1998) first confirmed the assumed existence of a link between entrepreneurial orientation and performance in large-sample studies of small to medium sized enterprises in Sweden.

The link between entrepreneurial orientation and performance also provides an empirical test of an entrepreneurship research concept applied to the field of technology transfer of publicly-supported research discoveries (Autio & Laamanen, 1995; Spann, Adams & Souder, 1995; Harmon, et al., 1997). The strong connection between entrepreneurial orientation and technology transfer performance establishes empirical evidence for the usefulness of entrepreneurship theoretical concepts in examining technology transfer processes.

Implications for Technology Transfer Organizations

University technology transfer or commercialization has been a subject of much interest in recent months (e.g., Associated Press, 1998; Deutsch, 1997; Foster,1998; Machen, 1998; Melcher, 1998; Mejia, 1998; Melzor, 1998; Mian, 1998; National Science Foundation, 1998; Piercey, 1998; The Christian Science Monitor, 1998; Vedovello, 1998; US General Accounting Office, 1998). The interest in the popular press as well as in government-related publications focuses on the economic benefits to the universities, the faculty and the overall economy (e.g., Buschberger, 1998; Fairweather, 1990). Much of the work written for or about technology transfer organizations in articles or books emphasizes the very valuable practical experiences of

the authors (e.g., Ambrosio, 1995; Burnham, 1997; Cheng, 1995; Del Campo et al., 1998; Hazlett & Carayannis, 1998; Muir, 1997). Recently, theoretically-grounded research and articles have appeared that deal with the processes and outcomes of transfer or commercialization of publicly-funded technology (e.g., Mejia, 1998; Harmon, et al., 1997; Kassiecieh, Radosevich, & Umbarger, 1996). Both the prescriptive articles based on the authors' technology transfer experiences and the theoretically-grounded research offer valuable insights about the management of the university technology transfer processes. The pragmatic insights of practitioner-based articles reflect the view from the trenches, often based on experiences in a single technology transfer organization. The present study offers theoretically-grounded insights or clues about successful methods of operations from a wide variety of technology transfer organizations in many different types of universities from all parts of the United States. The present study offers a theoretically grounded view from the trenches combining the benefits of theoretical foundations with extensive data from the experiences of diverse technology transfer offices.

Entrepreneurial Orientation

Technology transfer offices with entrepreneurial orientations generated more patents, more licenses and more royalties, even after controlling for size of the university. Entrepreneurial attitudes and entrepreneurial actions such as pro-activeness, risk-taking, innovativeness, and competitive leadership related to strong commercial performance. Technology transfer offices would benefit from reward structures that recognize entrepreneurial activities, including rewarding risk-taking and the occasional

failure resulting from risk-taking. Hiring entrepreneurial employees, those willing to assume risks, be creative and fail , could also foster the entrepreneurial orientation needed for high levels of technology commercialization success (e.g., Melcher, 1998). Entrepreneurial orientation was also found to be a predictor of institutional research funding (even after controlling for university size). One can conclude that entrepreneurial actions could benefit organizations pursuing goals other than technology commercialization, such as research funding acquisition.

Missions and Policies

Mission statements and policies related to strong commercial orientation as well as performance. The data and results cannot reveal the direction of the causal relationship, but without commercial missions and policies, the commercial orientation and ultimately, commercial performance was lower. I also found that universities and technology transfer offices that posted missions and policies in accessible sites on the Internet had stronger commercial orientation than organizations without such information accessible. Perhaps the offices with more information available had established and clarified their goals and policies, thus they were willing to have them accessible to public review. Another interpretation would be that faculty researchers and potential industrial partners having access to the missions and policies can be more knowledgeable about and more focused on commercializing research. It could also be that publicly posted and clear missions and policies reflect a broader cultural acceptance of technology transfer. Based on the relationships found between commercial missions, commercial policies, and entrepreneurial orientation, technology

transfer offices would benefit from clearly stated, publicly-available missions and policies.

Attention to Institutional and Commercial Demands

I found evidence of greater success for technology transfer offices that were attentive to both the traditional academic-institutional demands and the commercial demands of their unique environments within university. Technology transfer offices operate in situations with many different, if not at times conflicting, opportunities, demands and constraints. Successful technology transfer offices were often those that were able to attend to both sets of demands or at least acknowledge the different factors influencing their choices of business activities. The technology transfer offices in this study that had strong institutional and strong commercial orientations also were those having higher institutional research funding and higher levels of commercial performance results. Perhaps these universities and technology transfer offices understood the academic-institutional realities as well as the commercial realities, and could work effectively in both types environments. In terms of management of a technology transfer office in a university having a balanced understanding of the expectations of both academic-institutional environments and the commercial environments would appear to be important for everyone in the organization. Such a balance might be achieved through the selection process of hiring people with both types of experience or through reward systems that encourage attending to diverse types of demands.

Directions For Future Research

The results of this study tell us that entrepreneurial orientation relates to performance of university technology transfer offices. The results suggest that technology transfer organizations that attend to both the institutional and the commercial aspects of their environment will be more successful. The study also reveals that all university technology transfer offices have similar levels of institutional orientation across the three defined environmental pressure groups of institutional pressures, mixed pressures and commercial pressures. We can conclude from this research that the most effective university technology transfer programs align their missions, their policies, and their actions with commercial demands while still recognizing and cooperating within the academic institutional framework of the university. Suggestions for related future research follow based on the findings or the questions raised by the results of this research.

The results of the present research do not reveal the antecedents to entrepreneurial orientation. The results of the present study also do not tell us why entrepreneurial orientation relates to both strong commercial and strong institutional types of performance. A study seeking to identify antecedents to entrepreneurial orientation in an organization would provide insight to help organizations develop and manage the entrepreneurial behaviors of the organization. Understanding antecedents to entrepreneurial orientation also could help to clarify the construct (Lumpkin & Dess, 1996) and its relationship to various types performance as revealed in the present research.

Another question related to entrepreneurial orientation would be interesting to examine in light of the results of the present research: Does entrepreneurial orientation affect the performance of other types of organizations faced with changing institutional pressures? In future research it would be interesting to broaden the application of the characteristics of institutional and technical commercial pressures to examine other organizations faced with competing or changing environmental demands. A first step might be to examine university administrative and research units to assess the commercial and institutional orientations of the university overall. One might discover an overall culture of complementary actions that successfully manage diverse environmental demands. Other types of technology transfer programs or processes could be examined in the context of the institutional and commercial demands of their environments. Beyond the technology transfer field, studying various types of organizations existing within strong but changing institutional foundations could provide cross-sectional data to test the concepts across organizational types, rather than within one type of organization or industry.

The relationship between university technology transfer performance and entrepreneurial orientation may provide a starting point for future research at the intersection between entrepreneurship theories and institutional theory. DiMaggio and Powell (1991:28) posed a question for future research: "Under what conditions are challengers and entrepreneurs able to refashion existing rules or create new institutional orders?" In the language of institutional theory, successful technology transfer offices may be in the process of creating a new institutional order of entrepreneurial or commercial orientation for the conduct of the technology

commercialization business of the university. Answers to questions about such new institutional forms could be addressed in a longitudinal investigation examining the formation dates and time-lagged performance of technology transfer offices combined with data from the current analyses of organizational orientation.

Longitudinal studies examining time-lagged performance data would be of particular interest for future research particularly in the area of technology transfer with its inherently lagged performance (Keller, 1997). While I used prior year data as a proxy for current year performance, a potential weakness in the present study, the data and results form a solid foundation for future longitudinal research. The performance data measures were all collected from archival sources which are updated each year making longitudinal research not only interesting but also feasible.

Researchers and those interested in commercializing technology sometimes view university intellectual property policies as constraints to transferring technology (e.g., Del Campo, et al., 1998). Based on analyzing and coding the intellectual property policies of more than 130 US universities I am impressed by the similarities among the policies. The policies seem to differ slightly in terms of the structure and level of royalty participation, in terms of the process and required speed of responding to inventors, and perhaps, in terms of the policy-defined relationships between the inventors and the administrators. These impressions of differences are just that, impressions, because I was not specifically coding the policies along these dimensions. In terms of practical benefits, research specifically examining and quantifying intellectual property policy variability and the relationship to technology transfer would provide critical information to universities throughout the US. Many universities

are in the process of updating and revising their intellectual property policies to accommodate rapidly changing categories of technologies such as software, internet-based course materials, genetically-engineered organisms, etc. Monitoring and understanding the impact of policies could provide valuable information for universities and their technology transfer offices.

Conclusion

The present study was conducted with the intent of exploring factors contributing to successful technology transfer in US universities. Because the technology transfer organizations exist within highly institutionalized settings I applied concepts from institutional theory to examine factors contributing to performance. Thus, the second purpose of the research was to examine organizational responses and performance as affected by combined institutional and commercial environments.

The results of the research contribute to institutional theory research streams, to entrepreneurship research, and to the successful operation of US university technology transfer organizations. While university technology transfer offices all revealed similar levels of institutional orientation, there were differences in levels of commercial orientation. These differences may be related to changing institutional patterns as well as to commercial pressures in the environment. Both of these conclusions contribute to extending our understanding of institutional theory applied to organizations in complex institutional environments. In terms of contributions to entrepreneurship research, university technology transfer offices with strong entrepreneurial orientation also have strong performance in both institutional and commercial performance measures. This

finding lends support to the value of the entrepreneurial orientation construct. Finally, in the application of the findings to technology transfer management, two conclusions are especially important. First, entrepreneurial orientation related to commercial performance. Second, attending to both institutional and commercial demands related to both strong institutional and strong commercial performance. These two findings suggest that technology transfer offices should consider selection and retention tactics that emphasize entrepreneurial actions.

Several directions for future research evolve from the present study. It would be interesting to explore the question: Does entrepreneurial orientation affect the performance of other types of organizations faced with changing institutional pressures? Investigating the antecedents to entrepreneurial orientation could provide valuable theoretical and practical insights for a better understanding of the entrepreneurial orientation construct. Conducting the present study as a longitudinal design would allow examination of time-lagged the performance impact of entrepreneurial in a technology transfer setting. Extending the research data to other university units such as research centers, individual researchers and university administration would enhance our understanding of the technology transfer process, the impact of institutional and commercial demands, and the role of entrepreneurial orientation to other types of performance. Testing the model in other conflicted or changing institutional settings would extend our knowledge about changing institutional environments, such as Federal research centers, NASA, or military research centers. Specifically related to university technology transfer, it would be useful to understand and examine the relationship between the intellectual property

policies and technology transfer performance. Finally, in terms of greater understanding of organizations in the context of changing institutions, it would be useful and interesting to examine entrepreneurship and its relationship to changes in institutional settings as well as to changes in organizations.

I conclude with the following from Robert Pirsig's Zen and the Art of Motorcycle Maintenance:

> When are we going to get to the top?
>
> Probably quite a way yet.
>
> Will we see a lot?
>
> I think so. Look for blue sky between the trees. As long as we can't see the sky, we know it's quite a way yet. The light will come through the trees when we round the top. (p. 238)

We may not be able to see the entire sky yet but I hope the findings from this study allow us to see a little more light coming through the trees.

REFERENCES

REFERENCES

Abrahamson, E. & Rosnekopf, L. 1993. Institutional and competitive bandwagons: Using mathematical modeling as a tool to explore innovation diffusion. Academy of Management Journal, 18. (3):487-517.

Abbott, A. 1988. The System of Professions: An Essay on the Division of Expert Labor. Chicago: University of Chicago Press.

Abbott, A. 1995. Sequence analysis: New methods for old ideas. Annual Review of Sociology, 21. 93-113.

Adams, M. & Spann, M. 1993. Strategic redirecting via technology commercialization: Preliminary results from defense and space contractors. Proceedings: Third Annual High Technology Management Conference. Boulder, CO: University of Colorado. 11-20.

Adams, M. & Spann, M. 1995. Strategic redirection via technology commercialization: Preliminary results from defense and space contractors. Journal of High Technology Management Research, 6. (1):77-93.

Aldenderfer, M. S. & Blashfield, R. K. 1984. Cluster Analysis. Quantitative Applications in the Social Sciences Series. Beverly Hills, CA. Sage.

Aldrich, H. E. & Fiol, C. M. 1994. Fools rush in? The institutional context of industry creation. Academy of Management Review, 19. (4):645-670.

Ambrosio, E. M. 1995. Technological management and transfer of technology. International Journal of Technology Management, 10. (7/8):665-675.

Arbaugh, J. B. & Sexton, D. L. 1995. Assessing performance differences among configurations of strategic orientation and customer dependency in a discontinuously changing external environment: A study of the defense industry. Paper presented at the 1995 Academy of Management Conference. Vancouver, B.C.

Arzeni, S. 1992. Encouraging the entrepreneur. The OECD Observer, 174. February/March. 19-22.

Associated Press. 1998. Universities reap windfall from research. CNN Interactive: CNN.com. http:// cnn.com/ US/ 9802/ 18/ university.inventions. Accessed February 18, 1998.

Astley, W. G. & Van de Ven, A. H. 1983. Central perspectives and debates in organization theory. Administrative Science Quarterly, 28. 245-273.

Autio, E. & Laamanen, T. 1995. Measurement and evaluation of technology transfer: Review of technology transfer mechanisms and indicators. International Journal of Technology Management, 10. (7/8): 643-664.

AUTM (The Association of University Technology Managers). 1996. AUTM Licensing Survey: FY 1991 - FY 1995 (Full Report). Association of University Technology Managers, Inc. Norwalk, CT.

AUTM (The Association of University Technology Managers). 1997. AUTM Licensing Survey: Fiscal Year 1991 - Fiscal Year 1996 (Full Report). Association of University Technology Managers, Inc. Norwalk, CT.

AUTM (The Association of University Technology Managers). 1997. The 1997 Membership Directory. Association of University Technology Managers, Inc. Norwalk, CT.

AUTM (The Association of University Technology Managers). 1998. University Technology Offices. http://autm.rice.edu/university.html. Accessed 1996-1998. Association of University Technology Managers, Inc. Norwalk, CT.

Bailietti, A. J. & Callahan, J. R. 1992. Assessing the impact of university interactions on an R&D organization. R&D Management, 22. (2):145-156.

Baron, J. 1993. The small business technology transfer program: converting research into economic strength. Economic Development Review. Fall. 63-66.

Barney, J. B. 1991. Firm resources and sustained competitive advantage. Journal of Management, 17. (1):99-120.

Baum, J. A. C. & Oliver, C. 1991. Institutional linkages and organizational mortality. Administrative Science Quarterly, 36. 187-218.

Baum, J. A. C. & Oliver, C. 1992. Institutional imbeddedness and the dynamics of organizational populations. American Sociological Review, 57. 540-559.

Baum, J. C. & Powell, W. W. 1995. Cultivating an institutional ecology of organizations: Comment on Hannan, Carroll, Dundon, and Torres. American Sociological Review, 60. 529-538.

Baumol, W. J. 1993. Formal entrepreneurship theory in economics: Existence and bounds. Journal of Business Venturing, 8. 197-210.

Beekun, R. I. & Ginn, G. O. 1993. Business strategy and interorganizational linkages within the acute care hospital industry: An expansion of the Miles and Snow typology. Human Relations, 46. (11):1291-1318.

Beveridge, G. S. G. 1991. Technology transfer form a regional university: Origins, developments and diversity. International Journal of Technology Management, 6. (5/6):441-449.

Beard, D. W. & Dess, G. G. 1988. Modeling organizational species' interdependence in an ecological community: An input-output approach. Academy of Management Review, 13. (3) 362-373.

Bigelow, B. & Stone, M. M. 1995. Why don't they do what we want? An exploration of organizational responses to institutional pressures in community health centers. Public Administration Review, 55. (2):183-192.

Bird, B. J. 1988. Implementing entrepreneurial ideas: The case for intention. Academy of Management Review, 13. (3):442-453.

Bird, B. J., Hayward, D. J., & Allen, D. N. 1993. Conflicts in the commercialization of knowledge: Perspectives from science and entrepreneurship. Entrepreneurship: Theory and Practice. Summer. 57-77.

Blum, T. C., Fields, D. L. & Goodman, J. S. 1994. Organizational-level determinants of women in management. Academy of Management Journal, 37. (2):241-268.

Boeker, W. P. 1988. Organizational origins: Entrepreneurial and environmental imprinting at the time of founding. In Glenn R. Carroll (Ed.) Ecological Models of Organizations. Cambridge, MA: Ballinger. 35-51. (ordered via ILL)

Boeker, W. P. 1989. The development and institutionalization of subunit power in organizations. Administrative Science Quarterly, 34. 388-410.

Brenner, R. 1992. Entrepreneurship and business ventures in the new commonwealth. Journal of Business Venturing, 7. 431-439.

Brown, M. A., Berry, L. G., & Goel, R. K. 1991. Guidelines for successfully transferring government-sponsored innovations. Research Policy, 20. 121-143.

Brown, T., Davidsson, P. 1998. Entrepreneurial orientation versus entrepreneurial management: Relating Miller/Covin & Slevin's conceptualization of entrepreneurship to Stevenson's. Paper presented at the 18th Babson Entrepreneurship Conference. Ghent.

Brint, S. & Karabel, J. 1991. Institutional origins and transformations: The case of American community colleges. In W. W. Powell & P. J. DiMaggio (eds.) The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 337-360.

Brust, M. F. 1990. Technology transfer and the university. The Journal of Applied Business Research, 7. Winter. (1):1-5.

Burnham, J. B. 1997. Evaluating industry/university research linkages. Research-Technology Management, 40. (1):52-55.

Buschberger, B. 1998. University research vitalization and social change. Technological Forecasting and Social Change, 57. 211-215.

Campbell, K. J. 1989. Technology transfer in the Navy research and development community: An analysis of private industry and Navy laboratory performance. Unpublished doctoral dissertation. Graduate Faculty of the School of Business and Management: United States International University. San Diego.

Carnegie Foundation. 1998. The 1994 Carnegie Foundation Classification. http://www.carnegiefoundation.org/cihe/cihe-dc.htm. Accessed March 12, 1998 through April 24, 1998. Carnegie Foundation for the Advancement of Teaching.

Chen, M. J. & Hambrick, D. C. 1995. Speed, stealth and selective attack: How small firms differ from large firms in competitive behavior. Academy of Management Journal, 38. (2):453-482.

Chidamber, S. R. & Kon, H. B. 1994. A research retrospective of innovation inception and success: The technology-push, demand-pull question. International Journal of Technology Management, 9. (1):94-112.

Cheng, J. T. 1995. Technology policy paradigms and intellectual property strategies: Three national models. Technological Forecasting and Social Change, 49. 35-48.

Choo, C. W. 1993. Environmental Scanning: Acquisition and use of information by chief executive officers in the Canadian telecommunications industry. Unpublished Doctoral Dissertation. University of Toronto, Canada. DAI-A54/09, p. 3246.

Cohen, J. & Cohen, P. 1983. Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences. Hillsdale, NJ. Lawrence Erlbaum Associates.

Cook, T. D. & Campbell, D. T. 1979. Quasi-Experimentation: Design and Analysis Issues for Field Settings. Boston. Houghton Mifflin.

Commons, J. R. 1970, 1950. The Economics of Collective Action. Madison, WI. The University of Wisconsin Press.

CORDIS: Community R&D Information Service. 1996. <http://www.cordis.lu> Worldwide Web.

Covaleski, M. A. & Dirsmith, M. W. 1988. An institutional perspective on the rise, social transformation and fall of a university budget category. Administrative Science Quarterly, 33. 562-587.

Covin, J. G. & Slevin, D. P. 1991. A conceptual model of entrepreneurship as firm behavior. Entrepreneurship Theory and Practice. Fall. 7-25.

Covin, J. G. & Slevin, D. P. 1993. A response to Zahra's "Critique and Extension" of the Covin-Slevin entrepreneurship model. Entrepreneurship Theory and Practice. Summer. 23-28.

Cutler, R. S. 1989. A survey of high-technology transfer practices in Japan and in the United States. Interfaces, 19. (6):67-77.

Dacin, M. T. 1997. Isomorphism in context: The power and prescription of institutional norms. Academy of Management Journal, 40. 1:46-81.

D'Aunno, T., Sutton, R. I., & Price, R. H. 1991. Isomorphism and external support in conflicting institutional environments: A study of drug abuse treatment units. Academy of Management Journal, 14. 636-661.

Del Campo, A. A., Sparks, A., Hill, R. C., & Keller, R. T. 1998. The transfer and commercialization of university-developed medical imaging technology: Opportunities and Problems. IEEE Transactions in Engineering Management. Forthcoming.

Deutsch, C. H. 1997. The private sector life of a government lab: Drumming up business to survive in a world without Cold War. The New York Times. August 23, 1997. Business Day Section. 23.

Dillman, D. A. 1978. Mail and telephone surveys: The total design method. Wiley. New York.

DiMaggio, P. J. 1991. Constructing an organizational field as a professional project: US art museums, 1920-1940. In W. W. Powell & P. J. DiMaggio (eds.) The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 267-292.

DiMaggio, P. J. & Powell, W. W. 1983. The iron cage revisited: Institutional isomorphism and collective rationality in organization fields. American Sociological Review, 48. 147-160.

DiMaggio, P. J. & Powell, W. W. 1991. The iron cage revisited: Institutional isomorphism and collective rationality in organization fields. In W. W. Powell & P. J. DiMaggio (eds.) The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 63-82.

Doucouligaos, C. 1995. Institutional bias, risk, and workers' risk aversion. Journal of Economic Issues, XXIX. (4):1097-1118.

Dunford, R. 1987. The suppression of technology as a strategy for controlling resource dependence. Administrative Science Quarterly, 32. 512-525.

Edelman, L. 1992. Legal ambiguity and symbolic structures: Organizational mediation of civil rights law. American Journal of Sociology, 97. 1531-1576.

Edwards, P., Ezzamel, M., Robson, K., & Taylor, M. 1995. The development of local management of schools: Budgets, accountability and educational impact. Financial Accountability of Management, 11. (4):297-315.

Elsbach, K. D. & Sutton, R. I. 1992. Acquiring organizational legitimacy through illegitimate actions: A marriage of institutional and impression management theories. Academy of Management Journal, 35. 699-738.

Elsbach, K. D. 1994. Managing organizational legitimacy in the California cattle industry: The construction and effectiveness of verbal accounts. Administrative Science Quarterly, 39. 57-88.

European Commission. 1995. Technology transfer networking: A decade of experience. Innovation & Technology Transfer, 2. 12-17.

Fairweather, J. S. 1990. The university's role in economic development: Lessons for academic leaders. SRS Journal. Winter. 5-11.

Fligstein, N. 1991. The structural transformation of American industry: An institutional account for the causes of diversification in the largest firms, 1919-1979. In W. W. Powell & P. J. DiMaggio (eds.) The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 311-336.

Foster, C. 1998. One-stop shopping. Forbes Magazine. April 20, 1998. Accessed April 29, 1998. http://www.forbes.com/forbes/98/0420/6108066a.htm.

Friedland, R. & Alford, R. R. 1991. Bringing society back in: Symbols, practices, and institutional contradictions. In W. W. Powell & P. J. DiMaggio (eds.) The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 232-266.

Fu, S. & Perkins, D. S. 1995. Technology licensors and licensees: Who they are, what resources they employ, and how they feel. International Journal of Technology Management, 10. (7/8): 907-920.

Galaskiewicz, J. 1991. Making corporate actors accountable: Institution-building in Minneapolis-St. Paul. In W. W. Powell & P. J. DiMaggio (eds.) The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 293-310.

GAO. 1998. Technology Transfer: Administration of the Bayh-Dole Act by Research Universities. Report to Congressional Committees. GAO/RCED-98-126. Transferring Federal Technology. B-275266. United States General Accounting Office. Washington, D.C. www.gao.gov. Accessed June 30, 1998.

Gartner, W. B. 1993. Words lead to deeds: Towards an organizational emergence vocabulary. Journal of Business Venturing, 8. 231-239.

Goodstein, J. D. 1994. Institutional pressures and strategic responsiveness: Employer involvement in work-family issues. Academy of Management Journal, 37. 350-382.

Goslin, L. N. & Trune, D. R. 1996. Innovative medical technology and entrepreneurial transfer. Paper presented at the Babson College-Kauffman Foundation Entrepreneurship Research Conference. March 20-23. University of Washington. Seattle, Washington.

Greening, D. W., & Gray, B. 1994. Testing a model of organizational response to social and political issues. Academy of Management Journal, 37. 467-498.

Gupta, A. K. & Wilemon, D. L. 1990. Accelerating the development of technology-based new products. California Management Review. Winter: 24-44.

Gupta, P., Dirsmith, M. W., Fogarty, T. J. 1994. Coordination and control in a government agency: Contingency and institutional theory perspectives on GAO audits. Administrative Science Quarterly, 39. 264-284.

Hackman, J. D. 1985. Power and centrality in the allocation of resources in colleges and universities. Administrative Science Quarterly, 30. 61-77.

Hagedoorn, J. 1990. Organizational modes of inter-firm co-operation and technology transfer. Technovation, 10. (1): 17-30.

Hagedoorn, J. 1993. Understanding the rationale of strategic technology partnering: Interorganizational modes of cooperation and sectoral differences. Strategic Management Journal, 14. 371-385.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. 1992. Multivariate Data Analysis with Readings. New York. Macmillan Publishing.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. 1995. Multivariate Data Analysis with Readings. Englewood Cliffs, NJ. Prentice-Hall.

Hannan, M. T. & Carroll, G. R. 1995. Theory building and cheap talk about legitimation: Reply to Baum and Powell. American Sociological Review, 60. 539-544.

Hannan, M. T., Carroll, G. R., Dundon, E. A., & Torres, J. C. 1995. Organizational evolution in a multinational context: Entries of automobile manufacturers in Belgium, Britain, France, Germany, and Italy. American Sociological Review, 60. 509-528.

Harmon, B., Ardishvili, A., Cardozo, R., Elder, T., Leuthold, J., Parshall, J., Raghian, M., & Smith, D. 1997. Mapping the university technology transfer process. Journal of Business Venturing, 12. (6): 423-434.

Haveman, H. A. 1993. Follow the leader: Mimetic isomorphism and entry into new markets. Administrative Science Quarterly, 38. 593-627.

Hazlett, J. A. & Carayannis, E. G. 1998. Business-university virtual teaming for strategic planning. Technological Change and Social Change, 57. 261-265.

Hiraoka, L. S. 1987. Frontiers of commercial biotechnology: US and Japanese potential in a new industry. Futures. October: 528-543.

Ingram, P. & Simons, T. 1995. Institutional and resource dependence determinants of responsiveness to work-family issues. Academy of Management Journal, 38. (5):1466-1482.

Institute of Medicine (IOM). 1998. Institute of Medicine Member Directory by Institution. Institute of Medicine. http:// www2.nas.edu/ iompub/ institution.html. Accessed January 28-April 20, 1998.

Jennings, P. D., & Zandbergen, P. A. 1995. Ecologically sustainable organizations: An institutional approach. Academy of Management Review, 20. (4):1015-1052.

Jepperson, R. L. 1991. Institutions, institutional effects, and institutionalism. In W. W. Powell & P. J. DiMaggio (eds.) The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 143-163.

Jepperson, R. L. & Meyer, J. W. 1991. The public order and the construction of formal organizations. In W. W. Powell & P. J. DiMaggio (eds.) The New

Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 204-232.

Judge, W.Q., Jr., & Zeithaml, C. P. 1992. Institutional and strategic choice perspectives on board involvement in the strategic decision process. Academy of Management Journal, 35. 766-794.

Kassicieh, S. K., Radosevich, R., & Umbarger, J. 1996. A comparative study of entrepreneurship incidence among inventors in national laboratories. entrepreneurship Theory & Practice. Spring. 33-49.

Katz, J. & Gartner, W. B. 1988. Properties of emerging organizations. Academy of Management Review, 13. (3):429-441.

Kearns, D. (1990) Federal labs teem with R&D opportunities. Chemical Engineering. April. 45-50.

Keller, R. T. 1997. Job involvement and organizational commitment as longitudinal predictors of job performance: A study of scientists and engineers. Journal of Applied Psychology, 82. (4):539-545.

Kenward, M. 1991. The painful journey from labs to riches. Director (UK). June. 3-4.

Kerlinger, F. N. 1992. Foundations of Behavioral Research. Harcourt Brace College Publishers. New York.

Kim, J. O. & Mueller, C. W. 1978. Introduction to Factor Analysis. Quantitative Applications in the Social Sciences Series. Beverly Hills. Sage.

Kotabe, M. & Suan, K. S. 1995. The role of strategic alliances in high-technology new product development. Strategic Management Journal, 16. 621-636.

Lloyd-Kolkin, D. 1979. Communication network analysis of an educational dissemination system: The research and development exchange. Ph.D. Thesis. Stanford, CA: Stanford University.

Lopez, W. H. 1998. How universities can organize to support industrially relevant research effectively. Technological Forecasting and Social Change, 57. 225-228.

Low, M. B. & Abrahamson, E. 1997. Movements, bandwagons, and clones: Industry evolution and the entrepreneurial process. Journal of Business Venturing, 12. 435-457.

Lumpkin, G. T. 1995. Entrepreneurial Orientation: Relationships among Key Constructs and Performance Implications. Unpublished doctoral dissertation. University of Texas at Arlington.

Lumpkin, G. T. & Dess, G.G. 1996. Clarifying the entrepreneurial orientation construct and linking it to performance. Academy of Management Review, 21. (1):135-172.

Lynn, L. H. & Rao, H. 1995. Failures of intermediate forms: A study of the Suzuki *zaibatsu*. Organization Studies, 16. (1):55-80.

Machen, M. M. 1998. Academic R&D expenditures maintain steady growth in FY 1996. Data Brief, NSF 98-303. Science Resources Studies Division. National Science Foundation. Accessed April 28, 1998. http:// www.nsf.gov/ sbe/ srs/ databrf/ sdb98303.htm. Accessed March 3, 1998.

Maxwell, S. E. & Delanney, H. E. 1990. Designing Experiments and Analyzing Data: A Model Comparisons Approach. Wadsworth Publishing. Belmont, CA.

Mejia, L. R. 1998. A brief look at a market-driven approach to university technology transfer: One model for a rapidly changing global economy. Technological Forecasting and Social Change, 57. 233-235.

Melcher, R. 1998. An old university hits the high-tech road. Business Week. August 31, 1998. 94-96.

Melzer, B. 1998. Faculty ideas reap rewards. ABCNEWS.com. http:// www.abcnews.com// sections/ business/ Daily News/ inventions980717. Accessed July 24, 1998.

Meyer, J. W. & Rowan, B. 1977. Institutionalized organizations: Formal Structure as myth and ceremony. American Journal of Sociology, 83. 340-363.

Meyer, J. W. & Rowan, B. 1991. Institutionalized organizations: Formal Structure as myth and ceremony. In W. W. Powell & P. J. DiMaggio (eds.) The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 41-62.

Meyer, J. W., Scott, R. S., & Deal, T. E. 1981. Institutional and technical sources of organizational structure: Explaining the structure of educational organizations. In H. D. Stein (Ed.) Organization and the Human Services. Philadelphia: Temple University Press. 151-178.

Meyer, J., Scott, W. R. & Strang, D. 1987. Centralization, fragmentation, and school district complexity. Administrative Science Quarterly, 32. 186-201.

Merz, G. R. & Sauber, M. H. 1995. Profiles of managerial activities in small firms. Strategic Management Journal, 16. 551-564.

Mezias, S. J. & Glynn, M. A. 1993. The three faces of corporate renewal: Institution, revolution, and evolution. Strategic Management Journal, 14. 77-101.

Mian, S A. 1998. Assessing and managing the university technology business incubator: An integrative framework. Journal of Business Venturing, 12. 251-285.

Miller, D. 1983. The correlates of entrepreneurship in three types of firms. Management Science, 29. (7): 770-791.

Mitchell, W. 1991. Using academic technology: Transfer methods and licensing incidence in the commercialization of American diagnostic imaging equipment research, 1954-1988. Research Policy, 20. 203-216.

Mitchell, W. & Singh, K. 1996. Survival of businesses using collaborative relationships to commercialize complex goods. Strategic Management Journal, 17. 169-195.

Moe, T. 1984. The new economics of organization. American Journal of Political Science, 28. (4):739-777.

Muir, A. E. 1993. Technology transfer office performance index. The Journal of the Association of University Technology Managers, V. http://autm.rice.edu/autm.

Muir, A. E. 1997. The Technology Transfer System. Latham Book Publishing. Latham, NY.

Munene, J. C. 1995. The institutional environment and managerial innovations: A qualitative study of selected Nigerian firms. Journal of Occupational and Organizational Psychology, 68. 291-300.

Naman, J. L. & Slevin, D. P. 1993. Entrepreneurship and the concept of fit: A model and empirical tests. Strategic Management Journal, 14. 137-153.

National Academy of Engineers (NAE). 1998. National Academy of Engineers Member Directory by Organization. National Academy of Engineers. http:// www.nae.edu/ naepub/ Inst.html. Accessed January 28-April 20, 1998.

National Academy of Sciences (NAS). 1998. National Academy of Sciences Member Directory by Organization. National Academy of Sciences. http:// www2.nas.edu/ naspub/ institution.htm. Accessed January 28-April 20, 1998.

National Science Board. 1998. Science &Engineering Indicators - 1998. National Science Foundation. Arlington, VA. http:// www.nsf.gov/ sbe/ srs/ seind98/ ch5_cont.htm. Accessed May 7-May 29, 1998, among other times.

National Science Foundation (NSF). 1998. "Academic Science and Engineering: R&D Expenditures, Fiscal Year 1996." NSF WebCASPAR Database System. http:/ /www.nsf.gov/ sbe/ srs/ stats.htm. http:// caspar.qrc.com/ cgi-bin/ WebIC.exe. Accessed May 7-May 29, 1998, among other times.

Nee, V. & Young, F. E. 1991. Peasant entrepreneurs in China's 'second economy:' An institutional analysis. Economic Development and Cultural Change, 39. (2):293-311.

Nelson, R. R. 1995. Why should managers be thinking about technology policy? Strategic Management Journal, 16. 581-588.

North, D. C. 1990. Institutions, Institutional Change and Economic Performance. New York: Cambridge University Press.

North, D. C. 1994. Economic performance through time. The American Economic Review, 84. (3): 359-368.

Nunnally, J. C. 1978. Psychometric Theory. New York. McGraw-Hill.

Oliver, C. 1988. The collective strategy framework: An application to competing predictions of isomorphism. Administrative Science Quarterly, 33. 543-561.

Oliver, C. 1990. Determinants of interorganizational relationships: Integration and future directions. Academy of Management Review, 15. 241-265.

Oliver, C. 1991. Strategic responses to institutional processes. Academy of Management Review, 16. 145-179.

Orru, M., Biggart, N. W., & Hamilton, G. G. 1991. Organizational isomorphism in East Asia. In W. W. Powell & P. J. DiMaggio (eds.) The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 361-389.

Parsons, K. H. 1970. Foreword to the 1970 edition. In Commons, J. R. 1970, 1950. The Economics of Collective Action. Madison, WI: The University of Wisconsin Press. vii-xvi.

Pedhazur, E. J. 1982. Multiple Regression in Behavioral Research: Explanation and Prediction. Harcourt Brace Jovanovich College Publishers. New York.

Peng, M. W. & Heath, P. S. 1996. The growth of the firm in planned economies in transition: Institutions, organizations, and strategic choice. Academy of Management Review, 21. (2):492-528.

Perlmutter, F. D. & Cnaan, R. A. 1995. Entrepreneurship in the public sector: The horns of a dilemma. Public Administration Review, 55. (1):29-36.

Peters, L. & Fusfeld, H. 1983. Current US university/industry research connections. In University-Industry Research Relationships: Selected Studies. Washington, DC: National Science Foundation. 1-162.

Peterson's, Inc. 1997. Peterson's Guide to Graduate and Professional Programs: An Overview 1997: Book 1. 31st Edition. Princeton, NJ.

Pettersen, I. J. 1995. Budgetary control of hospitals -- Ritual rhetoric and rationalized myths? Financial Accountability of Management, 1. (3):207-221.

Pfeffer, J. & Salancik, G. R. 1978. The External control of Organizations: A Resource Dependence Perspective. New York: Harper Row.

Phillips, F. & Eto, M. 1998. Revitalizing university research and its contribution to society. Technological Forecasting and Social Change, 57. 205-209.

Piercey, L. 1998. Go team, go! Signals. Recombinant Capital. San Francisco. http://www.signalsmag.nsf/. Accessed on June 30, 1998.

Powell, W. W. 1990. Neither market nor hierarchy: Network forms of organizations. In B. M. Staw & L. L. Cummings, (eds.) Research in Organizational Behavior, 12. 295-336.

Powell, W. W. 1991. Expanding the scope of institutional analysis. In W. W. Powell & P. J. DiMaggio (eds.) The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 183-203.

Powell, W. W. & P. J. DiMaggio (eds.) 1991. The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press.

Robson, G. S., Wholey, D. R. & Barefield, R. M. 1996. Institutional determinants of individual mobility: Bringing the professions back in. Academy of Management Journal, 39. (2):397-420.

Rosenkopf, L. & Tushman, M. L. 1994. The coevolution of technology and organization. In A. C. Baum & J. V. Singh (eds.) Evolutionary Dynamics of Organizations. New York: Oxford University Press. 403 - 424.

Scheisel, S. 1997. The private life of a government lab. Business Day Section. New York Times. August 23:23

Schmoller, G. 1900-1904. Grundriss der Allgemeinen Volkswirtschaftslehre [Fundamentals of General Economic Principles]. Leipzig, Germany: Duncker & Humboldt. In Scott, W. R. 1995. Institutions and Organizations. Foundations for Organizational Science: A Sage Publication Series. Thousand Oaks, CA: Sage Publications. 2.

Schneider, E. 1998. University Patents. Intellectual Property Education Coalition: Intellectual Property Management Inc. (ipm@en.com) http://surf.to/ipec.

Scott, W. R. 1987. Organizations: Rational, Natural and Open Systems. Second Edition. Englewood Cliffs, N. J. : Prentice Hall.

Scott, W. R. 1991. Unpacking institutional arguments. In W. W. Powell & P. J. DiMaggio (eds.) The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 164-182.

Scott, W. R. 1994. Institutional analysis: Variance and process theory approaches. In Scott, W. R. & Meyer, J. W. 1994. Institutional Environments and Organizations: Structural Complexity and Individualism. Thousand Oaks, CA: Sage Publications. 81-99.

Scott, W. R. 1995. Institutions and Organizations. Foundations for Organizational Science: A Sage Publication Series. Thousand Oaks, CA: Sage Publications.

Scott, W. R. & Meyer, J. W. 1991. The organization of societal sectors: Propositions and early evidence. In W. W. Powell & P. J. DiMaggio (eds.) The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 108-142.

Scott, W. R. & Meyer, J. W. 1994. Institutional Environments and Organizations: Structural Complexity and Individualism. Thousand Oaks, CA: Sage Publications.

Senker, J. 1991. Evaluating the funding of strategic science: Some lessons from British experience. Research Policy, 20. 29-43.

Shanks-Meil, S. L. & Dobratz, B. A. 1995. Blindness rehabilitation agencies and organizational environments. Human Relations, 48. (1):57-72.

Shepsle, K. A. 1986. Institutional equilibrium and equilibrium institutions. In H. Weisburg, (ed.) Political Science: The Science of Politics. New York: Agathon. 51-82.

Shepsle, K. A. 1989. Studying institutions: Some lessons from the rational choice approach. Journal of Theoretical Politics, 1. 131-147.

Shrum, W. & Wuthnow, R. 1988. Reputational status of organizations in technical systems. American Journal of Sociology, 93. (4):882-912.

Singh, J. V., Tucker, D. J., & House, R. J. 1986. Organizational legitimacy and the liability of newness. Administrative Science Quarterly, 31. 171-193.

Singh, J. V., Tucker, D. J., & Meinhard, A. G. 1991. Institutional change and ecological dynamics. In W. W. Powell & P. J. DiMaggio (eds.) The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 390-422.

Smith, D. J. 1995. Personal communication. Senior Analyst, Western Economic Diversification Canada. 200 Kent Street, PO Box 2128 Station D, Ottawa, Ontario, K1P 5W3. Telephone: 613/952-3479.

Souder, W. E. & Moenaert, R. K. 1990. An information transfer model for integrating marketing and R&D personnel in new product development projects. Journal of Product Innovation Management, 7. 91-107.

Spann, M. S., Adams, M., & Souder, W. E. 1995. Measures of technology transfer effectiveness: Key dimensions and differences in their use by sponsors, developers and adopters. IEEE Transactions of Engineering Management, 42. (1):19-29.

Spencer, W. J. 1990. Research to product: A major US challenge. California Management Review, 32. (2):45-53.

SPSS. 1997. SPSS 7.5 for Windows. SPSS, Inc. Chicago.

Steele, T. J., Schwendig, W. L., & Johnson, G. A. 1990. The Technology Innovation Act of 1990, ancillary legislation, public policy, and marketing: The interfaces. Journal of Public Policy and Marketing, 9. 167-182.

Stevenson, H. H. & Jarillo, J. C. 1990. A paradigm for entrepreneurship: Entrepreneurial management. Strategic Management Journal, 11. 17-27.

Tabachnick, B. G. & Fidell, L. S. 1989. Using Multivariate Statistics. New York. Harper Collins.

Teece, D. J. 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. Research Policy, 15. (6):285-305.

The Christian Science Monitor. 1998. EE.UU.: Más fondos para investigación y desarrollo. (The United States: More funds for research and development.) Reprinted in El Mercurio de Santiago, Chile. June 1, 1998. A9.

Tolbert, P. S. 1985. Institutional environments and resource dependence: Sources of administrative structure in higher education. Administrative Science Quarterly, 30. 1-13.

Tolbert, P. S. & Zucker, L. G. 1983. Institutional sources of change in the formal structure of organizations: The diffusion of civil service reform, 1880-1935. Administrative Science Quarterly, 30. 22-39.

Trune, D. R. & Goslin, L. N. 1998. University technology transfer programs: A profit/loss analysis. Technological Forecasting & Social Change, 57. 197-204.

Van de Ven, A. H. 1993. The institutional theory of John R. Commons: A review and commentary. Academy of Management Review, 18. 129-152.

Van de Ven, A. H. 1993. The development of an infrastructure for entrepreneurship. Journal of Business Venturing, 8. 211-230.

Van de Ven, A. H. & Garud, R. 1989. A framework for understanding the emergence of new industries. In R. S. Rosenbloom (Ed.) Research on Technological Innovation, Management and Policy. Greenwich, CT. JAI. 195-225.

Van de Ven, A. H. & Garud, R. 1994. The coevolution of technical and institutional events in the development of an innovation. In J. A. C. Baum & J. Singh (eds.) Evolutionary Dynamics of Organizations. New York: Oxford University Press. 425-443.

Vedovello, C. 1998. Firms' R&D activity and intensity and the university-enterprise partnerships. Technological Forecasting and Social Change, 57. 215-226.

Waugaman, P. G. 1990. University-industry technology transfer in Germany: Implications for US partners. SRA Journal. Summer. 7-15.

Weick, K. E. 1995. Sensemaking in Organizations. Foundations for Organizational Science Series. Sage Publications. Thousand Oaks, CA.

Wiklund, J. 1998. Entrepreneurial orientation as a predictor of performance and entrepreneurial behaviour in small firms -- Longitudinal evidence. Paper presented at 18th Babson Entrepreneurship Research Conference, Ghent. Forthcoming in Frontiers of Entrepreneurship Research 1998. Babson College. Wellesley, MA.

YAHOO! 1998. Regional: Countries: United States: Education: Colleges and Universities: Complete Listing. www.yahoo.com/ Regional/ Countries/ United_States/ Education/Colleges_and_Universities/all.html. Accessed 1996 - 1998.

Zahra, S. A. 1993. A conceptual model of entrepreneurship as firm behavior: A critique and extension. Entrepreneurship Theory and Practice. Summer. 5-21.

Zahra, S. A., Sisodia, R. S., & Das, S. R. 1994. Technological choices within competitive strategy: A conceptual integration. International Journal of Technology Management, 9. (2):172-195.

Zaheer, S. 1995. Overcoming the liability of foreignness. Academy of Management Journal, 38. (2):341-363.

Zucker, L. G. 1991. The role of institutionalization in cultural persistence. In W. W. Powell & P. J. DiMaggio (eds.) The New Institutionalism in Organizational Analysis. Chicago: The University of Chicago Press. 83-107.

APPENDIX A

SURVEY PRINTED FROM WEBSITE

University of Houston Law Center

Texas Superconductivity Center

Purpose of the Research

Your participation in this research will help identify organizational characteristics that affect technology commercialization. We ask you to evaluate short statements describing technology transfer organizations. Your task is to rate how well each item reflects your organization.

Space Vacuum Epitaxy Center

Go To Survey

I am conducting research that examines various characteristics of organizations responsible for technology transfer at US universities. The research project is being conducted as part of the Shell Corporation's Interdisciplinary Scholars Program at the University of Houston in cooperation with the College of Business Administration, the University of Houston Law Center, the Texas Superconductivity Center and the Space Vacuum Epitaxy Center (a NASA Center for the Commercial Development of Space).

I would appreciate your help with the research.

Sincerely,

Barbara A. Kuhns
Principal Investigator
University of Houston
Study of Organizational Factors and Technology Transfer

THANK YOU FOR YOUR HELP WITH THIS RESEARCH

Best experienced with

Click here to start.

Globalport.com,inc.

September 9, 1997

Barbara A. Kuhns
Principal Investigator & Ph. D. Candidate
University of Houston
Study of Organizational Factors and Technology Transfer

Purpose, Scope and General Procedures of the Research

The research project's purpose is to understand characteristics of organizations that commercialize university research discoveries. The researcher plans to examine organizational-level attributes of about 250 US university-affiliated technology commercialization offices. A second phase of the project plans to survey approximately 1500 to 2000 university-affiliated research centers. We are also examining data from World Wide Web Sites and reports published by the Association of University Technology Managers.

Your participation in this research will help identify organizational characteristics that affect technology commercialization. We would like your responses to a questionnaire which includes 90 short items describing a technology transfer organization. We ask you to rate how well each item reflects characteristics and activities of your organization.

Benefits

We believe that the results of the research will provide valuable information to university technology commercialization organizations. Knowledge about characteristics that contribute to successful technology commercialization could be applied to other technology commercialization efforts to help broaden the economic and social impact of university-conducted research. Some respondents may also find the results useful in managing their own technology commercialization programs.

Confidentiality

Responses from individuals and organizations will be held in strict confidence.

The analysis will only be presented in aggregate. No individual responses or organizational information will be revealed to any other party.

We ask for organizational identification at the end of the survey so that data collected now can be analyzed in conjunction with publicly-available data described above. In order to protect the identity of responding organizations, the primary researcher will assign code numbers that will be known only to the primary researcher. No identifying data for any respondent or individual organization will ever be released or reported.

The results of this study are expected to be published in a scholarly journal and possibly presented at a professional meeting or conference. However, no individual respondents or organizations will be identified.

Instructions and Procedures

Please mark the number that corresponds with your answer. For each item simply "click" the on-screen button to indicate your level of agreement with the item. When you have completed the survey, "click" on the submit button to send your responses to the researcher. In preliminary trials respondents completed the survey in 20 -35 minutes. Please respond honestly to the items in sequence and, if possible, in one sitting. There are no right or wrong answers. Your answers need not be consistent or in agreement.

Your participation in this study is voluntary. You do not waive any rights or privileges by your participation. We do not foresee any risks or discomfort associated with participating in the survey. Non-participation will not result in any penalty or loss of benefits to which you are otherwise entitled.

Additional Information

We value your participation in this research. If you have any questions about the research, contact the principal investigator, Barbara A. Kuhns, at 713.743.4646 or via electronic mail (Barbara Kuhns @ University of Houston). You may also reach Ms. Kuhns at her e-mail address in Santiago, Chile (Barbara Kuhns in Chile). Ms. Kuhns is a doctoral candidate at the University of Houston. If you would like a report of the results of this study send an e-mail with 'Report' in the subject heading. For additional information, you may also contact Professor Robert T. Keller, the faculty advisor for this project in the College of Business Administration. Professor Keller can be reached at 713.743.4676 or via electronic mail (Robert Keller @ University of Houston).

Any questions regarding your rights as a research subject may be addressed to the University of Houston Committee for the Protection of Human Subjects 713.743.9222. All research projects that are carried out by investigators at the University of Houston are governed by requirements of the university and the Federal Government.

If at any time you have difficulties with this website, you may either press your browser's BACK button to return to the previous page and try again, or complete the survey at a later time. Answers entered and recorded previously will show up on the page, but may be changed if necessary.

IMPORTANT NOTE: If your browser does not display the website adequately, you may choose to complete a "text" only version by entering your password in the Text Only box below. If you begin the survey and have difficulty with the graphics, you may start over by either using your 'back' button to return to this page or be re-entering the website from the beginning. Any pages completed will have been recorded by the database.

Please enter your Password

Password: [ ] **(required)** [Submit Query]

Please enter your Password (Text Only version)

Password: [ ] **(required)** [Submit Query]

Do the following statements describe *your technology transfer organization*?

Key:
1 - Strongly Disagree
2 - Disagree
3 - Neither Agree nor Disagree
4 - Agree
5 - Strongly Agree

This organization...

1. Places a strong emphasis on R&D, technological leadership, and innovations.

● 1 2 3 4 5

2. Designs its own unique new processes and methods to achieve success in research applications.

1 ● 2 3 4 5

3. Develops alternative procedures when necessary to work around university policies that hinder or slow progress in any area.

1 2 ● 3 4 5

4. Announced (or published articles or made technical presentations about) a large number of research breakthroughs in the past five years.

1 2 3 ● 4 5

5. Is considered a leader in new developments in its field by other organizations operating in the same field.

1 2 3 4 ● 5

6. Finds creative solutions to administrative problems such as funding, staffing, space, budgets, equipment acquisitions, or patent procedures.

1 2 3 ● 4 5

7. Has helped the university develop new

processes, policies or procedures that facilitate commercial endeavors by research units or faculty.

1 2 • 3 4 5

8. Nearly always adheres to established university policies even when the policies might hinder organizational progress.

1 • 2 3 4 5

9. Exhibits a strong proclivity for high-risk projects.

• 1 2 3 4 5

10. Takes bold, wide-ranging actions to achieve the organization's objectives.

1 • 2 3 4 5

Click Here for the Next Page (2/7)

If this page is blank, you've entered an invalid Password.

Do the following statements describe *your technology transfer organization*?

Key:
1 - Strongly Disagree
2 - Disagree
3 - Neither Agree nor Disagree
4 - Agree
5 - Strongly Agree

This organization...

11. Readily spends money on potential solutions if problems are holding us back.

1 2 3 4 • 5

12. Quickly seizes new opportunities.

1 2 3 4 • 5

13. When confronted with decision-making situations involving uncertainty, typically adopts a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities.

1 2 3 4 • 5

14. Circumvents policies that are perceived to get in the way of commercial developments.

1 2 3 4 • 5

15. Is exposed to potential administrative censure by selectively following university policies that relate to commercializing technologies.

1 2 3 4 • 5

16. Typically adopts a very competitive 'undo-the-competitors' posture.

1 2 3 4 • 5

17. Is very aggressive and intensely competitive.

1 2 3 4 • 5

18. Formally monitors competitors' actions.

1 2 3 4 • 5

19. Does not have competitors in its field of endeavor.

1 2 3 4 • 5

20. Monitors technological or scientific developments that potentially offer competing approaches to the research pursued by the organization.

1 2 3 4 • 5

21. Encourages researchers and engineers to pay attention to competing technological solutions or developments.

1 2 3 4 • 5

22. Exhibits a strong tendency to be ahead of other organizations in introducing novel ideas or products.

1 2 3 4 • 5

23. Typically initiates actions that other organizations later adopt or copy.

1 2 3 4 • 5

24. Is very often the first organization to introduce new product/services, administrative techniques, operating technologies, etc.

1 2 3 4 • 5

Click Here for the Next Page (3/7)

How important is each of the following for *evaluating* the performance of your organization?

Key:
1 - Very Unimportant
2 - Unimportant
3 - Somewhat Important
4 - Important
5 - Very Important

25. The number of patent disclosures issued.

● 1 2 3 4 5

26. The number of patents filed.

1 2 3 ● 4 5

27. The number of commercial customers.

● 1 2 3 4 5

28. Amount of income from royalties or patents.

1 2 3 ● 4 5

29. Licenses granted or sold.

● 1 2 3 4 5

30. New businesses started.

1 2 3 ● 4 5

31. Financial or in-kind support from industry partners.

● 1 2 3 4 5

32. Number of new products developed.

1 2 3 ● 4 5

33. Honorary appointments (such as the National Academy of Sciences and the National Academy of Engineers) held by members of your organization.

● 1 2 3 4 5

34. Number of refereed journal articles published by members of your organization.

1 2 3 ● 4 5

35. The amount of Federal funding attracted and received by your organization.

● 1 2 3 4 5

36. Number and quality of technical problems solved.

1 2 3 ● 4 5

37. Technical briefs/papers presented.

● 1 2 3 4 5

38. Number of innovations developed.

1 2 3 ● 4 5

39. Number of graduate students participating in your organization.

● 1 2 3 4 5

Click Here for the Next Page (4/7)

Consider the following statements in terms of the organization as a whole, not in terms of your own personal values.

Key:
1 - Strongly Disagree
2 - Disagree
3 - Neither Agree nor Disagree
4 - Agree
5 - Strongly Agree

Relative to the organization as a whole...

40. The work of our organization emphasizes knowledge creation.

1 2 3 • 4 5

41. Knowledge creation is best measured by scholarly publications and presentations.

1 2 • 3 4 5

42. Our organization values and rewards acceptance in scholarly circles.

1 2 3 • 4 5

43. Research with students is important to our organization.

1 2 3 • 4 5

44. Most people working here prefer the faster feedback of the industrial world over academe.

1 2 3 • 4 5

45. Our work emphasizes linking resources and opportunities to create new organizations

or products.

1 2 • 3 4 5

46. Knowledge is best embodied in a finished, marketable product or service.

1 2 3 • 4 5

47. In our work, protecting proprietary information is important.

1 2 • 3 4 5

48. Collegiality is important in our work organization.

1 2 3 • 4 5

49. Our organization encourages competition with others.

1 2 • 3 4 5

50. Free exchange of ideas is important.

1 2 3 • 4 5

51. Most people in our organization consider personal wealth as an important measure of success.

1 2 3 • 4 5

52. Most people in our organization prefer the reflective thinking environment of academe to industry.

1 2 • 3 4 5

Click Here for the Next Page (5/7)

Rate the amount of change in the *past two years* for the following.

Key:
1 - Major Decrease
2 - Slight Decrease
3 - Stable
4 - Slight Increase
5 - Major Increase

53. The pace of innovations initiated by our organization ....

1 2 3 • 4 5

54. The pattern of risk-taking exhibited by our organization ...

1 2 • 3 4 5

55. Our rate of commercializing new technology ...

1 2 3 • 4 5

56. The yearly number of refereed technical publications generated by members of our organization ....

1 2 3 • 4 5

57. Introduction of new products each year.

1 2 3 • 4 5

58. The yearly number of invited technical presentations given by members ....

1 2 3 • 4 5

59. Our mission or goals...

1 2 3 • 4 5

60. Our top management or organization head....

1 2 3 ● 4 5

Please provide Fiscal Year beginning and ending dates.

61. Previous FY dates are from

September 1995 to
September 1996 .

62. Current FY dates are from

September 1996 to
September 1997

Click Here for the Next Page (6/7)

We are interested in obtaining a few empirical measures of your organization's activities.

In the table below, we would like you to *indicate the comparison between last year and* the current year for each category. Using last year as a base of 100, what do you expect for the current year? For example, if you expect a 25% increase in a category, mark 125. If you expect a decrease of 25% you would mark 75%.

	Prev. FY	Current FY
63. Royalties & License Fees Rec'd	100	25 %
64. Invention Disclosures Rec'd	100	64
65. US Patent Applications Filed	100	65
66. US Patents Issued	100	66
67. Total Active Licenses & Options	100	67
68. Spin-off Companies Formed	100	68
69. Research Publications	100	69
70. Technical Presentations	100	70

71. Respondent's Title/Position

71

72. Are you the overall head of the organization?

yes • no

73. What is the organization's approximate total

annual budget? $

73

74. Does your position have overall responsibility for the organization's activities, goals, and plans?

• yes no

75. In your position, do you have knowledge about the overall organizational activities, goals, and plans?

yes • no

76. How many employees (including administrative and research or professional workers) are in your organization? (number)

76

77. In what year was your organization established as part of the university? (year)

1977

Click Here for the Last Page

Responses from individuals and organizations will be held in strict confidence.

However, in order to analyze the response data in conjunction with other data obtained from published sources we need to identify the name of your organization. The analysis will only be presented in aggregate. No individual responses or organizational information will be revealed to any other party. In order to protect the identity of responding organizations, the primary researcher will assign code numbers that will be known only to the primary researcher.

Organization Name:

Organization

University:

university

City and State:

City

World Wide Web Site Address:

www.www.www

E-mail Address:

email@email

Does your organization publish annual reports?

yes • no

If yes, the report can be obtained via:

E-mail

reportemail

World Wide Web (URL)

reporturl

Mail

Address:
address

City:
city

State:
state

Zip
Code:
zip

Finish

University of Houston Law Center

Thank You

Your participation in this research is greatly appreciated. You may now browse the Internet as usual.

Texas Superconductivity Center

Please send an e-mail request to bakuhns@uh.edu with "Report" as the subject if you would like a summary report of this research.

[redacted]
Space Vacuum Epitaxy Center

[redacted]

[redacted]

[redacted]
Globalport.com,inc.

This website designed, developed, and hosted by Globalport.com,inc.
September 9, 1997
Check out Scientific American, a favorite website of the Globalport staff.

APPENDIX B

MESSAGES SOLICITING PARTICIPATION

Request 1

Sent December 1-3, 1997

E-Mail Message to Directors of Technology Transfer Office

From: Barbara A. Kuhns <Santiago e-mail address>
TO: Name <e-mail address>
RE: Shell Corporation Interdisciplinary Scholars' Research

December 1, 1997
<NAME>

We need your help. And we know you are very busy.

We also appreciate that you may be swamped with requests for information.

But, please take a quick look at the web site before deciding to delete this note. Or, forward this message to one member of your staff who has broad knowledge about your technology transfer organization.

The web site can be found at http://www.globalport.com/techsurvey/. Use this numerical password: <password> .

Input from your organization is very important to building a better understanding of success factors related to university technology commercialization. We also will be happy to share our findings with you.

Four university-affiliated organizations are working together to gather and analyze information about university technology transfer. The study is part of the Shell Corporation's Interdisciplinary Scholars Program. The collaborating teams are from the Texas Center for Superconductivity, the University of Houston College of Business Administration, the University of Houston Law Center, and the Space Vacuum Epitaxy Center (a NASA Center for the Commercial Development of Space).

One part of the project requires information from the people responsible for university technology transfer programs in the United States. The study also includes analyzing extensive data collected from Internet web sites and other major technology transfer research projects.

We hope you will help.

Please save this message, pass it along to a staff member, or go directly to the web site.

Barbara A. Kuhns Santiago, Chile
bakuhns@interactiva.cl Teléfono: 562-215-2316
bakuhns@uh.edu Fono-fax: 562-217-5815

APPENDIX B

REQUEST 2
Attempted to Send December 11, 1997

E-Mail Message to Directors of Technology Transfer Office

From: Barbara A. Kuhns <Santiago e-mail address>
TO: Name <e-mail address>
RE: Shell Corporation Interdisciplinary Scholars' Research

<Name>

If you have already responded to the Shell Interdisciplinary Scholars' research survey, thank you very much for your time and effort.

If you haven't sent your responses:

We hope you put the survey note aside to do later. If so, this is a plea to ask a staff member to take 20 minutes or so to click buttons and provide information about your technology transfer organization or process.

The Internet site for the survey is http://www.globalport.com/techsurvey/.

Your password is: < unique password >

If you already did part of the questionnaire, you can still submit more information. No answers or comments entered earlier will be lost.

If you prefer a paper copy or a copy via e-mail, just reply to this note or send a message to bakuhns@uh.edu with your request in the subject line. I will be happy to send a copy via fax or e-mail, or regular mail.

We hope you will contribute to what we think will be important new information about the process of technology commercialization at US universities.

Any questions, just send a note to either e-mail address below.

Barbara A. Kuhns

Note: If you scanned through the survey before last week, you might have found an error message at the end. This may have been because no responses were entered. That has been changed.

Barbara A. Kuhns Santiago, Chile
bakuhns@interactiva.cl Teléfono: 562-215-2316
bakuhns@uh.edu Fono-fax: 562-217-5815

Request 3

February 10-12,1998

E-Mail Message to Directors of Technology Transfer Office

From: Barbara A. Kuhns <Santiago e-mail address>
TO: Name <e-mail address>
RE: Shell Corporation Interdisciplinary Scholars' Research

Shell Interdisciplinary Scholars' Project

«Full_Name»
«University_Name»

Your response would be extremely valuable to the Shell Interdisciplinary Scholars' research. We've heard from many US university technology transfer offices over the past several weeks. We hope you will join your colleagues in contributing to this unique study.

It's easy to help. Just forward this note to a staff member who knows your technology transfer process. The entire questionnaire can be completed on-line. It takes about 20 minutes.

The Internet site address is: http://www.globalport.com/techsurvey/.

The required password is: «Password»

Contact me at either e-mail address listed below if you have questions or would rather have a printed copy of the questionnaire via fax or as a Word attachment via e-mail.

At the end of the survey we provide a direct link so you can easily request a summary of the research results.

Barbara A. Kuhns
Principal Investigator

P.S. No individual or university responses will ever be revealed.

Barbara A. Kuhns — Santiago, Chile
bakuhns@interactiva.cl — Teléfono: 562-215-2316
bakuhns@uh.edu — Fono-fax: 562-217-5815

Request 4

Sent via US Mail March 31, 1998

U N I V E R S I T Y *of* H O U S T O N

College of Business Administration
Department of Management

Houston, TX 77204-6283 713/743-4646

March 31, 1998

<Name>
<Title>
<Office Name>
<University Name>
<Address Line>
<Address Line>
<City, State, Zip>

Dear <Mr., Ms., Dr., Mrs., Name>:

I am writing to ask for your help with our research project. A technology transfer study being conducted with the support of the Shell Corporation's Interdisciplinary Scholars Program would be greatly enhanced by information from <University Name>.

I urge you to join the many university technology transfer offices who have already responded with information about organizational factors that we predict relate to the successful commercialization of university technologies. Of course, we will be happy to provide you with a summary report of the results.

The entire questionnaire can be completed on-line in about 20 minutes. The questions are designed to not require research. We just want your opinions.

The survey is posted on the Internet at http://www.globalport.com/techsurvey/ . The required password is: <Password>. If you prefer a paper copy of the survey drop me a note at bakuhns@interactiva.cl or bakuhns@uh.edu.

The study is one of several projects funded in part by the Shell Corporation's Interdisciplinary Scholars Program. Students and faculty from four university-affiliated organizations are working together to analyze the many distinct approaches to US university technology commercialization. The collaborating teams are from the Texas Center for Superconductivity, the University of Houston College of Business Administration, the University of Houston Law Center, and the Space Vacuum Epitaxy Center (a NASA Center for the Commercial Development of Space). For this phase of the project we have added the dimension of international telecommuting as I lead the survey data collection from Santiago, Chile.

I hope you will help by completing the questionnaire or passing this information along to a staff member. If you recently sent your responses I apologize for the overlap with this letter.

Sincerely,

Barbara A. Kuhns

Request 5

Attempted to Post on Listserv lists (TIM and TECHNO-L)

University Tech Transfer Offices

Thank you to the many university tech transfer offices who have already participated in our study. In addition, thank you to all of the offices that have posted great information on web sites.

We are still seeking a few more responses from university technology transfer offices. The questionnaire attempts to capture organizational views on a variety of operational issues.

The survey can be completed on-line. To get a password, a paper copy or more information contact Barbara A. Kuhns at <bakuhns@interactiva.cl> or <bakuhns@uh.edu>.

The research is supported in part by the Shell Corporation's Interdisciplinary Scholars' Program at the University of Houston. The overall project includes teams from the University of Houston Law Center, the College of Business Administration, the Space Vacuum Epitaxy Center and the Texas Center for Superconductivity. As part of the study, we also examine intellectual property policies, mission statements, NSF data, patents, Carnegie Foundation classifications, and data from the AUTM reports.

Thanks and apologies for multiple postings.

APPENDIX C

INTERNET URL SITE ADDRESSES

Internet Data Sources[a]

Association of University Technology Managers (AUTM). 1998. University Technology Offices. Accessed various times in 1997 and 1998. http://autm.rice.edu/autm/university.htm.

Association of University Technology Managers (AUTM). 1998. Intellectual Property Policies. Accessed January 20, 1998. http://autm.rice.edu/autm/intellectual.htm.

Ball State University. The Office of Academic Research and Sponsored Programs. http://www.bsu.edu/provost/oarsp/offmission.htm.

Baylor College of Medicine. Policy & Procedure Manual. Office of Technology Administration at BCM Technologies, Inc. http://www.bcm.tmc.edu/bcmt/bcmt-activity.html.

Brigham Young University. Technology Transfer Office Home Page. http://www.byu.edu/~ttdata/index.html. Policies: Intellectual Property. http://www.byu.edu/~ttdata/intell.html.

Brown University. Brown University Research Foundation. http://www.brown.edu/Research/Research_Foundation/BURF.html.

California Institute of Technology.

California State University Institute. http://www.co.calstate.edu/CSUI/.

Carnegie Mellon University. Technology Transfer at Carnegie Mellon. http://www.cmu.edu/cmufront/research.html.

Case Western Reserve University. University Technology Incorporated. http://www.cwru.edu/affil/UTI/

Case Western Reserve University School of Medicine. University Technology Incorporated. http://www.cwru.edu/affil/UTI/school_of_medicine.htm.

Clemson University. Special Projects Office of Technology Transfer and Commercialization. http://hubcap.clemson.edu/IPC/ Last revised June 1, 1997

Colorado State University. Colorado State University Research Foundation. http://www.research.colostate.edu/. http://www.colostate.edu/orgs/FacultyCouncil/sectionj.html. http://www.research.colostate.edu/rs/rshome.htm. http://www.research.colostate.edu/csurf/.

Columbia University. Columbia Innovation Enterprise.
http://www.cc.columbia.edu/cu/cie/

Cornell University. Cornell Office for Technology Access and Business Assistance (COTABA). http://www.research.cornell.edu/cotaba.html.

Cornell University. Cornell Research Foundation, Inc.
http://www.research.cornell.edu/VPR.html

Creighton University. Grants Administration.

Dartmouth College. Statement of Purpose of Dartmouth's Technology Transfer Office.

Duke University. Sponsored Projects and Research Administration.
http://delphi.mis.duke.edu/ors/research/resadmn.htm.
http://delphi.mis.duke.edu/ors/policies/unvind.htm.
http://delphi.mis.duke.edu/ors/policies/patpol.htm.
http://delphi.mis.duke.edu/ors/policies/list.htm.

Florida Atlantic University. Patent Policy.
http://www.fau.edu/academic/provost/patent.htm.
http://www.fau.edu/admin/sponsorsc/dstr.htm.

Florida Institute of Technology. Office of Research and Sponsored Programs. Research and Sponsored Programs at Florida. Tech. http://www.fit.edu/research/.

Georgetown University. http://www.georgetown.edu/OSP/.

Harvard University. Harvard Medical School. Office of Technology Licensing & Industry-Sponsored Research.

Indiana University. Office of Technology Transfer. Accessed 19-Aug-97.
http://www.indiana.edu/~techtran/index.html.

Iowa State University. Office of Intellectual Property and Technology Transfer and Executive Director of the Iowa State University Research Foundation (ISURF).
www.iastate.edu/~isurf/.

Johns Hopkins University School of Medicine. Office of Technology Licensing.
http://infonet.welch.jhu.edu/admin/spons_project/handbook/appendo.html.
http://www.med.jhu.edu/otl/.

Kansas State University. Mission Statement Copyrights, Patents, Royalties {from the Faculty Handbook July 30, 1996}The Kansas State University Research Foundation (KSURF). http://www.ksu.edu/research/intellect.prop/ksurf/ksurf.htm

Kent State University. The Office of Technology Transfer (OTT). http://www.kent.edu/rags-alpha/techtran/. Policies. http://www.kent.edu/www/policy_reg/chapter5/.

Lehigh University. Rules And Procedures Of The Faculty.

Marquette University. Office of Research and Sponsored Programs Mission and Personnel. http://INFO.ORSP.MU.EDU/.

Massachusetts Institute of Technology. http://web.mit.edu/tlo/www/.

Michigan Technological University. The Intellectual Property Office. http://www.admin.mtu.edu/rgs/ip_tl/.

Michigan State University. Office of Intellectual Property. A Division of the Office of the Vice President for Research and Graduate Studies. http://web.miep.org/oip/index.html. Accessed 19-Mar-97.

Mississippi State University. Office of Sponsored Programs. www.msstate.edu/Dept/ott/page1.html.

Montana State University. Intellectual Property Administration and Technology Transfer Office. http://www.montana.edu:80/wwwfachb/. http://www.montana.edu:80/wwwvr/ipatnt/. http://www.montana.edu/wwwvr/. Vice President for Research, Creativity, and Technology Transfer Accessed 19-Mar-97.

National Science Foundation. 1998. US Patents Awarded to 100 Academic Institutions with Largest 1993 R&D Volume and other academic institutions: 1969-1994. Table 5-42. Science and Engineering Indicators - 1996. http://www.nsf.gov/sbe/srs/seind96/ch5_acad.htm.

New York Medical College. Office of Research Administration. www.nymc.edu/research/service.htm.

New York University. Office Of Industrial Liaison Technology Transfer at NYU Medical Center.

North Carolina State University. Office of Technology Transfer and Industry Research. http://www2.ncsu.edu/ncsu/research_outreach_extension/OTTIR/index2.html.

North Dakota State University. NDSU Research Foundation. www.ndsu.nodak.edu/ndsu/sizer/resfdn.html.

Northwestern University. Technology Transfer Programs. www.nwu.edu/research/offices-service.html.

Northern Illinois University. Technology Commercialization Office. http://www.niu.edu/depts/tco/.

Ohio State University. Ohio State Research Foundation http://www.techtransfer.rf.ohio-state.edu/OTTannmeas.html.

Ohio University. Ohio University's Technology Transfer Office. Virtual Licensing Office. http://www.cns.ohiou.edu/ictto/.

Oregon Health Sciences University. Office of Technology Management. http://www.ohsu.edu/tech-transfer/.

Oregon State University. Research Office. http://www.orst.edu:80/Dept/research/tectra.htm.

Pennsylvania State University. Intellectual Property Office. http://www.ipo.psu.edu/faq.htm. Research and Technology Transfer Organization. http://infoserv.rttonet.psu.edu/index.htm.

Princeton University. Technology Transfer and Trademark Licensing. http://www.princeton.edu/~jean/contents.html. Office of Research & Project Administration. http://www.princeton.edu/~orpa1/

Purdue University. Purdue Research Foundation. www.purdue.edu/DSP/TTOffice/OTT-home.html.

Rice University. Intellectual Property Policy.

Rutgers University. Office of Corporate Liaison and Technology Transfer. http://info.rutgers.edu/Services/Corporate/.

Schneider, E. 1998. University Patents 1987-1996. University Patent Navigator: Patents for 1997. Intellectual Property Education Coalition. http://surf.to/ipec.

Stanford University. Office of Technology Licensing. http://www-Leland.stanford.edu/group/OTL/.

State University of New York at Albany. http://albany.edu/pr/campus_hightech.html.

State University of New York - Binghampton Office of Research and Sponsored Programs Binghamton University. http://orsp1.adm.binghamton.edu/.

Syracuse University. Intellectual Property Agreement. http://www.syr.edu:80/WWW-Syr/FacultyInfo/FacManual/index.html. Office Of Sponsored Programs. http://sumweb.syr.edu/osp/.

Texas A&M University System. Technology Licensing Office http://engineer.tamu.edu/tlo/.

Temple University. Vice Provost for Science and Technology. Office of Technology Transfer. http://www.techtrans.temple.edu.

Tulane University. Tulane Intellectual Property Policy and Procedures. Office of Technology Development Tulane University. http://www.tmc.tulane.edu/techdev.

University of Akron. The ORSSP Personnel. http://ecgfhp01.ecgf.uakron.edu:80/~orssp/.

University of Alabama-Birmingham UAB Research Foundation. Birmingham, AL. http://www.uab.edu/uarbrf/rflictec.html.

University of Alabama - Huntsville. http://isl-garnet.uah.edu/Techhome/techhome.html.

University of Alaska Technology Development Corporation, Inc. http://www.polarnet.com/users/technology/tdc_does.htm.

University of Arizona. Office of Technology Transfer. http://vpr.admin.arizona.edu/ott/otthome.htm.

University of Arkansas. Office of Research and Sponsored Programs. http://www.uark.edu/admin/rsspinfo/techno.html. Technology Transfer. http://www.uark.edu/admin/rsspinfo/new.html.

University of California System. Office of Technology Transfer. http://www.ucop.edu/ott/.

University of California at UCLA. http://www.research.ucla.edu/sr2/srgroup.htm#brp.

University of California - San Francisco. http://itsa.ucsf.edu/ ~otm/.

University of Central Florida. Patent and Invention Policy and Agreement. Office of Research and Graduate Studies.

University of Chicago and ARCH Development Corporation. 1997. http://www2.uchicago.edu/adm-spec-proj/arch_osp_toc.html. http://www-arch.uchicago.edu/Overview.html. Policies. http://www2.uchicago.edu/adm-spec-proj/arch_osp_toc.html. Technology Transfer. http://www2.uchicago.edu/adm-spec-proj/Inv_TechTr.html

University of Colorado at Boulder. The CU Boulder Office of Technology Transfer & Industry Outreach. http://txfr35.coloado.edu/home.html. http://www.uchsc.edu/csa/techtran/.

University of Connecticut-Health Center. http://cortex.uchc.edu:80/~coopres/index.html.

University of Delaware. The Office of the Vice Provost for Research (OVPR). Intellectual Property/Technology Transfer. http://www.udel.edu/OVPR/property.html. http://www.udel.edu/ExecVP/polprod/6-06.html.

University of Florida. Division of Sponsored Research's Office of Patent, Copyright and Technology. Office of Technology Licensing. http://www.ortge.ufl.edu/.

University of Georgia. University of Georgia Research Foundation. http://www.ovpr.uga.edu.

University of Hawai`I. Office of Technology Transfer and Economic Development. Intellectual Property Program. Honolulu, Hawai`i. http://www.mic.hawaii.edu.otted/otted.html.

University of Houston. Office of Technology Transfer.

University of Idaho. Idaho Research Foundation, Inc. http://users.moscow.com/anowakowski/about.htm.Faculty-Staff Handbook Chapter Five: 5300 Research Policies. http://www.uidaho.edu/admin/fsh/5300.html.

University Of Illinois At Chicago. Intellectual Property Office. http://www.uic.edu/depts/ovcr/ipo/ipohome.htm.

University of Illinois at Urbana-Champaign. Research and Technology Management Office. http://www.oc.uiuc.edu/rtmo/.

University Of Kansas. Intellectual Property Information And Discussion Site. http://www.cc.ukans.edu/history/unigov/fac.html. The Kansas Innovation Corporation. http://www.kic.org/html/mission.html.

University Of Kentucky Research and Graduate Studies.
http://www.rgs.uky.edu/research.htm. Policies.
http://www.rgs.uky.edu/ip/ipdintro.html.

University of Louisville. Office of Research Administration. Office of Technology Management. http://www.louisville.edu/vpr/index.html.

University of Maryland. Office of Technology Liaison. http://www.otl.umd.edu.

University of Maryland at Baltimore. Office of Technology Development.

University of Massachusetts-Lowell. http://www.uml.edu.research/IMPACT.html.

University of Massachusetts-Medical Center.
www.umed.edu/dept/oor/support/supptdir.htm#E10E4.

University of Miami. Office of Technology Transfer. University of Miami School of Medicine. http://www.med.miami.edu/technology_transfer/contact.html.

University of Michigan. Technology Management Office. http://www.tmo.umich.edu/.

University of Minnesota. Directory Office of Research and Technology Transfer.
http://egms.ortta.umn.edu. http://www.ortta.umn.edu/.

University of Missouri. Practices and Policies.
http://www/system.missouri.edu/vpacad/P&L/.

University of New Hampshire. Office of the VP for Research.
www.unh.edu/orps/index.html.

University of New Mexico. The Science & Technology Corp. www.unm.edu/ ~scitech/
.

University of New Orleans. Office of Research and Sponsored Programs.
www.uno.edu/~orsp/.

University of North Carolina-Chapel Hill. Office of Technology Development .
http://groucho.admin.unc.edu/otd/.

University of Oklahoma Health Science Center.
www.uokhsc.edu/admin/oraORA1HOM.HTM.

University of Oregon. http://darkwing.uoregon.edu/~techtran.

University of Pennsylvania. Center for Technology Transfer.
http://www.upenn.edu/ctt/

University of Rhode Island. University of Rhode Island Foundation.
http://www.uri.edu/research/.

University of Rochester. Technology Transfer Office. Office of Research and Project Administration. http://www.cc.rochester.edu:80/ORPA//tto/.

University of South Florida. Office Of Research. USF Research Foundation, Inc.
http://www.research.usf.edu/dsp/econ95/econtc.htm.
http://www.research.usf.edu/dsp/rf.htm

University of Tennessee Research Corporation. http://utrc08.admin.utk.edu.

University of Texas-System. http://www.utsystem.edu/ogc/intellectualproperty/.

University of Texas - Houston Health Sciences Center. Office of the Executive Vice President for Research and Academic Affairs. Intellectual Property and Research Policies. Office of Technology Management.

University of Texas Southwestern Medical Center at Dallas. Office of Legal Affairs and Technology Transfer.
http://www.swmed.edu/home_pages/technology_transfer/staff.htm.

University of Utah. Technology Transfer Office. http://www.tto.utah.edu/.

University of Washington. Office of Technology Transfer.
http://cary.u.washington.edu/ott/ott.html.

University of Wisconsin-Madison-WARF. http://www.wisc.edu/warf/.

Vanderbilt University. Office of Technology Transfer.
http://www.vanderbilt.edu/technology_transfer/.

Virginia Tech Intellectual Properties, Inc. Policy On Intellectual Property.
http://www.vt.edu:10021/admin/vtip/index.html.
http://ate.cc.vt.edu/PROVOST/rhb/rhb4-3.html.
http://www.vt.edu/govern/cmtINTPROP.html.

Washington State University. Virtual.ogrd.wsu.edu/ogrd1.

Wayne State University. Office of Sponsored Programs Services.
http://gopher.orsps.wayne.edu/orsps/orsps.html.

Wisconsin Alumni Research Foundation (WARF). http://www.wisc.edu/warf/.

Wright State University. The Office of Research and Sponsored Programs. http://www.cs.wright.edu/rsp/Pubs/RN/rsp-overview.html.

Yale University. Office of Cooperative Research. http://www.yale.edu/ocr/.

[a]Internet URL addresses are listed for most university technology transfer offices accessed to collect mission statements, intellectual property policies and/or director's name and address. The AUTM University Technology Transfer Office website provides links to many university technology transfer offices and their missions, policies and personnel. Unless otherwise noted the websites were accessed at various times throughout 1997 and 1998.

IMAGE EVALUATION TEST TARGET (QA-3)

150mm

6″