THE INTERSECTION OF ACADEMIA AND INDUSTRY: AVOIDING PITFALLS AND NAVIGATING SUCCESSFUL PARTNERSHIPS

Lynne Scott Safrit

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Approved by:

John E. Paul

John R. Anderson Jr.

Edward F. Brooks

Margaret B. Dardess

Steven Leath

ABSTRACT

Lynne Scott Safrit: The intersection of academia and industry: Avoiding pitfalls and navigating successful partnerships
(Under the direction of John E. Paul)

This dissertation focused on characteristics of successful academic-industry partnerships, barriers causing them to fail, and the development of better strategies for collaborative opportunities and initiatives.

Fifty-seven key informant interviews identified 12 barriers to successful partnerships:

1. Intellectual property rights
2. Meeting agreed upon timetables, accountability and reliability issues.
3. Cultural differences.
4. Poorly trained technology transfer offices.
5. Lack of clearly defined goals and objectives.
6. Overhead rates.
7. Publication rights.
8. Change in personnel.
9. Changing priorities.
10. Internal issues.
11. Confidentiality issues.
12. Threat to academic freedom.

Fifteen characteristics of successful partnerships were identified:

1. Long term partnership relationships.
2. Trust.
3. Clear alignment of goals and mission.
4. Win-win situation.
5. Communication.
6. Interpersonal relationship/prior relationship with partner.
7. Reputation and expertise.
8. Ability to resolve problems at the onset.
9. Flexibility.
10. Manager who keeps the project on track.

11. Well-trained tech transfer office.
12. Internal champion.
13. Support from the top.
14. Interdisciplinarity.
15. Physical proximity.

Several fundamental qualities were found to be essential for successful partnerships:

- Trust
- The ability to form interpersonal relationships
- The ability to align goals and objectives
- The presence of strong communication skills
- The ability to look at the relationship as a true partnership.

Solutions to the identified barriers include improved communication and trust in the partnership effort, a convergent vision, improved reporting structures, measureable goals and clearly defined objectives, the building of interpersonal relationships and strategic partnership opportunities, the ability to articulate vision and work through the plan of action, higher levels of trust in the partnership endeavor, and an undisputable acceptance of the academic mission.

An integrated set of policies is required to confront the complex exchange between academia and industry, addressing education, research, development, recruitment, potential employment and job creation. These policies must strike a delicate balance between entrepreneurship and autonomy of research and innovation that give rise to novel discovery and commercialization of new industry. Further research is needed to clarify actual mechanisms necessary for a more comprehensive, intersectoral policy development approach incorporating institutional and organizational efforts toward long-term partnerships.

To my family: my husband, Wally, and my children, Elizabeth and Wil, for their constant support and encouragement during this journey.

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1.0 EXECUTIVE SUMMARY

The research questions -

This dissertation is the culmination of research that sought to understand what characterizes successful academic-industry partnerships, what barriers cause them to fail, and how this knowledge can be utilized to develop better strategies for both academic and industry partners in pursuit of collaborative opportunities and initiatives.

The framework for this research considered several domains, including the following:

University type	Industry type	Nature of project	Organizational issues	Process issues
public	agriculture	orientation	tech transfer	intellectual property
private	pharmaceutical	fee for service	administration	publication rights/timing
land grant	food	interrogative	scientific participation	cultural issues
	medical device	focused time frame	industry participation	alignment of goals & objectives
	other	long term	interdisciplinarity	policies
			bureaucracy	time horizon
			leadership	confidentiality
			management	communication
				prior relationship
				commitment
				trust
				interdependence

These domains and variables were considered and reviewed in terms of their contribution and relevance to successful outcomes to both the academic and the industry participants.

Importance of the research –

Academic-industry partnerships are able to capture the best that each of the individual partners has to offer: the strength of academic research in focusing intellectual capital and resources on long-term collaborative projects with the applied research and technological development of industry. Academic contributions have become increasingly important to economic success and entrepreneurial science as industries have become more dependent on open innovation models. Academic research has become increasingly dependent on collaborations with industry for sponsored research and other partnership opportunities as federal research funding has dwindled. These partnerships have the potential to pair discovery and dissemination of knowledge and workforce development to facilitate economic growth and contribute to the public good.

Methodology –

The study design for this research involved the collection of both primary and secondary data. Primary data collection consisted of a series of 57 key informant interviews conducted through a purposive sampling of semi-structured interviews. Interviews lasted an average of 43 minutes and were conducted in person and by telephone. Two of these semi-structured interviews were selected for a more detailed case perspective analysis. Informants were well-informed regarding the research topic with experience ranging from 4 to over 30

years and were from a variety of backgrounds, including public and private universities, industry and institutional settings. In selecting the informants, consideration was given to geographic, industry, and academic representation in order to assure a high level of credibility. Secondary data collection consisted of a document review of publicly available information regarding academic-industry partnerships, including websites, annual publications, written policies and guidelines, meeting notes from conferences and other industry meetings.

Upon completion of the primary and secondary data collection, a thematic analysis was conducted using notes memos, transcriptions and digital recordings. These transcriptions were analyzed using coding to identify pertinent themes, patterns and concepts.

Findings –

Findings of the research were summarized in three categories and described below:

1. Why academic-industry partnerships exist

1.	Partnerships offer opportunities for early introduction to industry for students; Industry gets an early look at talent within the university as potential employees.
2.	Ability to refine academic curriculum to better prepare students for real world experience in the workplace.
3.	Enhanced faculty retention as a result of opportunities for industry collaboration.
4.	Economic development opportunities.
5.	Harnessing of intellectual capital of academic scientists to help industry achieve novel solutions and speed to market.
6.	The ability to marry the basic research of academic science and practical application of industry commercialization.
7.	Enhanced educational opportunities for students.

2. Barriers to successful partnerships

1. Discussions regarding intellectual property rights and ownership often prohibit partnerships from ever getting off the ground.
2. University researchers often have difficulty meeting the time tables and schedules required by industry partnerships, creating issues of accountability and reliability.
3. The culture of academic and industry scientists is inherently different.
4. Technology transfer offices are often under-staffed or staffed with individuals who have little experience with the commercialization process, often making the documentation process to establish a partnership cumbersome and lengthy.
5. Unrealistic expectations, due to a lack of clarity of goals and objectives, time frames and other deliverables, often cause the relationship to collapse.
6. Overhead rates are a source of misunderstanding and misinterpretation and greater transparency is needed to avoid potential conflicts.
7. Partnerships will not survive if the publication rights of either faculty or students are jeopardized.
8. A change in personnel among either side of the partnership threatens the continuity of the research initiative.
9. Changing priorities by either side of the partnership may threaten the research initiatives by making the project irrelevant.
10. Internal issues and intra-organizational struggles, conflicts and shifts of power may hinder the execution of the project goals and struggles. Bureaucracy, either within the university hierarchy or the corporate organizational structure, makes it difficult to communicate issues and problems.
11. Confidentiality issues may impact the development of partnerships because of the fear that proprietary information may not be adequately protected.
12. The university's mission of providing academic freedom to its faculty and students to perform basic research cannot be compromised.

3. Characteristics of successful partnerships

1. Long-term partnership relationships are more successful than short-term projects.
2. A strong element of trust exists between the partners.
3. Clear alignment of goals and overlapping missions.
4. Partnerships provide a win-win situation.
5. Effective communication skills.
6. Interpersonal relationship or prior experience with the partner.
7. Reputation and expertise of the partner.
8. The ability to iron out problems at the beginning of the relationship.
9. Flexibility.
10. A manager who keeps the project on track.
11. Well-trained tech transfer staff.
12. The presence of an internal champion.
13. Support from the top.
14. Interdisciplinarity.
15. Physical proximity.

An analysis of the rationale for partnerships and an examination of the barriers to and characteristics of successful partnerships led this researcher to focus upon collaboration and the building of coalitions. Partnerships were observed to exist along a spectrum beginning with coordination, extending to cooperation, and finally building to true collaboration. Barriers to high levels of collaboration were characterized and mapped in several categories that addressed individual, relationship, community, and organizational and societal factors. Underlying successful partnerships that were identified were several critical and fundamental qualities exhibited by the individual partners. These qualities are:

- Trust
- The ability to form interpersonal relationships
- The ability to align goals and objectives
- The presence of strong communication skills
- The ability to look at the relationship as a true partnership

A heightened level of social capital must be developed between the partners in order to create the trust necessary to achieve the high level of collaboration which is characteristic of successful partnerships. Partnerships will not succeed absent the presence of complete trust. There must be a shared vision and direction and no desire to manipulate the partnership to the greater benefit of one of the partners. Unless goals have been aligned such that there is a clear understanding of the mission and objectives, the partnership will not succeed.

Plan for change –

Before change can occur, the areas of resistance to change must be acknowledged and addressed. Following Yukl's model (2006, 285-286), seven potential areas of resistance were identified:

1. Partners do not trust the people who propose the change.
2. The belief that change is unnecessary.
3. The belief that change is not feasible or that the plan is unlikely to succeed.
4. The potential of higher costs in doing things a different way.
5. Fear of personal failure.
6. The threat to values and ideals.
7. The threat of interference.

In order to evoke change, people must acknowledge the need and perceive that they have a choice in determining how to change. Such change will involve creating the necessary vision, communicating that vision widely, empowering a broad base of people to take action, ensuring credibility, and anchoring these new approaches in the organization's culture.

The barriers to successful partnerships that were identified in the key informant interviews were addressed with potential solutions.

Reported barrier	**Potential solution**
1. Intellectual property rights & ownership	Open communication and discourse, trust in the partnership effort, convergent vision
2. Accountability issues relating to timetables and schedules	Open and frequent conversation and reporting structure, established measurables and end goals, clearly defined objectives
3. Cultural differences	Building interpersonal relationships, shared beliefs and missions, skilled communication
4. Poorly staffed tech transfer offices resulting in lengthy documentation process	Ability to see strategic partnership opportunities, working through contract issues at onset of partnership
5. Unrealistic expectations & lack of clear goals and objectives	Ability to articulate the vision and work through the plan of action, effective and clear communication channels

6. Overhead rates and lack of transparency	Trust, effective communication
7. Publication rights	Willingness to understand the academic mission of education, trust, confidentiality
8. Changes in personnel	Strategic relationships and interpersonal connections that override individual preferences and "pet projects"
9. Changing priorities	Strategic goals that supersede individuals' goals and speak to the mission of the partner organizations
10. Internal issues & intra-organizational struggles	Belief in the common overarching mission of the partnership
11. Confidentiality	Clear understanding of what is acceptable to each of the partners
12. Academic freedom	Indisputable acceptance of the academic mission

Kingdon's theory (2002) suggests that policy alternatives exist across three independent streams: problems, policies, and politics. According to Kingdon, problems are matters of interpretation and social definition which will only be perceived as legitimate issues when there is adequate pressure to take action. Policies are formed when ideas float around, forming combinations and recombinations, and in many ways are more defined as mutations of familiar concepts as opposed to entirely new ideas. In order to facilitate policy change, a high level of social interaction and shared social capital must exist among the stakeholders. The political stream is impacted when groups and shareholders achieve consensus, allowing them to have significant impact on policy agendas and outcomes.

A summary of the plan for change action items along the three policy streams, the problem stream, the policy stream, and the political stream follows:

Change within the problem stream	1. Oral presentation of dissertation research findings
	2. Dissemination of written research findings through white paper
	3. Industry conferences and symposiums
	4. Submission of findings in scientific journals or scholarly publications
Change within the policy stream	1. Establishment of monthly scheduled meetings to discuss partnership progress
	2. Mentoring opportunities for young faculty and industry employees on the NCRC
	3. Poster presentation at fall symposium at NCRC
	4. Establishment of Chemistry 101
Changes within the political stream	1. Sharing of research findings with policy makers and leaders
	2. Consensus building and policy development among NCRC faculty and industry officials

Evaluation of the plan for change –

Outcome measures will be qualitative, and will involve personal, sociological and professional levels. Personal interviews with participants in the plan for change will provide rich information concerning barriers and successes, and can be used to further refine working groups, dissemination of information and policy recommendations. Feedback will be gathered on a quarterly basis as a result of systematic monitoring and evaluation in the form of formal interviews with stakeholders and informal monitoring of interactions at meetings, symposiums, social opportunities and professional interactions.

Closing Observations –

An integrated set of policies is needed to address the complex exchange between academia and industry: one which addresses education, development, research and development, recruitment, potential employment of students and job creation. These policies must strike a delicate balance between entrepreneurship and the autonomy of research and innovation that can give rise to novel discovery and commercialization of new industry. Further research is needed to clarify the actual mechanisms necessary for a more comprehensive, intersectoral policy development approach that incorporates an institutional and organizational approach to the development of long-term partnerships.

2.0 STATEMENT OF THE ISSUE

Academic-industry partnerships have grown rapidly over the past twenty-five years. At times, the efforts of academia and industry appear to be aligned and, at other times, collaborative efforts between the academic and industry communities are characterized by frustration and friction. Industry partners view university researchers as a source of ideas and innovation, as catalysts for accelerating technological advances, as individuals who can validate their products and lend credibility to their judgment, as vehicles for increasing their organization's competitiveness, and finally, as developers of talent that can sustain their organizations. University partners, saddled with the uncertain reliance on local and state resources for their financial support, have begun to develop collaborative relationships with industry for revenue contribution, including sponsored research, technology transfer, and licensing opportunities, as well as forwarding their mission of economic development and job creation set forth by the early land grant and public universities. Yet the disparate goals, objectives, organizational characteristics, and operational capabilities of each partner often make these partnerships challenging to implement and more difficult to sustain.

The strengths of academic research - principally the resources to focus on long-term, fundamental risky goals and to mount broad collaborative projects – complement the basic and applied research and development performed by industry. Universities are a source not only of scientific and technological ideas that lead to new products and process, but also of the social and political insights which strengthen our nation's ability to adopt and adapt to

new technologies and therefore to embrace continued innovation. As industries have become more dependent on open versus internal innovation models, new skills, and technological prowess, academic contributions have become increasingly critical to economic success and important to a new wave of "entrepreneurial science," a "high-impact, problem-based, approach to the world's biggest problems that produces measurable results in terms of public benefit" (Thorp & Goldstein, 2010, 23).

The contributions of academia to the pharmaceutical industry, with treatments for AIDS, the commercialization of insulin, and the development of chemotherapy drugs like Taxol for the treatment of many forms of cancer, along with contributions to the field of nutrition, with vitamin-enriched milk and the development of Gatorade; agriculture, with enhanced growing and breeding techniques; information technology with the development of software and internet protocol; biotechnology and medicine with the development of DNA sequencing and other biologic drugs; and energy, with the development of the insulated gate bipolar transistor, are but a few of the obvious contributions that universities have made to industry and the public good. But less obvious than these commercial contributions are those to the local, regional, and national economy through the production of well-trained graduates entering the workforce and the ability to work hand in hand with industry to tackle the world's most pressing health issues and accelerate finding solutions to these problems.

Academic-industry partnerships have the potential to pair discovery and dissemination of knowledge and workforce development with the creation of goods and services. They can endow society with a private and public good that exceeds the combined contributions of the parties. These contributions include economic growth, improved standards of living and extension of humanity's intellectual reach. The overarching goal of

academic-industry partnerships should be to create value and the public good while satisfying the mission and objectives of each partner.

The university can be an integral partner with industry in ways that accelerate translation of research findings into practical applications which can achieve technological, health-related, and economic objectives that have a positive impact on society. Despite the mutual advantages that such partnerships afford, there are frequent chasms among the partners that serve to damage these relationships, sometimes before they have the opportunity to develop. The focus of this dissertation is to explore variables that make academic-industry partnerships successful, to understand the issues that often serve as obstacles and barriers to these partnerships, and therefore, to understand how better to overcome these issues to achieve successful relationships.

3.0 SIGNIFICANCE OF THE ISSUE

New technology ventures which originate in university laboratories fulfill a "bridging function between curiosity-driven academic research on the one hand and the strategy-driven corporate research on the other hand" and have "the potential to introduce technological disequilibria" that can alter the rules of competition in existing industries and can provide a "breeding ground for new venture creation" (Debackere & Veugelers, 2004, 326). As early as the 1945 ground-breaking report by Vannevar Bush, science advisor to Presidents Roosevelt and Truman, it has been recognized that research partnerships "hold the key to meeting the challenge of transition that our nation now faces" (Bush, 1945, 2-3). Mowery further commented that academic-industry partnerships represent a critical strategic response to global competition and a shift of "increased reliance by U.S. firms on sources of R&D outside of their organizational boundaries through such mechanisms as …. collaborations with U.S. universities" (Mowery, 1998, 646). These new open innovation models allow for the random collision of ideas that often are the precursors of successful partnership opportunities.

The globalization of our economy, which has inextricably changed the nature of corporate innovation and competition, has resulted in corporations placing a premium on products and processes that are derived from scientific innovation. This increased demand by industry, coupled with a decrease in federally funded research, has placed market-like pressures on faculty members and academic institutions to shift their focus in the pursuit of

support and funding for research, resulting in what Slaughter and Leslie (1997) refer to as "academic capitalism." In addition to the decline in federal funding, universities have been forced to adapt quickly to the changing environment in research administration due to additional factors such as decreased state funding, increased competition for extramural funding, regulatory compliance issues, financial compliance, and auditing (Casey, 2005, 10). Today, nearly two-thirds of the department chairs of universities located in the United States have some sort of personal interaction with industry, including roles as consultants, members of scientific advisory boards, paid speakers, or as a member of a board of directors (Campbell et al., 2007, 1783).

Academic advances in molecular biology have contributed to commercial success within the pharmaceutical industry with the discovery of small molecule synthetic chemical drugs, such as the closing of target receptors used to screen new compounds, as well as through advances in combinatorial chemistry which have allowed for quicker synthesis of hundreds of thousands of experimental substances for preliminary screening. Academic scientists also have contributed powerful advances in structural biology using x-ray crystallography; nuclear magnetic resonance to allow the more precise molecular design of drugs; and chip technology, using DNA assays, to permit the molecular separation of phenotyping to enhance diagnostic and therapeutic drug development. University physics, mathematics, and engineering professors have contributed research essential to the development of high performance computing and advanced instrumentation, new medical devices, and new scientific and technological principles, designs, and materials that have allowed industry to downsize their basic research laboratories, making academic research all the more critical to commercialization efforts (Gelijns & Thier, 2002, 73).

There are numerous examples of the powerful influence of corporate partnerships in the academic process (Table 1). The University of Utah's semi-conductor work led to Cirrus Logic, while Genentech's roots lie at the University of California at San Francisco, MIT and Biogen, Stanford University and Google, Hewlett Packard and Yahoo!, Carnegie Mellon University and internet search engine provider Lycos, are all examples of successful commercialization originating from academic research (Shane, 2005, 34). North Carolina State University's Aseptin and Biolex Therapeutics UNC Chapel Hill's Algynomics, AlphaVax, and Inspire, and Duke University's Trimeris, Angiomics, Bradmer, and Cellective Therapeutics are also examples of recent commercial spin-offs. By the early 1940's, over fifty companies in the United States were supporting 270 biomedical projects in over 70 universities (Carlson, 2000, 41), as depicted in Table 1.

Table 1: Selected examples of successful commercial academic-industry partnerships

(Rogers et al., 2000, 257; Libecap, 2007, xi; Blumenstyk, 1999; Fraser, 2008, 10, Thorp & Goldstein, 2010, 34; Blumenstyk, 2001, 2; Blumenthal, 2003, 2452)

Emory University	$320M for development of Emtriva for AIDS treatment
University of Pennsylvania	Development of electronic calculator during 1940s led to advances in computer industry
University of Toronto, University of Rochester and Eli Lilly	Early twentieth century commercialization of insulin and liver extract to cure pernicious anemia.
MIT	1960s launch of fiber optics stimulated growth in telecommunications industry
Stanford University, University of California- Berkley	1970s work involving DNA provided basis for growth in biotechnology industry, leading to $143M payout to Stanford for

	recombinant DNA gene-splicing patent
University of Illinois	1980s supercomputing led to developments in internet protocol
California Tech, Johns Hopkins	DNA sequencing, human genome project, advanced pharmacogenomics
Florida State University	Development of chemotherapy drug Taxol
Michigan State University	Cancer treatment drugs Cisplatin and Carboplatin, yielding $160M
University of Florida	$37M earnings from Gatorade
University of Toronto	Infant food Pablum
University of Wisconsin	Vitamin-enriched milk
Iowa State University	$27M fax algorithm
Indiana University	Stannous fluoride used in Crest toothpaste
University of Iowa	Bufferin
University of Illinois	Mosaic, browser software for Netscape
Northwestern University	Led licensing revenues in 2007 with $824M for partial rights to pain-relieving drug Lyrica
Johns Hopkins University	Record 12 spinoffs in 2008, including Amplimmune, used to develop biologic drugs to train immune system to kill cancerous tumors
University of California	Led licensing revenues in 2007 with $146M
Columbia University	$134M in licensing revenues in 2007

University research is often linked to the community and the needs of local industry. For example, Purdue University has contributed significantly to the development of the locomotive technology; the University of Oklahoma was an important participant in the development of the petroleum industry, and the University of Akron was a major contributor in the field of polymer science (Rosenberg & Nelson, 1994, 326).

The following key facts underscore the global significance of academic-industry partnerships:

- As of 1994, companies invested over $1.5 billion to support over 6,000 life science projects in U.S. universities, accounting for about 14% of total academic research funding (Blumenthal, 2003, 2454).
- A 2010 survey by the Association of University Technology Managers (AUTM) identified tech transfer activities at 183 different universities. Survey respondents reported 651 new spinout companies in 2009, an increase of 10.6% over 2008, and 4,284 newly executed licenses. Total sponsored research in the 183 universities was $59.1 billion, a 9.6% increase over the previous year. Research funding from industry contributed $4.3 billion, an increase of 5.6% over the previous year (www.autm.net/AM/Template.cfm?Section=FY_2010_Licensing_Survey).
- From 1980 to 1999, American university spin-offs were estimated to have generated 280,000 new jobs, a rate of job creation per company that greatly exceeds the rate of the average new company in the U.S. economy during the same period (Shane, 2005, 34).
- Of the 141 universities reporting in the 2008 AUTM survey, the top 20 universities generated 77% of the three year royalty averages (Fraser, 2009, 13-17).

- Pharmaceutical and large biotechnology companies increased research and development spending by 147% from 1993 to 2004, and since the beginning of 2008 alone, Merck, Glaxo Smith Kline, AstraZeneca, and Pfizer have all established multi-million dollar, multi-year collaborations with academic institutions across a number of therapeutic areas (Melese et al., 2009, 502). A substantial portion of the total $55 billion to $60 billion of industry research and development investment in basic biomedical discovery and clinical trials occurs within universities (Moses & Martin, 2001, 933).
- The direct economic impact of university spin-off companies from 1980 to 1999 was $33.5 billion, or roughly $10 million per company founded.
- University technology transfer offices at U.S. universities increased dramatically from 25 in 1980 to 200 in 1990. The number of university patents issued annually more than doubled from 264 to 551 from 1979 to 1984, and doubled again to 1228 from 1984 to 1989. In 2002, 3,673 patents were issued to U.S. universities and research institutes (Shane, 2005, 199).

In 2001, the Business Higher Education Forum issued a report entitled "Working Together, Creating Knowledge: The University-Industry Research Collaboration Initiative." The report acknowledges that the "rise of a knowledge society is based largely on the collaborative generation and the use of information" (Business Higher Education Forum, 2001, 3). It maintains that "no one scientist, institution or even nation can sufficiently conduct wholly independent research programs" and that "rising costs, driven by increasingly complex research, make resource-sharing an imperative."

In 2006, the National Council of University Research Administrators and the Industrial Research Institute jointly issued a study entitled "Guiding Principles for University-Industry Endeavors" that addressed the serious issues that face academic-industry partnerships. This report was a result of the first Industry-University Congress which was held in 2003 and which focused on the importance of strong academic-industry partnerships. The Congress established as its focus the deliberation of "the causes of, and potential solutions to, the difficulties facing universities and companies when attempting to work together" (National Council of University Research Administrators, 2006, 2). The preamble's opening statement appropriately underscores the significance of these relationships:

"University-industry collaborations pair the discovery and dissemination of knowledge with the application of that knowledge to the creation of goods and services. Properly constructed, these collaborations ultimately endow society with a public good far exceeding the combined contributions of the parties: economic growth, an improved standard of living, an extension of humanity's intellectual reach. In the broadest sense, the goal of university-industry collaborations should be to create this public good while simultaneously satisfying the mission and objectives of each partner."

Despite the obvious advantages, questions concerning these relationships persist. Universities are constantly asking themselves to what degree they should enter into agreements with commercial concerns, and industries are perpetually contemplating how they can access the cutting edge research capabilities of U.S. universities in order to solve problems of national economic importance and give themselves a commercial edge over their competitors.

Notwithstanding the challenges, the potential rewards to each side are vast. For industry, the access to research innovation as well as academia's ability to see problems through perspectives that are not burdened by commercial concerns is a potentially invaluable advantage. For the academic institution, students, faculty and scientists gain the opportunity to investigate real world problems whose solutions can potentially generate valuable and far-reaching economic and social benefits. Academia offers intellectual horsepower and a fresh perspective to a set of problems, while industry contributes an equal but focused intellectual horsepower supplemented by business-oriented project management discipline. When both parties to the relationship understand and value their respective roles, successful partnerships can evolve.

4.0 THE RESEARCH QUESTIONS

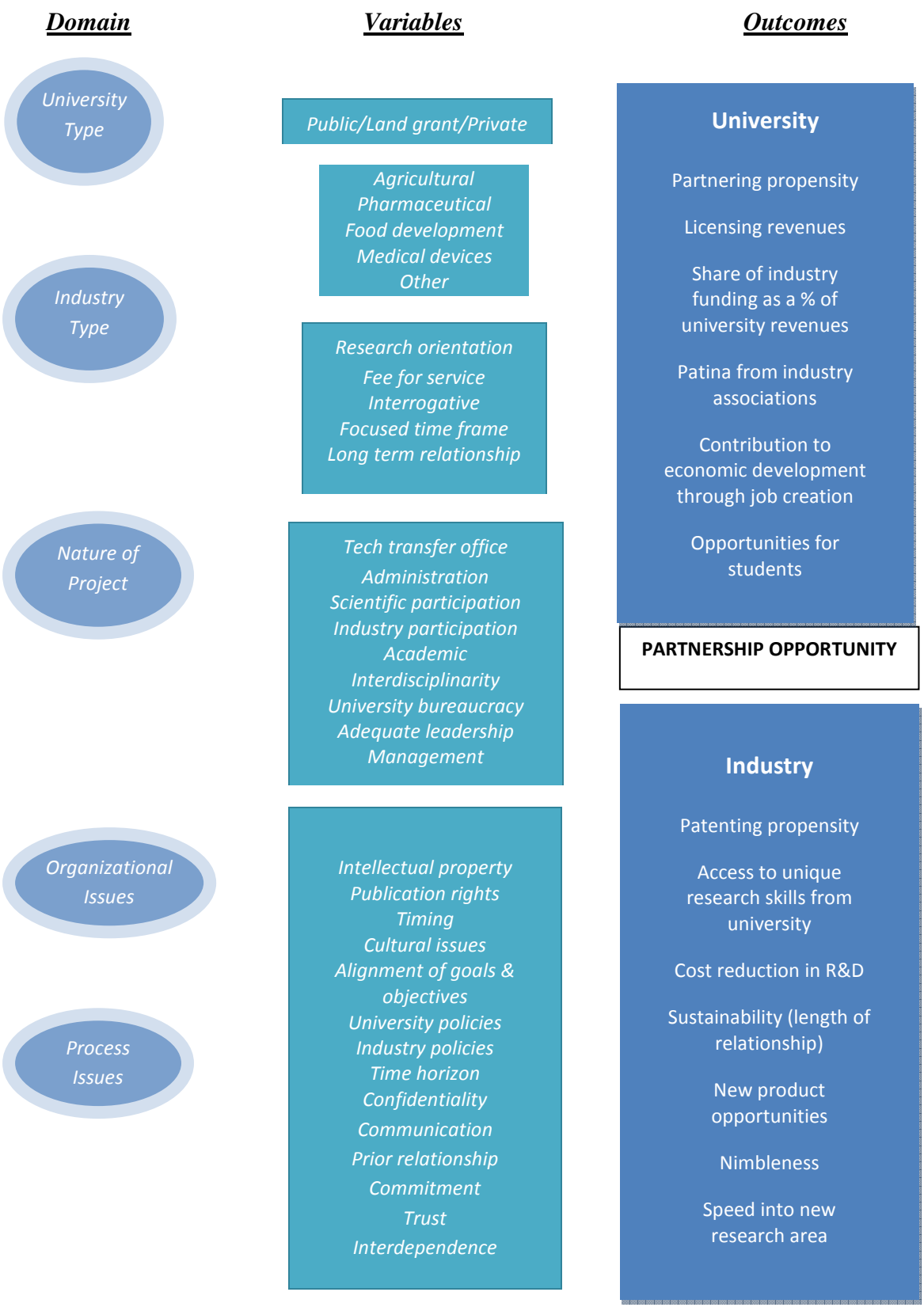
Nearly every industrial country is focused on making the academic-industry partnership a centerpiece of its innovation system. With this embracing of technology as a key to innovation and development, the importance of developing partnerships with research universities and harnessing the brainpower of the university researchers has become even more significant.

1. What are the characteristics of successful academic-industry partnerships?
2. What barriers can be identified that cause these partnerships to falter or fail?
3. How can this knowledge be utilized to develop better strategies for either industry or academic partners in their pursuit of future partnership relationships in terms of developing long-term partnerships, project specific partnerships, or other research related partnership initiatives?

Table 2[1] illustrates the conceptual framework which will be utilized when considering the aforementioned questions.

[1] Table 2 adapted from Shortell & Kaluzny (1994)

Table 2: Conceptual Framework



5.0 LITERATURE REVIEW

The literature review for this topic focused on the relationship between several selected variables, including academic research and subsequent commercialization, the partnerships for research between academia and private industry, and technology transfer within universities, particularly when in collaboration with industry partners. Articles were included that are both descriptive and relational, studies which contained observational data and those containing surveys, interviews and qualitative analysis.

A review of these articles suggests which qualities define a successful partnership and what obstacles, issues or problems may arise in the relationship between academia and industry as a result of these types of collaborations. By reviewing "success stories" we are able to better define best practices for these partnerships. A systematic review of academic-industry partnerships provides the basis of a better understanding of the components of a successful working relationship between academic researchers, industry researchers, and subsequent product development. Likewise, a review of the literature explored barriers to these partnerships and a review of issues and problems that prevent these collaborations from achieving success.

Literature was selected that reviewed partnerships with both public and private academic institutions within the United States, Europe, and Asia, with institutions of higher education (four year institutions or higher), and both private and public industry partners.

5.1 Sources

The literature that encompassed the search related to collaboration and partnerships between academia and industry. All searches were conducted utilizing the University of North Carolina at Chapel Hill library E-Research capability. Initially, a preliminary search of the following databases was conducted: Google Scholar, Public Administration Abstracts, ERIC, Lexis Nexis and Academic One-File. While the scope of this study did not afford the time to pursue alternative research venues, it is anticipated that a further review would include publicly available reports from technology transfer offices from both public and private universities throughout North and South Carolina.

Table 3 lists the databases which were selected:

Table 3: Selected databases

Electronic Database	Years Searched	Description
Google Scholar	1980-current	*Google Scholar is a subset of Google Web Search that searches specifically for scholarly literature, including papers, theses, books and reports.*
Public Administration Abstracts	1980-current	*Public Administration Abstracts cover over 150 academic journals, including governance and administrative functions of public and governmental agencies.*
ERIC	1980-current	*ERIC is produced by the Educational Resource Information Center and provides indexing and abstracting for journal and report literature from 1966 to the present in education and other related disciplines.*
Lexis/Nexis Academic	1980-current	*Lexis/Nexis provides full-text access to general, regional and international news, company news and financial information. It also covers general, regional and international news.*

Academic Search Premier	1980-current	*Academic Search Premier covers popular and scholarly journal articles with many full-text articles and provides information from a wide range of academic areas including business, social sciences, humanities, general academic, general science, education and multi-cultural topics. This multidisciplinary database features full-text articles for over 4,000 journals with many dating back to 1975, abstracts and indexing for over 8,200 scholarly journals. It also includes coverage of over 6,800 peer-reviewed journals.*

5.2 Search terms

The table below indicates the search terms that define the variables being explored by the research question. Table 4 describes the combinations of the key terms that were used in searching all five databases.

Table 4: Search terms

Public University	**AND**	**Private Industry**	**AND**	**Collaboration**
OR				
University	**AND**	**Corporate**	**AND**	**Partnership**
OR				
Academic	**AND**	**Business**	**AND**	**Collaboration**
OR				
Academia	**AND**	**Technology Transfer**	**AND**	**Relationship**
OR				
Higher Education	**AND**	**Private Corporation**	**AND**	**Productivity**
OR				
Academic Research	**AND**	**Life Sciences Companies**	**AND**	**Innovation**

5.3 Criteria for inclusion

Only journal articles and books that were obtained through the use of the electronic databases indicated above were included in this review. The review encompasses a comprehensive survey of peer-reviewed articles from 1980 through 2013. In addition, several articles and books from earlier than 1980 were included in the review. Only articles in English were included, although articles that discussed academic/corporate partnerships in Europe, China, and Japan also were reviewed.

The research did not seek to exclude academic-corporate partnerships in any industry sector. The research includes findings from partnerships as diverse as weapons manufacturing, microelectronics, nutrition, and pharmaceutical development.

Articles that were included were selected with a focus on development of findings that would be applicable to a variety of settings, in smaller university settings as well as larger, research-oriented institutions.

5.4 Criteria for exclusion

Articles that were not from scientific or academic databases were not considered. Articles that focused on research initiatives and/or partnerships between federal or state government and university researchers as opposed to corporate/university partnerships were excluded from this review.

Articles were reviewed taking a broad approach to the success and failure of academic-industry relationships. Although the focus of my question is idiosyncratic to the North Carolina Research Campus and the partnerships that are being developed there with

private industry and public institutions, the results of the analysis can be generalizable to multiple types of public-private partnerships and a variety of research initiatives.

5.5 Process for article review

Articles were selected through the use of the five databases previously discussed through the use a systematic literature survey to filter and summarize results. As was previously discussed, a list of key phrases was identified and utilized, and articles were selected through the utilization of the criteria for inclusion and exclusion previously set forth.

Articles were first reviewed on the basis of the title. If the title did not offer promising information, the article was excluded. Further relevant references were found through the use of the snowballing technique. A review of the abstract, if available, was then performed. The abstract was then evaluated based on whether the content was directly related to the subject matter, relationships between academia and industry.

After a review of the abstract, articles and books were selected for full review. Each article was read and a summary was made of each article, including article identification, author, source, date, data base from which the article was obtained, institution or industry partner, if applicable, type of collaboration, and variables affecting the partnership (for example, open-ended vs. project-based research project, length of relationship, complexity of technology transfer agreement, embedded industry partner vs. “for fee” university scientific research, policy issues, and additional funding mechanisms involved in the partnership, for example federal or private grants).

Articles were then collected and saved electronically in EndNotes entitled “Academic-Industry Partnerships.” The literature source yielded 314 articles that were

relevant and based upon evidence of sufficient quality and information. Complementary information was taken from websites, conferences and other reports that were published by government agencies, professional organizations and other academic affiliations.

5.6 Findings

Overall, the PubMed, GoogleScholar and Academic Source Premier databases proved to be the most beneficial sources of pertinent articles and resources. The measurement of academic-industry research is relatively undeveloped and sometimes ambiguous, as the task of isolating, tracking and measuring these successes over time given the massive contributions of a given body of academic research to the performance of particular industry sectors, corporations, universities and regional economies is complex and difficult.

Several of the articles reviewed featured studies that incorporated interviews with life science companies, academic researchers, and university leadership. For example, Blumenthal (1994, 183-185) cites a study of 100 U.S. universities in which it became apparent that there were a wide variety of relationship structures and an even wider variety of management approaches to dealing with these relationships. A study cited by Hall et al. (2001, 88-90) included 38 academic-industry projects and discussed the difficulties that existed in these partnerships. Anthony's survey of 210 life science companies (Blumenthal et al., 1996, 368-374) indicated numerous responses regarding disputes over intellectual property. Campbell's (Campbell et al., 2002, 473) more recent study mentioned a high frequency of disagreements regarding the data confidentiality and publication rights.

It should be noted that the literature involving academic-industry partnerships is quite diverse in the methodologies undertaken in a review of the subject matter. Many authors

have taken a quantitative approach to the definition of "success" through a measurement of patents, licensing revenues, spin-offs and cooperative authorship of academic papers and articles. These are undoubtedly benchmarks of academic-industry success. However, these quantitative measures do not allow for such determinants as organizational structure, social relationships or other interpersonal factors, nor are they capable of measuring the benefits such partnerships may ensue over time, such as philanthropic contributions, other corporate support for the university or long term research support by industry, to enumerate but a few of the potential successful interactions. Additionally, research that is based only upon the results of patent data does not account for collaboration that does not result in patents but instead leads to other types of innovation where patents are not an important element.

Many of the articles which were reviewed are rich in survey data which have been collected from members of both industry and academia. These studies offer considerable breadth and they are able to capture a variety of academic-industry linkages. However, the nature of surveys does not allow for a great amount of detail in characterizing these relationships with a high degree of profundity. Some of the articles reviewed provided qualitative analysis, such as the use of interviews, and were able to provide more detail and understanding of individual arrangements, but did not necessarily provide a reliable evaluation of the impact and consequences of these relationships. Success in many of the articles is measured by an analysis of number of patents, licensing revenues and commercialization success. The focus of this study will be on these attributes as well as other facets of successful academic-industry relationships, including long-term research funding and partnerships, philanthropic involvement in the university, funding for basic research initiatives and other non-commercial partnership opportunities. Therefore, this review

contained articles that view these types of partnerships as relationships consisting of "social pathways through which information, knowledge and other resources are exchanged or jointly produced through academia and industry working together" (Perkmann & Walsh, 2007, 262).

6.0 OVERALL FINDINGS OF THE LITERATURE REVIEW

6.1 Background and historical review of academic-industry partnerships

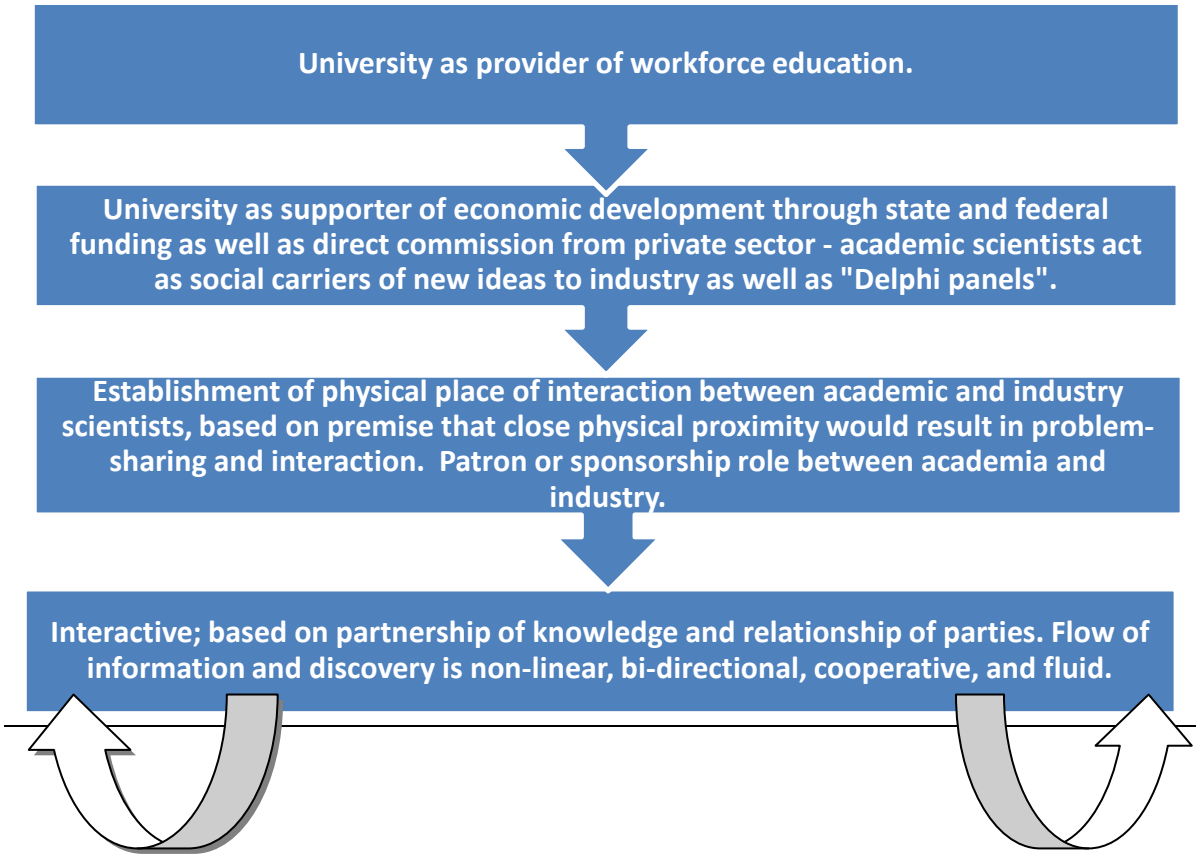
6.1.1 The division of applied and basic science

Historically, the division between the mission and purpose of academia and industry was relatively straightforward and uncomplicated: universities were formed with the purity of contributing to knowledge for knowledge's sake, and it was industry's mission to find a way to use this knowledge. Applied science and science-for-profit were considered less prestigious occupations than science for its own sake (Feldman & Desrochers 2004, 116). However, in reality, universities not only provided education and job training to the masses in the post World War II era, they provided an excellent platform for the investigation of the intersection of technologies within the university itself. The more recent move toward translational research has further muddied what some believe the earlier mission of the university to have been. Paradoxically, it is the early clarity of division of purpose and mission which sets the stage for a divergence that has sometimes made academic-industry partnerships fragile and tenuous.

6.1.2 The evolution of the university mission

The evolution of the university's science mission can be described as encompassing four distinct phases in which interaction has evolved from passive, non-interventionist forms of research to interactive partnerships (Jacob et al., 2000, 255-256; Perkmann & Walsh, 2007, 266). This evolution is depicted in Table 5.

Table 5: Evolution of academic-industry partnerships



6.1.3 The university's evolution as a societal and economic contributor

Universities stayed true to their course of training basic professional careers such as law or the clergy until the early 1800's. Universities' service to the business sector was largely in the form of providing "trained graduates, independent studies, expert advisors, or contract research" (Tudiver, 1999, 139). Wilhelm von Humboldt, one of the founders of the University of Berlin, established a new model that universities throughout Europe and the United States would follow. Humboldt espoused a new theory that emphasized research as an integral part of the teaching mission, one that placed a heightened emphasis on science, a more interdisciplinary approach, and a corporate and social mission that contributes to the economy and society (Thorp and Goldstein, 2010, 4). In time, academic institutions began to

link their basic research to more applied science for the purpose of contributing to the development of technologies for commercial purposes. German universities, for example, were a source of valuable scientific discovery for the emerging pharmaceutical industry in the late nineteenth century (Yusaf & Nabeshima, 2007, 3). Biomedical research flourished at universities such as the University of Pennsylvania, the University of Delaware, and Rutgers University, inducing the growth in those locations of such industries as Merck, DuPont, and Eli Lilly, and the Massachusetts Institute of Technology was a major factor in the growth of technology-related industries in Massachusetts (Yusuf & Nabeshima, 2007, 3). University communities served to attract residential growth as well, because of the perceived excellent quality of life issues associated with university campuses and provided additional economic growth in retail, residential and commercial sectors.

6.1.4 The impact of the Morrill Act and the land grant institution

The idea of academic-industry collaboration in the U.S. actually predates the civil war with the Morrill Act of 1862 and the Hatch Act of 1887 and the subsequent establishment of land grant institutions such as North Carolina State University, which began utilizing their research capabilities to assist small, rural agricultural communities in developing improved growing and harvesting techniques and with the installation of agricultural experiment stations in 1887 (Lee, 2000, 111). Land grant universities were established on the premise of "creating knowledge that entrepreneurs could use to improve local agriculture and manufacturing" (Shane, 2005, 33). Underlying the discussions surrounding academic-industry partnerships is a "social contract" between science and society, an embodiment of postwar science policy (Bush, 1945, 1-28) in which academia was expected to return the benefits of basic scientific research to society in return for the generous support they receive

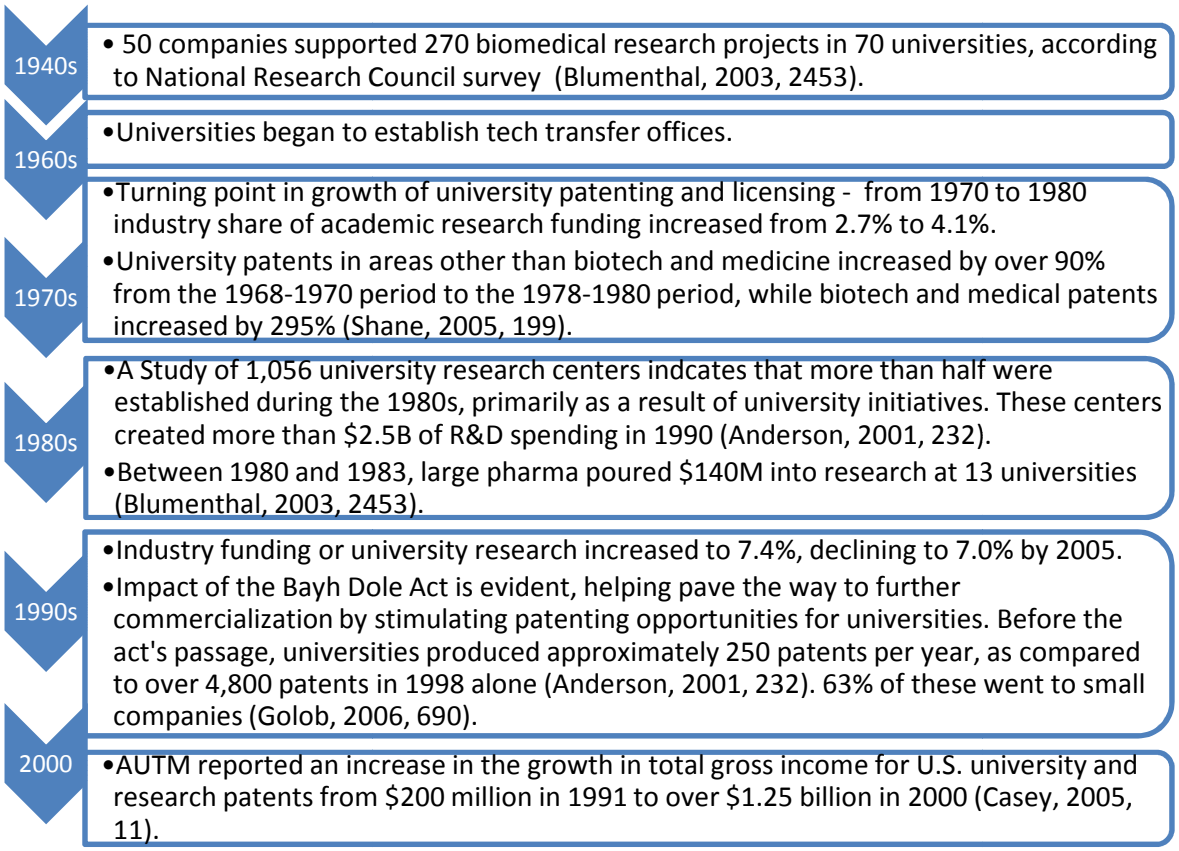
from public tax dollars. This "contract" is a compelling reminder that the relationship of science to American democracy is a delicate one (Guston & Keniston, 1994, 6). Further, the declining trend of U.S. economic and technological competitiveness has resulted in what Lee (1996, 848) refers to as "neotransferism," a call to return to the land grant philosophy with a renewed emphasis on the transfer to industry of knowledge, technology, know-how and a qualified workforce all in the interest of economic development.

6.1.5 The impact of increased government-funded research

Despite these developments, throughout the first half of the twentieth century, only a handful of universities engaged themselves in research collaborations with industry. It was not until World War II that, due to a sweeping increase in government funding for research and development, universities began to incorporate more comprehensive research aimed at technology development and the link between university and industry research partnerships was solidified (Rosenberg & Nelson, 1994, 293). From the period of time following World War II through 1997 the explosive growth in life sciences funding resulted in 54% of the overall public research budget being spent in this category, with most of this going to academia (Gelijns & Thier, 2002, 73).

Table 6 describes the increase of university research funded by corporate partners:

Table 6: Increase in university funded research



6.1.6 Universities as equity holders

By the mid to late 1990s, over 90% of firms that were conducting research in the life sciences arena had some type of relationship with a university and about 25% of faculty members in the life sciences at major U.S. universities had received support from industry . These same studies showed that over 50% of the faculty members in the life sciences had consulted for industry and that about 7% of them had held equity in a company that was performing work related to the faculty member's research. In 1999, a survey showed that 68% of the universities in the U.S. and Canada held equity in companies that sponsored research conducted by members of their own faculty (Blumenthal, 2003, 2453).

6.1.7 Measures of determining success of academic-industry partnerships

Clearly, the Bayh-Dole Act precipitated a flurry of activity by universities in their management of licensing and patenting new products. University patents in areas other than biotech and medicine increased by over 90% from the 1968-1970 time period to the 1978-1980 period, while biotech and medical patents increased by 295% (Shane, 2005, 195). The AUTM report indicates an increase in the growth in total gross income for U.S university and research patents from $200 million in 1991 to over $1.25 billion in 2000 (Casey, 2005, 11).

It should be noted, however, that the use of number of patents issued should not be considered a definitive measure of the success or the productivity of academic-industry partnerships. Patents among universities may vary dramatically in quality. Many factors contribute to this variance, including the effect of "home run" patents on overall university patenting revenues, the costs of establishing technology transfer and licensing offices, and the actual revenues that are generated from patents. That being said, revenues are certainly not the only reason for licensing among universities. Other motivating factors include faculty retention and recognition, or issues of regional economic development and the resulting political goodwill that may result from these activities. Partnership success must be thus measured using a different yardstick than patent counts – research dollars, length of partnership relationship, opportunities for students for internships and post-graduate employment, endowments, contributions through philanthropy, and other support for the university through financial or non-financial means must be considered when evaluating the results of the academic-industry relationship.

6.1.8 The emerging university research mission

The development of academic-industry partnerships has changed along with the emergence of the university research mission (Anderson, 2001, 229-230; Perkmann & Walsh, 2007, 260). Many public institutions struggled with the proper mission and role of university research and its service to society. Etzkowitz refers to this as a "second revolution," marking a fundamental change in which universities see the value of the "translation of research findings into intellectual property, a marketable commodity, and economic development for the good of society." As the university "increasingly provides the basis for economic development through the generation of social and intellectual, as well as human capital, it becomes a core institution in society" (Etzkowitz, 2001, 19). This gradual evolution of the research mission of the university has become a legitimized aspect of the higher education enterprise (Etzkowitz, 1998, 230). This suggests a new social contract between higher education and society, one which "formed the basis of a general model of how to create knowledge and wealth simultaneously." Universities have become "engines of entrepreneurship" with the explicit purpose of not only producing educated graduates and professionals but also as vessels that will capitalize the knowledge that they produce (Blumenthal, 2003, 2454). Likewise, as academicians begin to understand the economic potential of research, academic success is transformed from a "cultural artifact consumed by other scientists into a valuable object or commodity that can be utilized to generate future income" (Etzkowitz, 2001, 29). When scientific knowledge is appropriated to generate income, it is transformed from a cultural process that consumes the surplus of a society into a productive force that generates new income out of an aspect of culture.

6.2 Definition of academic-industry partnerships

Academic-industry linkages can occur at varying levels, including individual and small group links, departmental or faculty links, links managed by university-owned companies, or local, regional and national consortia of academic institutions. They also can be characterized as being "industry-pull" linkages, such as contract research initiatives, or "industry-push" linkages, such as spin-outs of new companies. These varying types of interactions imply that linkages and successful partnerships can vary according to the "relational involvement" between universities and industry (Perkmann & Walsh, 2007, 263). Academic-industry linkages can be described in the following categories shown in Table 7 (Perkmann & Walsh, 2007, 262; Business Higher Education Forum, 2001, 21):

Table 7: Types of academic-industry partnerships

Type of Partnership	*Comments*
Collaborative research partnerships	Inter-organizational agreements for collaborative research and development
Sponsored research services	Contract research, consulting, research consortia
Academic entrepreneurship	Development and exploitation of commercial technologies in which academic researchers have an ownership interest
Human resources transfers	Employee training, postgraduate training, graduate student trainees, adjunct faculty
Informal interactions	Social relationships and networks, meetings, conferences
Commercialization of property rights	Patents and licenses, technology transfer of university intellectual property
Scientific publications	Joint collaborative publication as a result of partnerships

There are several types of academic-industry relationships that are prevalent in today's research environment, the most common of which is an industrial research contract between a company and an individual academic investigator aimed at a focused acquisition of specific targets or technologies (Bander & Rosenberg, 1997, 216; Melese et al., 2009, 503). These relationships may be defined in the following way as shown in Table 8:

Table 8: Types of academic research partnerships

Type of Relationship	Description
One company-one investigator	Company funds specific research. Advantage is ability to provide starting point for relationship. Disadvantage is that it does not explicitly encourage and may even restrict communication with other investigators or companies that can add value.
One company-one university	Master agreement between university and company which funds multiple research projects. Advantage is a more synergistic leverage of existing relationship and streamlining of the process of initiating new collaborations. Disadvantage is that this relationship could limit scope of research, and academic work could be viewed as merely extension of company.
One company support of university consortium	Advantage is the sharing and leverage of joint knowledge and broader scope of research. Disadvantage is limited interaction which may not address industry-specific obstacles and issues.
One company support of university institute	Advantage is access to network of investigators and faculty with funding in specific research areas. Disadvantage is difficulty keeping resources and

	information proprietary**.**
Industry consortium	Advantage is ability to effectively resource and address important but noncompetitive innovation challenges. Disadvantage is if agenda is dominated by individual company contributors and can erode perception of meritocracy.
Competition	Advantage is that companies engage multiple parties to focus on issues and problems. Disadvantage is that researchers cannot share resources or information with other universities.
Venture capital investment	Advantage is potential to foster more rapid commercialization. Disadvantage occurs when researchers are expected to sever academic ties, potentially forfeiting major source of information and ideas.
Fee for service	Advantage lies in the ability to receive funding for and apply technology to real world problems, providing companies with access to commercially unavailable technology. Disadvantage is potential for researchers to feel like "hired help" as opposed to partners. Also, university's value as an intellectual and innovation stimulus may be severely limited by narrowly defining the change and scope of the research.
Start-up company	Advantage is in start-up ventures formed by academic researchers and industry. University incubator space is where collaboration with industry can occur. Disadvantage is that this may result in criticism by those who feel this detracts from the university's mission of conducting basic research.

Academic-industry partnerships may also be defined by their orientation as well as their structure. Table 9 describes these orientations (Link et al., 1989, 52):

Table 9: Types of academic-industry orientations

Industrial extension services	Information transfer, consulting, workshops, classes, industrial fellowships
Procurement of services	Prototype development, fabrication, testing on-the-job training for students, education, training of employees
Cooperative research	Joint research planning, faculty and student participation, cooperative research projects, direct cooperation between academic and industry scientists, basic and applied research on generic problems to an entire industry
Research parks	Research cooperation on new frontiers of science and technology, informal interactions, increased sharing of research facilities and participation in consulting, seminars, and continuing education

Partnerships can also be defined in terms of the channels of innovation which are the result of the affiliation. These include patents, informal information exchanges, publications and reports, public meetings and conferences, placement of graduates and interns, licenses, joint or cooperative research ventures, contract research, consulting, or other types of personnel exchanges (Perkmann & Walsh, 2007, 262). The partnerships can be defined as types of "knowledge interaction" including joint research, contract research, mobility (the movement of personnel between universities and companies) and training (cooperation in education, staff training, and staff lecturing) (Schartinger et al., 2002, 304-307).

Partnerships can range from a one-shot transfer of knowledge to a complex and long-term relationship. The more complex, lengthy and binding the partnerships, the more complex the issues may be. According to Link et al. (1989, 52), the more frequency and intensity of the contact between the research partners, the more cultural differences and other contentious issues may be accentuated, or conversely, the more they may be diminished, depending upon the nature of the partnership.

Not only are there many types of partnership models, there appear to be differences in the propensity of companies to engage in academic-industry partnerships based upon their size, their R&D activity and their degree of openness, but not necessarily by the type of innovation they generate (process or product innovation). Larger companies with a high absorptive capacity generally tend to cooperate with academia. The openness of the company to the external environment appears to affect the propensity for and the level of collaboration with academic researchers (Fontanta et al., 2006, 321). Table 10 illustrates the ways in which today's academic-industry partnerships differ from the strict "consultancy" arrangements of the past (Jacob et al., 2000, 258).

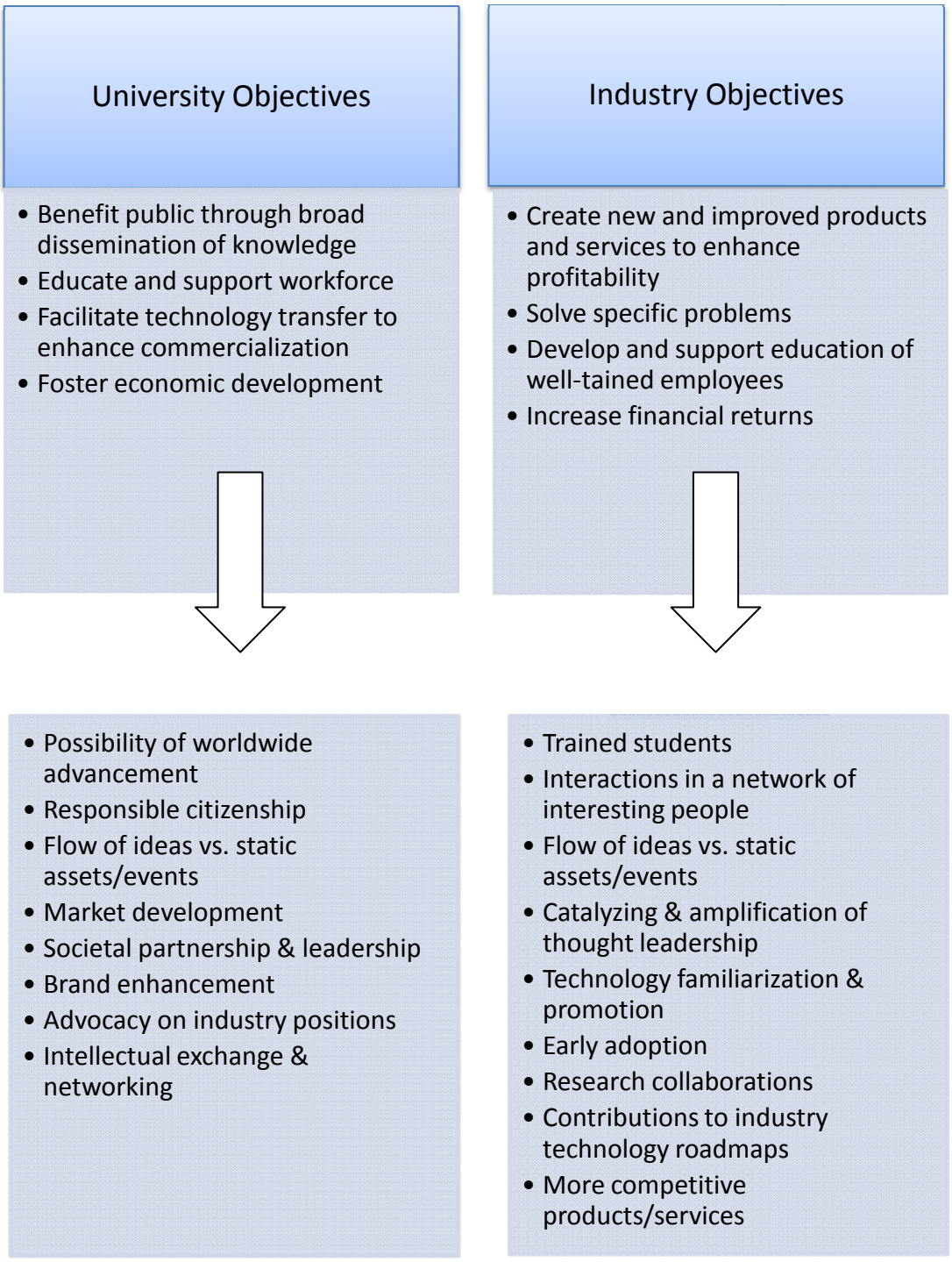
Table 10: Models of academic-industry partnerships

OLD MODEL	NEW MODEL
Academics hired as consultants to industry, usually for one-off projects.	Sustained interaction between researchers and practitioners.
	Ability to deliver solutions in real time to meet specific needs of the partners.
	Research aimed at knowledge creation for partners as well as for more general audience.
	Continuous in-house meta-dialogue regarding goals, methods, and practices.
	Ability to generate income to cover cost of retaining core research and administrative staff.

6.3 Academia and industry objectives for partnerships

Table 11 describes The Guiding Principles for University-Industry Endeavors, a report issued by the National Council of University Research Administrators and the Industrial Research Institute, which identifies the key objectives and values that each partner brings to the partnership (2006,3).

Table 11: Academic & industry partnership objectives



(National Council of University Research Administrations, 2006, 7, 13-14)

The report further identifies the reasons for the partnership as follows: "University-industry partnerships pair discovery and knowledge with the creation of goods and services. They endow society with a public good that exceeds the combined contributions of the parties. These include economic growth, an improved standard of living and the extension of humanity's intellectual reach. The goal should be to create this public good while simultaneously satisfying the mission and objectives of each partner. Universities ask 'to what extent should we enter into agreements with commercial concerns?' Industry asks 'How can we gain access to the research capabilities of U.S. universities to solve problems of regional and national economic importance?'"

The Business Higher Education Forum's 2001 report, "Working Together, Creating Knowledge: The University-Industry Research Collaboration Initiative," states the following reasons that academic-industry partnerships are important (21):

1. A means by which academic and industry scientists can advance their own research and companies can move new products more quickly, serving interests of both partnerships, the pursuit of new knowledge, and society at large.
2. Working with outside experts can greatly improve the quality and comprehensiveness of the research and help to reduce its costs. "All of us are smarter than any of us," commented former Pfizer CEO Hank McKinnell (21).
3. Many scientific advances are occurring at the interface of traditional disciplines, heightening the rationale for collaborations. Universities are well-positioned to contribute to this kind of multi-disciplinary research by tapping the disparate resources on their campuses that companies do not possess. Innovation can potentially occur when the traditional players in the corporate arena allow new

players to see things from a different and often random perspective and in ways that they could not have envisioned. Industry, in general, can look to the university for validation, human capital, and intellectual diversity and the probability of a random, profitable collision of ideas and capital.

Academic-industry partnerships build upon the premise that the university mission is to answer fundamental questions. University scientists engaged in this pursuit may not always pursue the practical applications of the results of these questions, providing a beneficial spill-over of knowledge from academic scientists to industrial technology. Through collaboration, the benefits associated with scientific research are enhanced and positively exploited (Poyago-Theotoky et al., 2002, 14).

The National Academy of Engineering reviewed academic contributions to industrial research in five industries:

1. Aerospace
2. Financial Services
3. Medical devices
4. Network Systems and Communications
5. Transportation, Distribution, and Logistics

Their study found that the contributions of basic, long-term academic research played prominently in all five industries. Portfolio theory, linear programming, and derivative theory, all founded in academic research, have laid the foundation for many financial products and services. Academic contributions to linear and integer programming and queuing theory are the building blocks of information management and integrated logistics. Medical devices like magnetic resonance imaging, lasers, organ and joint replacements, ultrasound, tissue engineering, and fiber optic laparoscopes are built on fundamental

academic research contributions in physics, math, electrical engineering, computer science and materials science. The aerospace industry has benefitted from basic academic research such as heat transfer combustion cooling and aeromechanics to develop unmanned aerial vehicle flights controls and real time decision systems utilizing artificial intelligence (Grossman et al., 2001, 146).

The overlap of attributes of industry and academic laboratories in translational research has made collaborative efforts effective ones. Co-authorship by industry and academic scientists has been found to increase research productivity in both the pharmaceutical and biotechnology industries (Gelijns & Thier, 2002, 74). As noted above, universities have served as a breeding ground for many medical technologies, such as imaging machines, fiber optic gastrointestinal endoscopes, laparoscopic tools and coronary angioplasty catheters. However, universities may not have the technology available or the funding necessary to fully develop these technologies within the university setting. The contribution of industry as a partner in these endeavors may make the development of such devices more feasible, learnable, usable, and many times less expensive (Gelijns, 2002, 74).

6.4 Reasons that universities and industries partner

The reasons for academic-industry partnerships are varied, and relationships are symbiotic, with benefits accruing to each partner. A concomitant theme throughout the literature indicates that a university presence is a positive force for successful research. Table 12 describes the reasons universities and industry partner:

Table 12: Reasons universities and industry partner

Human Capital	Economic	Mission/Goals	Technical
• 1. Pool of students as future employees and experience for students working hand in hand with industry. • 2. Collaboration encouraged and incentivized by federal grant programs. • 3. Research innovation from academia's ability to see problems from a new perspective.	• 1. Research funding and non-financial support for universities. • 2. Industry funding less restrictive. • 3. Contributions to local, regional, national economy. • 4. Ability to contribute to public good by acceleration of, identification of and solutions to important problems. • 5. Rapid diffusion of ideas, leading to spin-offs.	• 1. Industry collaboration can advance university service mission. • 2. Positive effects on university curriculum. • 3. Universities have infrastructure desired by industry. • 4. Increase in corporate profitability.	• 1. Technical opportunities within industry. • 2. Access to facilities and equipment. • 3. Interactions allow instruction for students to be more relevent to today's technology.

Human Capital

1. Pool of students as future employees and experience for students working hand in hand with industry - Universities are able to offer an available pool of students, both graduate and undergraduate, who can receive valuable workforce training that they cannot access in a classroom setting. These students may become future industry employees who are well-trained with hands-on experience. Graduate students and undergraduate students can receive exceptional experience by working hand-in-hand with industry, which can provide better-prepared graduates for professional careers. Universities can establish strong linkages with alumni within industry who will hopefully become benefactors to their alma maters. Likewise, industry can benefit from the advancement of technology through the employment of graduate and undergraduate minds.
2. Collaboration is encouraged and incentivized by the federal government - Through grant programs such as the National Science Foundation (NSF) Partnerships for

Innovation programs, academic institutions and their partners are often rewarded for grant submissions that are collaborative and multi-institutional.

3. Research innovation from academia's ability to see problems from a new perspective - Companies can benefit from the research innovation that is the result of academia's ability to see problems from a perspective not encumbered by commercial concerns. The type of relationship between academia and industry is aimed at the creation of usable knowledge that is not merely transferred to practitioners but is jointly created in a collaborative process, placing a new emphasis on knowledge as both an input and an output and resource of the business enterprise (Jacob et al., 2000, 255-256). Kaufman et al. surveyed 517 firms and found that those surveyed felt that interaction with others in the scientific arena stimulated their innovativeness, because it makes available a much more diversified range of knowledge sources. Firms who cooperate with others in the scientific field increase their ability to realize more radical innovations and to introduce new products to the market (Kaufmann & Toddling, 2000, 802).

Economic

1. Research funding & non-financial support for universities - Collaborations with industry provide research funding and non-financial support for universities, either to enhance fundamental research through equipment acquisition or the additional of post-doctoral research or through the ability to attract and retain star scientists.
2. Industry funding is less restrictive - Industry funding to academia is far less restrictive than government funding and therefore allows for greater flexibility and quicker response times for the researcher.

3. Contributions to local regional and national economy - Collaborations contribute to the local, regional and national economic development, and through more rapid technological diffusion, new products, processes and new company spin-offs are accelerated, resulting in enhanced economic growth. Additionally, university spin-offs can make economies less dependent on older industries by diversifying a region's economic base. Venture capitalists have tended to open new offices in areas near universities who are involved in biotechnology research as a way to facilitate company growth. Qualitative evidence from the USATP program (Poyago-Theotoky et al., 2002, 12-15) implies that the social returns as a result of academic-industry partnerships are quite high. Economic growth in the United States is linked to the expansion and effectual use of science and technology.
4. Ability to contribute to the public good by acceleration of identification of and solutions to important problems - The ability to rapidly bring to society the "fruits" of corporate and academic investment in research accelerates the process of the identification and development of solutions to significant health problems (Casey 2007, 13; Fitzgerald, 2008, 334; Poyago-Theotoky et al., 2002, 14-17; Schartinger et al., 2001, 256; Yusef & Nabeshima, 2007, 18; National Council of University Research Administrators, 2006,3- 7; Business-Higher Education Forum, 2001,23-24; Krimsky, 1999, 15; Casey, 2005, 11; Shane et al., 2005, 25, 35-36; Löfsten & Lindelöf, 2002, 859-860).
5. Rapid diffusion of ideas, leading to spin-offs – Collaborative partnerships between academia and industry can speed up the transfer of ideas to proof of concept and then

ultimately to the commercialization of these ideas through the spin-off of new technologies and start-up companies.

Mission/Goals

1. Industry collaboration can advance university service mission - Collaborations with industry can advance the university service mission and can have positive effects on the university's curriculum as faculty members draw on their experiences with companies to develop instruction to students that is more relevant and more closely aligned with the technology of today's job market.
2. Positive effects on university curriculum – University faculty can more effectively plan curriculum that is directly related to the trends and needs of industry, helping students become prepared for the competitive workforce when they graduate.
3. Universities have infrastructure that is desirable to industry - This infrastructure provides a more cost-effective way of conducting research as opposed to building research capabilities from the ground up. Corporate agendas can be advanced through the university's completion of project objectives and deliverables.
4. Increase in corporate profitability - Industry outsourcing to academia may reduce the cost of doing business and increase corporate profitability. Melese, Lin, Change & Cohen (2009, 520) assert that "the current model for producing biopharmaceutical innovation is economically unsustainable." Companies look outside of their boundaries for ideas and intellectual property, and can reduce the cost of developing innovation if universities can bring in new technologies through collaboration. These alliances contribute to the acquisition of basic scientific knowledge, which can ultimately lead to the generation of additional

profit as well as the skill and knowledge enhancement of the company's existing scientific work force.

Technical

1. Technical opportunities within industry - More technical opportunities exist within industry that are not available in the academic setting. Siegel et al. (2002, 42) reported that 65% of scientists surveyed reported that interacting with industry has had a positive influence on their research, indicating that knowledge transfer works in both directions. "They help me refine my experiments and sometimes have a different perspective on a problem that sparks my own ideas," one commented.
2. Access to facilities and equipment - Materials are available in industry for research and educational purposes that may not be available in the academic setting. Students potentially have access to facilities and equipment that might not be available to them within their own organizations.
3. Interactions allow instruction for students to be more relevant to today's technology - Technology often changes more rapidly than universities can afford to update laboratories, information technology, and other facilities. By having access to the technical innovations, protocols, and procedures of industry partners, faculty can make sure that students are exposed to real world situations presented to them as part of their curriculum and educational experience.

6.4.1 Reasons for partnerships as cited by tech transfer offices

A 2001 survey by the Association for University Technology Managers (AUTM) survey of 62 technology transfer officers found that tech transfer officers desired collaboration for the following reasons: royalties and fees generated, number of inventions commercialized, number of licenses signed, sponsored research, and number of patents awarded. The reasons for collaborating were different for actual academic researchers (Carayol, 2003, 890).

6.4.2 Partnerships as funding sources

According to Meyer-Krahmer's survey of 400 German scientists, academic researchers perceive that the advantages of collaboration lie both in obtaining funding as well as in the opportunity for the exchange of knowledge (Meyer-Krahmer et al., 1998, 835).

Lee's survey of 100 academic scientists in the United States found that the most important reasons for collaboration were to secure funding for research assistants and lab equipment, to gain insights in one's own academic research, to test the application of a theory, and to supplement funds for one's own academic research (Lee, 2000, 113). Lee's survey of 671 faculty scientists from 40 research universities on the NSF list of top 100 research universities also indicated that a large majority (67%) of those surveyed state that they are experiencing substantial or considerable benefit to their academic support by acquiring the funds that are necessary to support graduate students and additional laboratory equipment. Of those surveyed, 66% say that industry collaboration allows them to gain valuable insight into their research agendas. Lee's subsequent study of 140 firms which collaborated with academia found that by partnering with academia, firms were first "gaining

increased access to new research and discoveries," and second, making "significant progress toward the development of new products and process," and third, helping them significantly toward a closer relationship with the university (Lee, 2000, 111). An overwhelming majority of those surveyed (94% of faculty members and 91% of industry managers) indicated that they would expand or at least sustain their present level of collaboration in the future (Lee, 2000, 132).

6.4.3 Academic-industry partnerships as vehicles for multi-disciplinary research

The Committee on the Impact of Academic Performance on Industrial Performance, commissioned by the National Academy of Engineering (2003), concluded that academic research has had a significant impact on the performance in the network systems and communications, medical devices and equipment, and financial services industries. They also found that academic research has made substantial contributions ranging from graduates trained in modern research techniques to fundamental concepts and key issues based on basic and applied research to the development of tools, prototypes, and marketable products, process and services (2). The committee concluded that universities are excellent venues of a greater range of ideas and disciplinary perspectives than any other institution in the U.S. innovation system, and that these partnerships have vast potential for multidisciplinary research. Universities are the only places where advanced research and education are integrated on a grand scale (9).

Blumenthal (1996, 1734) surveyed more than 2000 public researchers in the life sciences field and found that faculty members were more productive, in terms of peer-reviewed articles published in the past three years, when they received industry funding.

Gulbrandson and Smeby (2005, 947) contend that "industrial funding is strongly correlated with high publication productivity, even when adjusting for types of publication and co-authorship." Zucker and Darby (1996, 12709-12716) found an increase in the scholarly output of "star" academic scientists after they were involved in commercialization efforts in biotechnology.

Schartinger et al. (2001, 258) interviewed 99 firms with 421 questionnaires from faculty members. Potential benefits included highly skilled personnel (63.7%), ideas for new products and processes (47.2%), general and useful information (42.7%) direct support in development process (41.1%), new instruments and techniques (37.9%), results of basic research (33.3%) and consulting services (32.8%). Nearly half the firms responding indicated that universities are a significant source of new ideas for new products and processes (259).

A survey by Feller et al. of 355 companies (2005, 6) in 18 engineering research centers established between 1895 and 1990 found that 80 % of companies in the survey participated in academic partnerships primarily to gain access to upstream modes of knowledge rather than in the development of specific products and processes. The reasons cited in this survey for partnership development included access to new ideas, technological and research focus consistent with the focus of the company (73%), access to expertise (65%), the opportunity for joint projects, access to equipment or facilities, access to students as prospective new hires, prior connections or relationships with individuals, the ability to leverage research investment with money from other participants, the opportunity to interact with other affiliates for cross-disciplinary research, access to test facilities or prototyping capabilities, the ability to license inventions or software and the ease of in-person interaction and geographic proximity. The single most often mentioned item was the ability to obtain

access to new ideas, know-how, or technologies – a platform for creating different perspectives which leads to novel ideas or solutions (Feller et al., 1998, 464).

Similarly, a survey of 885 universities and 312 companies in France, Germany, and the U.K. by Caloghirou et al. (2001, 154) found that the principal objectives of companies to collaborate with universities include research synergies, keeping up with key technological developments, and R&D cost sharing. The increase in their knowledge base is the most significant reported benefit of companies from these partnerships. Thus, many companies choose not to assign value to these partnerships based on quantitative, concrete performance measures (Feller et al., 2002, 471; Shane, 2005, 21). These studies and others seem to indicate that the generation of tangible innovation outcomes for academic-industry partnerships only tells a partial story. Patents, licensing revenue, and new spin-off companies represent only partial benefits, while the benefits from relationship-based mechanisms exceed them in terms of relevance to companies. The contribution of academic knowledge is not limited to novel and radical innovation but over the entire innovation cycle, where companies see advantages in capacity-building and learning motivations as opposed to only tangible outcomes (Perkmann & Walsh, 2007, 267-272).

A report by the Biotechnology Industry Organization highlighting university input into commercialization from 1996 to 2007 surveyed 140 university partnerships and found that the most consistently cited benefit mentioned was access to students and faculty to new ideas and research results, rather than technology per se (BIO, 2009, 13). The report concluded that research universities have been among the most important economic institutions of the twentieth century. Sampat (2003, 56) states “most economic historians

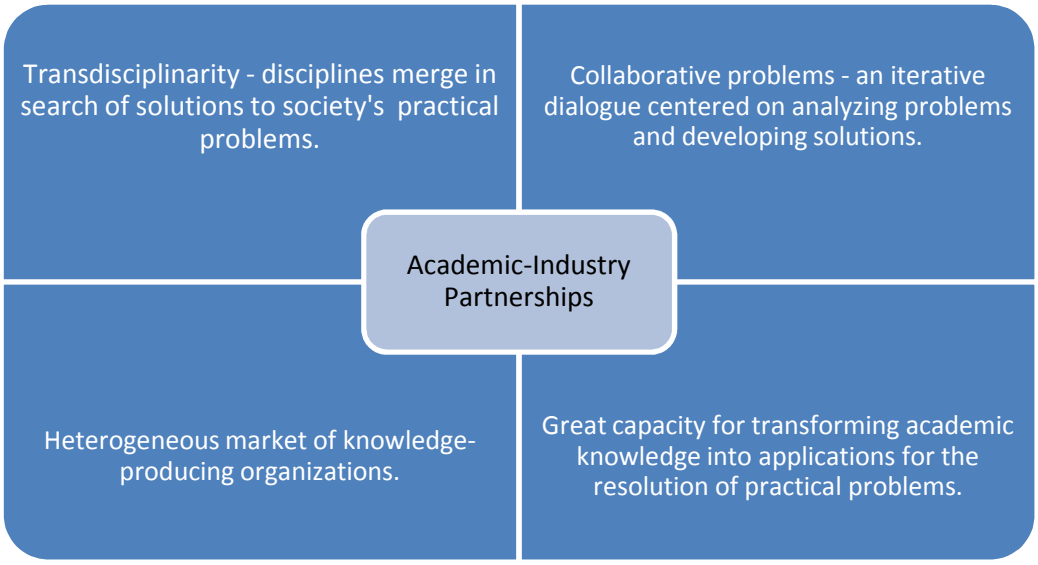
agree that the rise of the American technological and economic leadership in the postwar era was based in large part on the strength of the American university system."

The role of academia in partnerships seems to differ by industry sector. In the chemical industry, for example, collaboration with universities primarily is seen to be beneficial in the reduction of costs and risks and the ability for industry to acquire and update scientific knowledge in order to improve productivity. In the food industry, universities assist industry in meeting government regulations, particularly in testing activities related to bacteriology and contamination. In the computer services sector, the primary role of industry is to assist with acquisition and update of technical knowledge (Fontana et al., 2005, 314).

Universities create research awareness among the research partners of the joint venture. "It is the collective perception of the other research participants that the university could provide a research insight that is more anticipatory of future research problems that might be encountered and could thus take on the role of an ombudsman to anticipate and translate to all concerned the complex nature of the research being undertaken" (Hall et al., 2001, 88).

Academic-industry partnerships most certainly are characteristic of a "knowledge society," described by Jacob et al. (2000, 255). The attributes of academic-industry partnerships are described in Table 13:

Table 13: Attributes of academic-industry partnerships



In 1986, two years after the passage of the Cooperative Research Act, a study by the Public Policy Center for Stanford Research International indicated that 97% of the 200 public universities in the sample reportedly had plans to increase their efforts to work with industry (Lee, 1995, 845). Lee's national survey of 1000 faculty members at 115 research-intensive universities concluded that academic scientists in the 1990s were more favorably disposed than in the 1980s to closer academic-industry collaboration (Lee, 1995, 843).

A 1984 survey by the National Science Foundation of 226 university and industry researchers found that each member of the partnership felt that their joint efforts had improved their ability to cooperate with each other. University researchers were more optimistic than industry researchers with regard to the potential "likelihood of tangible benefits" (Link & Tassey, 1989, 53).

Link & Tassey write that there is motivation for cooperative research when there are economies of scale or scope with respect to research, production, or marketing, or the

shortening of time to achieve any of the aforementioned items. Industry is motivated by exposure to longer-term research, access to unique research skill sets, and access to highly skilled labor. Universities are motivated by the exposure to more applications-oriented research, increased funding, and better insights into curricula development (Link & Tassey, 1989, 44). According to Link & Tassey, a 1982 NSF survey of 400 academic-industry partnerships identified the following reasons for collaboration: access to technology for problem solving or obtaining state-of-the-art information, prestige, economical use of resources, support of technical excellence, proximity and access to university facilities, access to scientific or technical areas where industry has special expertise, the opportunity to expose students to practical problems, the use of earmarked government funding, and potential employment for graduates (Link & Tassey, 1989, 44).

Liyange & Mitchell report the following positive aspects of academic-industry (1994, 645):

1. The role of academic institutions to serve as clearinghouses for ideas and creative thought.
2. Universities act as data exchange junctions for accessing national and international research.
3. Universities develop excellence in research, which assists industry by deepening core technology areas that are central to its interest.
4. Universities are gatekeepers in the provision of skills and for the technical inputs required to maintain the competitive advantage of industry.

Lööf and Broström suggest that university collaboration has a positive influence on the innovation activities of large manufacturing firms. Their study of 2,071 firms in the areas of basic metals, medical, precision, and optical instruments indicated that university collaboration positively influences innovation sales as well as the propensity to apply for patents for manufacturing firms of 100 or more employees (2008, 88).

In a 1994 study, Mansfield (1998, 773) concluded that industrial innovations in over 5% of the total sales in major U.S. firms would have been delayed for a least a year without the input of academic researchers. Mansfield's 1991 study surveyed R&D executives from 76 major U.S. firms and results indicated that 11% of new products and 9% of new processes could not have been developed in the previous fifteen years without the results of academic research (Mansfield, 1991, 21). Likewise, a study of 2,300 companies in Germany (Beise & Stahl, 1999, 397) found that approximately 5% of new product sales could not have been developed without the assistance of academic research.

A survey of 1,478 R&D laboratory managers conducted by Carnegie Mellon University in 1994 found that two-thirds of the industries surveyed showed that university research was at least "moderately important" to their research (BIO, 2009, 21). MacPherson's study (2002, 121) of 63 medical device producers suggests that innovation rates are higher among companies that utilize university researchers, and also proposes that geographic proximity to academic resources is less important to the innovation process than the extent of academic-industry interaction.

"The strengths of academic research, primarily the resources to focus on long-term fundamental, risky goals and to mount broad collaborative projects, complement the applied research and development performed by industry. Universities are a source not only of scientific and technological ideas that lead to new products and processes, but also social and political insights that strengthen the nation's ability to adapt to new technologies and therefore to embrace continued innovation. As industry has become more dependent on innovation, new skills, and technological prowess, academic contributions have become increasingly critical to economic success" (National Academy of Engineering, 2003, vii).

6.5 Criticisms of academic-industry partnerships

6.5.1 Johns Hopkins University: An early critic of academic-industry partnerships

Criticism has been aimed at academic-industry partnerships as "potentially threatening academia's traditional role as a bulwark of open and disinterested inquiry: (Blumenthal, 1994, 176). Such objections are hardly recent phenomena: Johns Hopkins University, dedicated to promoting what Robert Merton called the norm of "open science" and a commitment to "wissenschaft" – the idea of knowledge for its own sake – originally exhibited an unwillingness to allow commercial interests to influence research (Feldman & Desrochers, 2004, 106-111). Much of the criticism directed at this issue has come from within the university itself; from those within the academic system who hold firm the belief that partnerships with those outside of the world of academia will somehow taint or dilute the conventional mission of the university as providers of knowledge, education and training.

Although today Hopkins ranks as one of the largest recipients of federal R&D funds, this was not the case for many years when Hopkins took a more arms-length approach to its relationship with industry. Trustee Lewis Hopkins, nephew of the university's founder, commented, "Great discoveries always came from those who were devoting themselves to practical applications" (Feldman et al., 2004, 112). Daniel Coit Gilman, Hopkins' first president, commented in his inaugural address, "In a land where almost every strong institution of learning is either a 'child of the church' or a 'child of the state' and is thus liable to political or ecclesiastical control, Johns Hopkins has planted the germ of a university which will doubtless serve both church and state the better because it is free from the guardianship of either (Feldman et al., 2004, 110).

William Brody, Johns Hopkins' president from 1996 to 2009, in a speech entitled "From Minds to Minefields: Negotiating the Demilitarized Zone between Industry and Academia," described these relationships as tentative and uneasy, a "minefield of potential conflicts, claims and counterclaims." Brody depicted four contentious issues: what can and should be patented, whether universities should patent at all, whether universities should license intellectual property, and if the university is to license, whether it should be on an exclusive basis. He commented, "Our scientists are by nature explorers. They are sailing uncharted seas in search of discoveries. Asking them to become managers, marketers, and accountants is unrealistic and ultimately inimical to the research enterprise" (Feldman et al., 2004, 108).

6.5.2 Similar concerns from MIT and Berkeley

The Atlantic Monthly's article, "The Kept University," provides illumination on one of the more commonly documented criticisms of academic-industry partnerships. The article states that "commercially sponsored research is putting at risk the paramount value of higher education – disinterested inquiry. Even more alarming…. is the fact that universities themselves are behaving more and more like for-profit entities" (Press & Washburn, 2000, 39). Karl Compton, President of MIT from 1930 to 1948 once expressed concern that with MIT's large corporate backers MIT would end up "a second rate university because all the professors did was consult" (Beath et al., 2003, 1303).

A 1960s Berkeley student denounced his university for bending over backwards to "serve the need of American industry" rather than serving as the conscience and critic of society, a reaction to the controversy that centered on a $25 million contribution from

Novartis, a Swiss pharmaceutical company. Under the terms of the agreement, Novartis committed funds for basic research on genetically engineered crops in return for a first right to commercialize licenses on approximately one-third of the plant and microbial biology department's discoveries (Poyago-Theotoky et al., 2002, 18). Gordon Rausser, the Dean of the College of Natural Resources at UC Berkeley, countered that the criticism was unfounded for many reasons, among which is the "university's land grant mission, which specifically directs the university to work cooperatively with private industry" (Chronicle of Higher Education, 2010, Letter to the Editor). Anderson (2001, 234) suggests that industry "operates in neither a controlling nor courting mode and that both parties to the partnerships are frequently frustrated by the complications and risks of the relationship."

6.6 Barriers affecting academic-industry partnerships

Various writers have identified major barriers that are stumbling blocks in forming collaborative partnerships (Business Higher Education Forum, 2001, 27; Link and Tassey, 1989, 44-45; Fontana et al., 2006, 314; Geisler, 1986, 37; Gelijns & Thier, 2002, 75; Casey, 2005, 13). Table 14 outlines many of these observations, which are detailed in the text which follows:

Table 14: Barriers to academic-industry partnerships

Goal-Related	Mission-Related	Contract-Related	Personnel-Related
• 1. Institutional goals are fundamentally different • 2. Companies & universities lack understanding of how the other operates • 3.Differing time horizons • 4. Differences in reward structures • 5. Publication delays • 6. Difference in funding mechanisms • 7. Global competition • 8. Conflicts of interest • 9. Financial risk for both partners • 10. Differing definitions of success	• 1. Academia & industry have distinct & inconsistent missions • **2.** The debate between basic & applied research • 3. Fear that corporate agendas may unduly influence the university research agenda • 4. Proprietary nature of sponsored research counters university's idea of atmosphere of free & open inquiry • 5. Concern for the university's commitment to independent and unbiased search for truth • 6. Lack of academic freedom • 7. Differences in strategic focus	• 1. Intellectual property disputes • 2. Delays in contract negotiations • 3. Attempts to make agreements "one-size-fits-all" are not effective • 4. Ineffective technology transfer offices • 5. Lack of coordination in monitoring and evaluation • 6. Agreement on timetables for completing the research	• 1. Lack of communication • 2. Universities & industry are not natural partners • 3. Inconsistency & turnover among personnel • 4. Distinct organizational characteristics • 5. Bureaucratic Inflexability • 6. Divisiveness among faculty • 7. Cultural differences

6.6.1 Goal-related barriers

1. Institutional goals are fundamentally different - A report by the National Council of University Research Administrations and the Industrial Research Institute (2006, 5-6) points out that the institutional goals between academia and industry are fundamentally different. Universities create knowledge through the process of open inquiry by students and faculty and knowledge is disseminated through publication and technology transfer. Any project that threatens the core mission of the university is virtually intractable from the university perspective. The core mission of industry is to exploit down-stream knowledge in order to create value for shareholders, to provide useful products and services and to expand the state of the art. Products created by industry must generate profits essential to sustain a healthy industry. Any project that limits this core mission is intractable from the industry standpoint.

2. Companies and universities lack understanding of how the other operates – University officials may have a fundamental lack of understanding of how companies operate and vice versa (Siegel et al., 2003, 42; Hopkins, Ibarreta, et al. 2006, 405). This may include the difficulty in a cost-benefit analysis for the investment in the partnership, sometimes causing the academic partner to advocate for hanging onto projects even when they are no longer financially feasible. The lack of specific mechanisms to properly evaluate the partnership is another critical issue. Budgeting and staffing problems are often overlooked but can be the source of considerable tension and conflict. One industrial R&D manager commented on the differences in the following terms: "Industry makes decisions and judgments on the basis of achieving a 90% success rate. There is a constant assessment of parallel paths. A good industrial researcher is parallel pathing in the most cost effective way so that the company can recover if disaster occurs. Academics are only concerned with publication. The worst that can happen is that referees question the work. If an industrial researcher makes a mistake, he faces a possible product recall and a possible company disaster" (Liyange & Mitchell, 1994, 644).
3. Differing time horizons - There are frequently differing time horizons between the two sectors (Pavitt, 2003, 18). Planning mechanisms differ in important ways. Planning for academic research is typically tied to a funding cycle corresponding to the university's fiscal calendar. Corporate planning is a continual process beginning with the senior levels of management and fed to division units according, but is inextricably linked to the corporate budget process. A study by Barnes et al. (2002, 10) of six British collaborative research projects found that academic researchers

expressed frustration at industry partners requiring "quick results" and having unreasonable expectations. According to Barnes' study, the apparent lack of visible progress left industry partners to draw their own conclusions as to the status of the projects, and since their expectations were often unrealistic, these were often negative.

Meeting company-established deadlines is a recurring challenge for industry. Industry officials often comment that university researchers lack the management expertise and fail to respect contractual deadlines. University researchers often comment that meeting schedules is the most difficult when the project has commercial applicability, which is also when the corporate pressure is greatest (Business Higher Education Forum, 2001, 72). Other timing issues that the partnerships experienced were more directly related to fundamental differences between the partners. According to Barnes (2002, 10), industrial participants were more concerned with elapsed time on the projects versus tangible progress made, while academic partners were more concerned with the allocating the sufficient attention to detail and in-depth investigation to ensure that correct and well-founded conclusions are drawn. The emphasis on the appropriate and most robust research approach is important to academia, independent of schedule, and therefore, academia has been traditionally seen as slow-moving and indifferent to the imposition of schedules and timeframes. In reality, the existence of this barrier to success lies in the failure of both partners to adequately acknowledge the limitations of the research within the time and resources available and to manage expectations accordingly.

4. Differences in reward structures - Institutional reward structures differ, including matters such as tenure criteria. Libecap (2007, 12) found that faculty site insufficient rewards for faculty involvement in university tech transfer, both pecuniary and non-pecuniary, such as credit toward tenure and promotion, as a major barrier to success. Some critics suggest that academic-industry collaborations may unduly influence tenure and promotion decisions (Siegel et al., 2002, 43). Cohen et al. (Lee, 1996, 846) found that university researchers are primarily rewarded with reputation, which in turn promotes mobility, salary increases, and teaching reductions. Thus, the rewards to academic researchers depend on the ability to conduct open science and disseminate those results. However, rewards to industry are linked to corporate profit, which in turn relies upon confidentiality. Therefore, the merger of academic and industrial research moves academic research towards secrecy, which is in conflict with standard academic practice. Siegel's study found that 60% of administrators and 70% of researchers reported insufficient rewards for faculty involvement in partnerships, and specifically referred to tenure and promotion policies and the university's royalty and equity distribution formula (Siegel et al., 2003, 42). University internal reward systems such as tenure criteria often do not take into account faculty participation in collaborations. Studies have shown that academic researchers who partner with industry are more productive in general, including their teaching responsibilities (Bonaccorsi et al., 2006, 389-410). However, the standard system of recognition within the university structure may be more focused on the traditional acknowledgments, such as tenure, and may ignore the value of a successful industry partnership as part of the equation.

5. Publication delays - Some critics warn that the proprietary nature of some sponsored research – with confidentiality restrictions and publication delays – counters the university's tradition idea of an atmosphere of free and open inquiry. Some university faculty members and administration remain skeptical of the idea that research collaborations should be a permanent addition to the menu of research options. In a case study focused on a partnership between the University of Colorado and Ribozyme Pharmaceuticals, one of the partners commented that "the trickiest part of any university-industry research collaboration involves balancing the university's need and requirement for academic freedom, collegiality and openness with the company's need for confidential information" (Business Higher Education Forum, 2001, 93). In a study by Lee (2000, 117), 57.3% of faculty members report that as part of a research contract they were required to execute a confidentially agreement promising to keep trade-sensitive information in confidence. In the same survey of industry leaders, 84% of managers indicated that they required faculty members to sign a confidentiality agreement.

Libecap states, "Academic scientists seek rapid dissemination of their ideas and breakthroughs. They manifest the propagation of new knowledge through selective scholarly journals, presentations at conferences and research grants with the end result being peer recognition through citations and stronger connections to the key social networks in academia. This peer recognition is the hallmark of a successful career in academia" (Libecap, 2007, 5). Companies, on the other hand, are motivated by the desire to commercialize university-based technologies for financial gain. They

place a strong emphasis on speed to commercialize as soon as possible in order to establish a "first mover" advantage (Libecap, 2007, 6).

The issue of publication delay is one that also plagues academic– industry partnerships. Because universities view intellectual property not only for its commercial value but as a tool in the advancement and dissemination of knowledge, this becomes a critical impingement. Industries often wish to hold scientific results in confidence pending commercialization while academic partners desire quick and succinct publication of results. In a survey of 210 life science companies, 58% reported that they required university investigators to keep information confidential for more than six months, considerably longer than the thirty to sixty days that the NIH considered reasonable for the purpose of filing a patent (Blumenthal, 1996, 371). Blumenthal's study implies that academic-industry partnerships seem to reduce the openness of communication within the research environment. In a survey of biomedical executives, over half admitted that their research agreements with universities included restrictions on communicating results (Blumenthal, 2003, 2455). Blumenthal concluded that although universities and industries seem to have formed durable partnerships in the life sciences area, these relationships may pose greater threats to the openness of scientific communication than universities generally acknowledge.

6. Difference in funding mechanisms - Funding mechanisms are vastly different with academic funding coming from a variety of sources including NIH, foundations, etc. and corporate funding originating from one primary source: the business itself. Academic research relies on the ability to obtain funding to dictate strategy, scope

and scale of the project, whereas corporate research initiatives are driven by the business strategy and the need to bring new products to market.

7. Global competition - Globalization is now both a barrier and an opportunity for academic-industry partnerships. Foreign universities are now better able to compete with American universities in research and discovery. U.S. companies are finding foreign universities less expensive and easier to work with because of more favorable intellectual property rights (Yusaf et al., 2007, 164). Foreign students are also considered to be less expensive and are valuable assets to companies (Casey, 2005, 11). In a testimony before the U.S. Senate Commerce Committee's Subcommittee on Science, Technology and Space, a Hewlett Packard manager stated, "Large U.S.-based corporations have become so disheartened and disgusted with the situation they are now working with foreign universities…. more than willing to offer extremely favorable IP terms" (Yusaf, 2007, 232).
8. Conflicts of interest - It is important to note that the majority of the literature points out the potential for conflict, not actual unintended consequences (Behrens, 2001, 181). A number of studies have addressed whether collaborations might create the conditions to predispose faculty to ethical or value compromises, or otherwise distort their behavior in a way that could tilt or skew research agendas in a way that could have personal financial benefits (Blumenthal, 2003, 2455). The need for transparency in these relationships is critical in dispelling these attitudinal landmines.

A 1998 study of 100 U.S. universities found a lack of specificity about the types of relationships that were permissible and wide variation in the types of administrative approaches utilized to deal with potential conflicts of interest

(Blumenthal, 2003, 2456). Cohen et al. (Behrens & Gray, 2001, 181) state that approximately 35% of academic-industry research centers allow companies to delete information from reports and over 50% allow them to delay publication of results. Campbell (1997, 357-359) writes that faculty engaged in partnerships were more likely to be supportive of various practices which could potentially lead to conflicts (such as exclusive licensing of technology) than were non-collaborating faculty. Lee (1996, 843-863) cautions that the potential for problems and the evidence of supportive conditions are not prima facie evidence of the negative effects of these partnership relationships.

Conflicts of interest have arisen between faculty and students regarding the alleged misuse of research. Cornell University and Columbia University both have been involved in litigation between students who claimed that their research had been misappropriated by faculty seeking to profit for the research's commercial potential (Marshall, 1999, 562). Conflicts of interest can take many forms. Financial conflicts may occur when scientists' private financial interests and research converge in a way that might call into question their ability to make unbiased decisions related to their work, which can weaken public trust and damage the reputation of the institution. Conflicts of commitment can result in interferences with the faculty member's schedule and time commitment to students or other duties. Institutional conflicts of interest or conflicts of the mission of the university can occur when a university becomes beholden to a company in which they have a financial stake (Business Higher Education Forum, 2001, 12).

9. Financial risk for both partners - While licensing is but one measure of partnership success, the administrative and legal expenses of technology licensing offices raise questions about their revenue-generating functions (Anderson, 2001, 234). Many of these offices barely break even, and only one in ten patentable discoveries will make enough money to cover the costs of filing for a patent, with only one in a thousand making a substantial financial return. From the industry perspective, other, more pressing financial needs may pre-empt the partnership involvement. Internal company politics may affect the allocation of research funding. There may be a feeling among decision makers that the research has low potential for commercialization. (Feller et al., 2002, 470).
10. Differing definitions of success - The expectations for defining success can be similar but are often distinct. Both the university and corporate research teams are interested in new biological and scientific discovery which result in new commercial opportunities. However, academic researchers are expected to produce results that can be translated for the good of mankind. Industry researchers are expected to produce results that can be commercially viable for new product development. Agreeing on valuation or productivity models for assessing partnership performance can be challenging. Universities may overvalue the value of the research they perform for industry. Industry officials may feel there is insufficient influence of the research on the research agenda or that the research is not sufficiently relevant to its needs (Link & Tassey, 1989, xix).

6.6.2 Mission-related barriers

1. Academia and industry have distinct and inconsistent missions - Universities have mixed missions, particularly with respect to the establishment of start-up companies. To some, this represents a significant departure from the university's commitment to education, service and research (Hopkins, Ibaretta, et al., 2006, 405). These types of collaborative partnerships require and almost demand an atmosphere of continual dialogue in order to assure that there is a clear assessment of the research agenda as it relates to the company's overall business strategy. Universities and industries operate under certain constraints that are endemic to their organizations. Universities must, above all, educate students and conduct research for the benefit of the public. They operate within volatile state and federal environments and must manage potential and actual conflicts of interest while maintaining consistency with all sponsors. They operate within the limitations of the academic year and face federal and state funding inconsistencies. Industries must, above all, show financial returns. They must distinguish between basic and applied research and plan for research that is a part of their competitive business plan and budget constraints. Companies strive to establish agreements in a commercially timely manner and to ensure the ability to commercialize with appropriate returns. They require clear goals, milestones and specific time frames for completion of the research (National Council of University Research Administrators et al., 2006, 7).
2. The debate between basic and applied research – The debate between basic and applied research is at the core of many of the criticisms directed at academic-industry partnerships. This discussion centers on the notion of who is the beneficiary of the end result and whether that result benefits society as a whole in terms of expanded knowledge

or merely accrues benefits to private entities (Anderson, 2001, 239-240). Slaughter's and Leslie's (1997) study found that most faculty members did not see rigid distinctions between basic and applied research, and that research is viewed as seamlessly joined in a way that "collapses the distinction between knowledge and commodity. Knowledge becomes commodity" (1997, 38). Faculty did not perceive basic research as having greater social value than applied research, and did not think that creating knowledge for profit contradicted their commitment to altruism and public service. Instead they saw the market as a mechanism for distribution of their discovery to society (Slaughter et al., 1997, 183). Etzkowitz and Webster found that faculty "layered" applied research onto a program of basic research, instead of substituting one for the other (1998, 46). A study by Louis et al. (2001, 233) found that entrepreneurial faculty members actually have higher scholarly productivity than non-entrepreneurial faculty. A study by Zucker & Darby (1996, 12,709) found that "star" scientists in biotechnology had excellent research performance after becoming involved in commercialization and patenting. Siegel's study (2003, 126) found that faculty members involved in commercialization projects typically reinvest their profits in laboratory equipment or the additional of post doctoral researchers, enabling them to conduct additional research. A study of 70 companies by Mansfield and Lee (1996, 1057) found that universities cited by companies as having contributed the most significantly to their product and process development tended to also be the leading generators of new fundamental knowledge. Universities such as MIT, UC Berkeley, Stanford, Harvard and Yale have had a significant impact on industrial innovation in the short term, as well as over an extended period of time.

3. Fear that corporate agendas may unduly influence the university research agenda – Critics question if the research collaborations unduly influence the research agenda of the university, pushing the focus from fundamental to applied research. However, a study (Business Higher Education Forum, 2001, 27) showed that the percentage of basic research being performed in universities remained unchanged from 1981 to 1995, which seems to contradict the concerns that industry support overwhelms the research agenda. Another study (Blumenthal, 1997, 1228) of 2,167 non-clinical life science faculty indicated that academic researchers who received a portion of their funding from industry published more often and in equally prestigious journals and were involved in more academic service activities, than their peers who did not receive industry support. An earlier study by Allen and Norling (Behrens et al., 2001, 182) of 400 university faculty in Pennsylvania found that faculty who were involved in commercial endeavors such as consulting and other start-up activities appeared to be as involved as other faculty in university activities and devoted a comparable amount of time to those activities. Additionally, faculty who were involved in commercial activities resembled faculty not involved in such activities in terms of perceived relevance of various traditional goals, such as publishing, generating pure knowledge, etc. A study of 1,554 Canadian researchers funded by the Natural Sciences and Engineering Research Council showed that knowledge transfer activities do not interfere with the more traditional activities related to the disinterested advancement of knowledge (Crespo, 2007, 64). Campbell's 2006 study of 459 department chairs in 126 medical schools in the U.S. found that nearly two-thirds had some form of personal relationship with industry. More than two-thirds of the chairs perceived that having a relationship with industry had no effect on their

professional activities. However, 72% viewed a chair's engaging in more than one industry-related activity (substantial role in a start-up company, consulting or board presence) as having a negative impact on the department's ability to conduct independent unbiased research (Campbell, 2007, 1783). Generally, these studies suggest that faculty who actively collaborate with industry continue to be engaged in a full complement of academic endeavors and supported the relevance of traditional academic goals.

4. Proprietary nature of sponsored research counters the university's idea of an atmosphere of free and open inquiry - While universities strive to publish and disseminate the results of their work, companies are often more secretive about the results of research in the search for competitive advantage and potential for profit. A 1994 study of 210 life science companies conducted by researchers at Mass General Hospital found that 58% of these companies required publication delays of six months or more (Business Higher Education Forum, 2001, 47). A 1997 study of 2,167 university scientists revealed that nearly one in five scientists had delayed publication for more than six months to protect proprietary information (Press & Washburn, 2000, 4). Nelson Kiang, professor emeritus at MIT and Harvard, organized a conference on "secrecy in science" and stated that "students, rather than learning proper scientific protocol, are being taught to accept the inhibiting power of money over science" (Press & Washburn, 2000, 4).

   A study by Louis et al. (2001, 241-242) of 847 clinical and non-clinical life science faculty in 49 U.S. research universities found that the non-clinical faculty are significantly more likely than clinical faculty to experience data withholding. The study also showed that the larger the scientists' research budget, the more likely they are to be denied access to other scientists' work and to deny others access to their own research. It

also showed that the more entrepreneurial (the more they were involved in "front end" commercial research) the more likely they are to withhold information from others who request it. Blumenthal's study (1997, 1227-1228) indicated that faculty with industry support were more likely than non-corporate supported scientists to restrict communication on their research results, supporting the concern that the focus on large-scale laboratory work and commercialization of results in the life sciences may have implication for communication systems.

5. Concern for the university's commitment to independent and unbiased search for truth - Critics say that faculty members who acquire equity in companies supporting their research can cloud their reputations as independent and unbiased truth-seeks and call into question their professional commitments to protect the well-being of their institutions and its students. A study by Lee (1996, 857-860) found that over 65% of the 985 faculty he surveyed felt that it was possible that collaboration with industry could affect academic freedom. His multi-variate analyses indicated that such concerns are the single best predictor of reluctance to support user-oriented research and commercialization activities and he concludes that the chief concern of faculty is a "Faustian bargain" trading income and research support for new work norms that threaten academic integrity. Despite certain reservations, however, most academic faculty is willing to "cross cultures and have a greater, if cautious, collaboration with industry (Bozeman, 2000, 639).
6. Lack of academic freedom - Concerns over academic freedom and whether collaborations with industry threaten the essence of what it means to be an academic institution are often barriers to successful academic-industry relationships. Research units should always be involved in both basic and applied research and a well-organized team

will allow for the exploitation of the complementarities of both the basic and applied research results (Crespo et al., 2007, 68). Jacob et al. (2000, 257) reports that academic researchers report that continuous interaction in partnerships reduces the time available for competence development and reflection in academe, implying that continued dialogue may contribute to the traditional tension between competing paradigms of utility between researchers and practitioners.

7. Differences in strategic focus - The strategic focus for academia and industry has a disparate origin. Research focus, orientation, horizon and methods may be dramatically different for universities and companies (Link & Tassey, 1989, 45). Also, universities and companies have different methods of dealing with their environment: universities prefer cooperation while companies prefer competition and confrontation. Academic research is organized along disciplinary lines with the result that research is held accountable within the peer review system. Often solving the problems of industry requires an interdisciplinary, multi-faceted approach (Liyange & Mitchell, 1994, 664).

6.6.3 Contract-related barriers

1. Intellectual property disputes - Without fail, the majority of studies on barriers to academic-industry partnerships list disputes over intellectual property as the most prevalent reason for the failure of these partnerships (Shane, 2005, 215; Geisler, 1986, 34). Hall et al. (2001, 87) showed that about 30% of the companies surveyed had an academic research partner and about the same proportion reported that IP issues are the most important obstacle to academic collaboration. Intellectual property disputes, along with issues concerning licensing, patents and other ownership issues are the most difficult and time-consuming to navigate and can drastically delay the

course of the research initiative. In one study alone, 32% of the participants described IP issues as an "insurmountable" barrier (Hall et al., 2001, 94). Hall's study also concluded that these conflicts have a greater likelihood of occurring when the research is expected to result in less appropriable results that have a greater degree of publicness or when the project duration is short-term and is thus more concrete in terms of the scope of the research findings. The appropriability of the intellectual property implies less publicness and then less tension between the two worlds of academia and business (Hall et al., 2001, 94). "The goal of business and universities in producing and protecting intellectual property is innovation for the production of revenue. Beyond this ultimate shared goal, the interest of universities and businesses diverge. Universities value intellectual property not only as a revenue-producing resource, but also as a toll in the advancement and dissemination of knowledge" (Hall et al., 2001, 89). These divergent interests can result in conflicts that are extremely difficult to resolve. However, the probability of success is higher when the lead participant in the partnership has prior experience partnering with universities. An example of this is the 1980 Interferon Lawsuit. Many U.S. companies have accused universities of unrealistic approaches to the valuation and assertion of patent rights and have described university policies as a source of friction rather than as a facilitator of collaboration with industry. Disputes have arisen as to who owns inventions, technical data, test results, research equipment, manufacturing know-how, drawings, unpublished reports and new methods, concepts and techniques (Link & Tassey, 1989, 46). Each situation necessitates negotiation on the merits of the relationship, within a general policy framework and the legal environment of patent

and invention rules and the legal and ethical views of the intellectual property. Each partner must address how they weigh the value of each other's assets: the value of the materials, data, knowledge and expertise of the university researcher versus the value of the financial backing, product development know-how and strategic market knowledge of the industry partner. This understanding must be met in order to properly allocate the return on investment created through the collaboration.

At a 2003 conference organized by the Government University Industry Research Roundtable (GUIRR) at the National Academy of Sciences, the following comment was made regarding intellectual property: "The requisite legal negotiations for IP that will ultimately prove to be useless are laborious, individualized and negotiated between universities and companies on a case by case basis. The up-front legal negotiations can easily cost more than the total cost of the research project being conducted and/or extend past the time when the company has interest in the technology path being pursued. In summary, the uncertainty of the true value of university-generated IP combined with a litigious culture has made the university-industry working relationship, one that has historically contributed greatly to graduate education, unaffordable and nearly unsustainable within the United States." Many universities have shifted their focus away from the priorities of managing patenting and licensing activities to accommodate a broader range of research initiatives other than the maximization of royalty income (Yusuf et al., 2007, 177-179).

Other issues related to intellectual property might be categorized as "the Gatorade Factor" (http://sites.nationalacademies.org/PGA/guirr/PGA_052182). A small number of colleges and universities have benefited from financial windfalls

related to IP developed by faculty. Most faculties as well as administrators have limited knowledge as to what it takes to move an idea from concept to an actual product with a commercial demand. This naiveté makes negotiations with academia over IP and royalty issues an exercise in frustration for many companies. In fact, 97% of all industry sponsored projects do not lead to income generation by IP at the end of the project (National Council of University Research Administrators et al., 2006, 15).

2. Delays in contract negotiations - Too much specialization in contract negotiations can lead to unnecessary delays in finalizing research contracts. Estimates show that it takes an average of 153 days to get from the first draft of the research agreement to a final, executed agreement. Property information from the University-Industry Congress suggests a slightly more optimistic view: 80% of contracts are successfully negotiated within a 150 day time frame. Negotiations that have a longer duration period are subject to a variety of risks, including 1) the goal of the technology becoming obsolete as technology changes, 2) the shifting of key players, 3) disappearing funding, 4) the costs of negotiations exceeding that which at stake in the agreement itself and 5) the agony of the protracted experience causing one partner to "swear off" the other for the duration of the careers of all those involved (National Council of University Research Administrators et al., 2006, 15). Additional thought should be given to a means of structuring contractual agreements that promote innovation while continuing to respect the intellectual property rights of the collaborators. Terms must be agreed upon to promote continued innovation and to clearly define what knowledge requires protection and what knowledge can be shared to create new avenues of research and development. If intellectual property protection

terms are too unyielding, it will be difficult for academic researchers to collaborate. If intellectual property protection extends too far into the future to include research that might be performed after the collaboration has ended, the result will be to restrict research with other collaborators. This serves to pointlessly limit all inventions exclusively to one partner and will become a significant barrier to innovation (Melese et al., 2009, 504).

3. Attempts to make agreements "one-size-fits-all" are not effective - There may be a tendency of the university to take a "one size fits all" approach to patenting research results, notwithstanding the evidence, for example, that patents and licensing play a much less significant role in the development of information technology than in the life sciences sector (Siegel et al., 2003, 122-123). There is robust evidence of the significant impact university research can have on licensing initiatives, as the numbers of patents granted to universities increased by 131% and the number of licenses granted increased by 158% from 1991 to 2000, with income from licensing increasing from $121 million to $997 million during the same period (Blumenthal, 2003, 2454-2455). Numerous studies have shown that university scientists who have industry support are more likely than those without it to participate in technology transfer activities such as patenting and licensing (Blumenthal et al., 1996, 369).
4. Ineffective technology transfer offices - Ineffective technology transfer offices (TTOs) are another barrier to success in collaborative partnerships (Siegel et al., 2003, 41). Link & Tassey (1989, xviii) comment that "the success in moving technology within as well as between organizations is people-correlated, that is the efficiency of technology transfer is dependent on the number and the quality of the

people involved in the process of transfer. Unless the recipient organization is highly committed to the consortium, neither the staffing nor the quality of the research output is likely to be sufficient to affect efficient transfer." Stephan (2001, 201) writes that the process of technology transfer can delay both publication of research as well as impede faculty's willingness to discuss their findings: "It is not just that this impacts the access that students and faculty have to new ideas. It also imbues the next generation of scientists with an attitude that privatization of knowledge is part of the game" (Stephan, 2001, 201). In a study by Siegel et al. (2003, 43), 55% of companies surveyed expressed dissatisfaction with the marketing and negotiating skills of TTO personnel. A lack of requisite business skills and expertise could have a significant deleterious effect on TTO productivity. Interviewees also noted that TTOs are often too narrowly focused on a small set of technical areas. 80% of those surveyed also stated that universities are exercising their intellectual property rights too aggressively. Technology transfer offices are often established with the internal motivation of covering immediate patent costs and covering all administrative costs and salaries associated with the office. This may result in an unwillingness to negotiate agreements that are directed at economic development goals as opposed to shorter term financial payouts or agreements that anticipate payments when the partnership reaches less than immediate milestones.

Washburn (2006, 2) states that currently many technology transfer offices are of such poor quality that industry leaders complaint they are "obstructing, rather than supporting, successful commercialization of academic research" (Washburn, 2005, 2). Siegel (2003, 27-48) reported that many faculty members fail to disclose their

inventions to the university and that when an invention is publicly disclosed, some companies contact scientists directly to avoid working through formal tech transfer offices. Siegel conducted over 100 structured interviews with academic scientists and found that many perceive the rewards for faculty involvement in technology transfer to be insufficient. Of particular importance are the terms of the university royalty distribution formula that determines the fraction of the licensing revenue that is allocated to the faculty member who developed the new technology. Link and Siegel (2005, 169-182) found that many faculty express frustration with the university bureaucracy and some point to concerns about licensing officers. Some mentioned the high rate of turnover among licensing officers, which is detrimental towards the establishment of long-term relationships with companies, and still others mentioned insufficient business and marketing experience with the tech transfer office and the possible need for incentive compensation. A study by Siegel et al. (2003, 41) found that interviewees perceived the mission of the TTO as being inconsistent with the traditional "public domain" philosophy regarding the dissemination of information that pervades most research universities. A recent essay by Nelson (2001, 13-19) states that "the cost of losing the culture of open science" that exists at leading research universities outweighs the benefits that might arise as a result of rapid technological diffusion.

Jenson & Thursby (2001, 243-245) found that 50% of all university-licensed inventions fail because they do not meet the need anticipated at the time the license was signed (Libecap, 2007, 204). Since inventions are risky and years away from

potential revenue, they conclude that royalties and equity might not provide a sufficiently strong incentive for faculty to cooperate.

Owen et al. (2003, 333-359) compared faculty involvement in tech transfer in the life sciences and physical sciences and reported substantial variation in perceptions across scientific fields on the outcomes of patenting. Life scientists appear to be more concerned about the proprietary benefits of patents and using them to gain leverage with companies. Physical scientists patent in order to have the freedom to publicize their work without fear of losing potentially valuable intellectual property rights and to gain leverage with the university. The authors concluded that institutional success in tech transfer depends on faculty attitudes toward the tech transfer office. Perceptions about the ease of working with the tech transfer office appear to be an important factor in faculty decision to patent.

Herzfeld (2006, 825-838) interviewed intellectual property attorneys at 54 legal firms and found that they expressed great difficulty working the university tech transfer offices on IP issues, citing the inexperience of the TTO staff, the lack of general business knowledge and the tendency to inflate the commercial potential of the patent. They reported that companies were similarly frustrated and were inclined, when possible, to bypass the TTO and work directly with the university scientist.

Link et al. (2007, 651) collected data from 1514 university scientists, 52% of whom had worked directly with industry within the last twelve months. The study found that male faculty members are more likely than female faculty members to engage in informal commercial knowledge transfer and consulting. Tenured faculty members are more likely than untenured faculty members to engage in all three forms

of informal technology transfer. Years with tenure also has a positive impact especially on the transfer of commercial technology and on publications. Liyange & Mitchell (1994, 650) report that the viability of partnerships depends upon the ability to disseminate results to partners in the first instance and to license technology to non-members and derive royalties in the second if partners decline to develop and commercialize research. Most of the difficulties in academic-industry relationships have arisen because of failures at the negotiations stage leading to the management of intellectual property. The relative freedom and flexibility of the academic environment compounds problems faced by companies regarding industrial secrecy. Companies fear that their core business opportunities will be eroded if they form loose alliances with academic researchers, which is why most companies prefer to build their linkages with specific individuals in academia as opposed to multi-organizational groups. These relationships work particularly well when the academic researchers understand the industry scientist's vision, objectives and management ethos.

The University-Industry Demonstration Partnership concluded that one of the primary barriers to academic-industry partnerships is the negotiation of sponsored research agreements and intellectual property provisions (http://sites.nationalacademies.org/PGA/uidp/index.htm). This barrier is exemplified by long contract negotiation times, contentious negotiation processes, added costs resulting from an increase in legal and administrative services and little or no benefits at the conclusion or the contract negotiation.

A recent announcement by Pennsylvania State University represents an attempt to try to simplify contractual negotiations by offering exclusive rights to the resulting inventions for an initial fee. Their hope is that by "exchanging back-door dealing for upfront terms, they will put to bed the university's reputation as difficult to deal with" and to "encourage more business-backed research (Ross, 2011)." Hank Foley, Vice President for Research for Penn State, commented, "In short, we are doing it because we consider the net present value of the interactions and relationships that our faculty and students have with industrial professionals to be very important and therefore greater than the apparent future value of the proceeds from such intellectual property. In fields from engineering to business, faculty who have contracts with industrial professionals and who work on both real-world and academic problems are even more effective teachers and mentors, and education is our core business. Our goal is to flatten any and all barriers or impediments to innovation and that includes our own past stance on intellectual property" (Mountz, 2011). Penn State touts this new approach as the "first step in realizing an aggressive new vision for technology development and translation to the market…. and a new approach to intellectual property creation and management." Penn State is focusing on "fostering a new ecosystem for technology innovation and translation," as well as the "successful marketing of Penn State intellectual property and much more vigorous licensing to corporations and to start-up companies, and assisting those interested in doing more market relevant research" (Pennsylvania State University, 2011). The goals of the changes in policy are as follows:

- To spur growth in corporately funded research with more flexible intellectual property policies.
- To manage master agreements in a way that provides real value to the corporation and the University by building end-to-end partnerships.
- To create a culture of entrepreneurship at Penn State by creating more trust, ownership and excitement among the faculty.
- To raise revenue by aggressively marketing existing Penn State intellectual property.
- To rename and explain the "conflict of interest policy" to make it easier for faculty to understand and adhere to the policy. (http://live/psu.edu/story/56887).

5. Lack of coordination in monitoring and evaluation - A study by Liyange & Mitchell (1994, 646) found that an area of contention for industry partners is the apparent unwillingness on the part of academic staff to include industry representatives in research monitoring and evaluation panels and a reluctance to accept the product design and product definition of industry partners. Academics, on the other hand, claim that industry employees claim superior knowledge of market conditions and greater proximity to customers. Industry officials indicated they perceived that academic scientists did not include or encourage commercial partners with product development experience to become involved at the earliest stage of research planning or in the monitoring and evaluation of project progress.
6. Agreement on timetables for completing the research - Although the notion of timing is in many ways a cultural issue that is certainly different for industry and academia, it translates into very real financial issues for the industry partner. Academic researchers and industry sponsors must agree upon the time required for deliverable

results, and must be committed to staying on task and on schedule in order to consummate a successful partnership. Industry may wish to utilize the concept of shared risk to drive universities to more fully commit to the terms of the research agreement and thus the success of the project and the relationship.

6.6.4 Personnel-related barriers

1. Lack of communication - Communication, or the lack thereof, (Schartinger et al., 2001, 266) can create many barriers in academic-industry partnerships. The needs and expectations of the partners often differ, and the failure to communicate them compounds the problems. Barnes et al. (2002, 12) report that some study participants indicate there was no immediate contact during the course of the research project. Participants expressed the need for intermediate communication, either through the occasional telephone call or email, and suggested that measures to set out a clear communication strategy with the establishment of the frequency of meetings is needed.
2. Universities and industry are not natural partners - Bander and Rosenberg (1997, 215) studied partnership relationships between Bristol Myers Squibb & Yale University and concluded that the principle goals for universities and industry are decisively different. Whereas universities are principally concerned with the assimilation and distribution of new information and the education of its students, corporations have as their overarching goal the discovery and commercialization of new products which can contribute to the financial success of their organizations. “Enterprise creation is seldom viewed as central to the mission of a research university” (Thorp & Goldstein, 2010, 38). Some see the interactions between academia and industry as risky if the

cultural and ethical principles of one partner overwhelm those of the other (Gelijns & Thier, 2002, 72). However, if in fact the university's primary goal is that of educating students in a way that enables them to enter the workforce, then universities must participate in leading edge research and collaborative industry partnerships in order to understand how best to educate and prepare their students. The spillover from this relationship, if successful, is innovation, economic development and job creation. In this sense, the barriers are merely structural, for example, historical division of disciplines, delineation of incentives or intellectual property disputes. The successful partnership will transcend these structural barriers for the greater good and the benefit of society.

3. Inconsistency and turnover among personnel - Inconsistency and turnover among university faculty, as well as a change in industry personnel, threatens the continuity of academic-industry partnerships. Recruitments, promotions, mergers and acquisitions may affect personnel and strategy which may disrupt partnership interactions (Gelijns & Thier, 2002, 75).
4. Distinct organizational characteristics - Organizational characteristics are markedly distinct (Link & Tassey, 1989, 44). Universities are proud of the independence and autonomy of their research efforts, which are usually decidedly decentralized and discipline oriented. Companies are hierarchical with clear chains of command. Corporate research is more frequently organized through a centralized research and development program aimed at unmet needs, specific targets and commercial opportunity. The decentralization of the university may lead to yet another barrier: people from within the university itself as well as those outside the university may see

the partnerships as having little impact on higher education, primarily due to the fact that these partnerships are largely the province of the sciences and generally involve particular departments or labs within particular research universities (Anderson, 2001, 232). The knowledge generated for companies is often centered in a specific research unit and people outside of these enclaves are often unaware of the value of university research and the effects of the partnerships underestimated. A study of 517 companies conducted by Kaufmann & Todtling (2001, 802) found that while the companies felt that interaction with academia stimulated their innovation, most concurred that it was not effective to try to change the operating principles of the university. Companies suggested that adjusting the university's modes of interpretation, decision-making processes, objectives, and specific communication standards to those of the company eliminates the most important factor which stimulates the innovation: diversity.

5. Bureaucratic inflexibility - Bureaucratic inflexibility is typically mentioned as a barrier for successful partnerships (Liyange & Mitchell, 1994, 643; Siegel et al., 2003, 118; Geisler, 1986, 34; Siegel el al, 2003, 43). Universities themselves are complex bureaucracies with their own rigid rules, regulations, rewards and incentive structures and administrative hierarchies with multifaceted objectives. Policies regarding collaborations can seem rigid, cumbersome and unclear to both university scientists as well as to their industry counterparts. Universities that organize their research activities solely along disciplinary lines show little strategic intent to engage in the commercialization of their research results and are not as successful in forging partnerships with industry as are those which allow for multidisciplinary interaction (Crespo & Dridi, 2007, 80).

In contrast, the industry partner is more likely to have a relatively simple profit motive as its primary objective. Owen-Smith and Powell have suggested that inconvenient or frustrating interactions with technology transfer offices may be enough to convince ambivalent inventors that the benefits of IP protection do not outweigh the costs (2001, 1222). A study by Jacob et al. (2000, 257) indicates that CEOs report feeling a lack of control on the part of industry, while academic partners counter with frustration over rigid accounting schemes.

6. Divisiveness among faculty - Conflict among faculty members from different departments among the university campus may arise due to a perceived feeling of exclusivity. For example, faculty members in the humanities or fine arts departments may feel excluded from certain opportunities on the university campus and not as partners in the innovative process, as opposed to those in the life sciences or engineering related curriculum. Such conflict can erode internal faculty relationships and cause administrative issues leading to negative views of academic-industry partnerships among the faculty itself and leadership of the university.
7. Cultural differences - At the most simplistic level, there is a basic clash of culture between academia and industry (Schartinger et al., 2001, 255). While corporations typically define their goals, objectives and timelines for their researchers, universities typically offer their researchers the freedom to define their own goals, objectives and timelines. It is important that both partners acknowledge the cultural differences, and that these differences be respected rather than criticized as barriers (Krumholz et al., 2007, 120). Negotiations cannot occur when they take place in ignorance of these cultural differences or when differences are simply ignored altogether. Feller et al.

(2002, 470) define barriers to academic-industry partnerships as a mix of factors internal to the company and intra-organizational differences relating to values, priorities, and time schedules. Their interviews of 355 firms in 18 engineering research centers found that the barriers to deriving benefits from partnerships had more to do with internal company constraints or changing company priorities rather than any shortcomings on the part of the partnership. Industry researchers have formed, over the years, certain attitudes which tend to negatively stereotype academic researchers as "blue sky explorers" detached from practical, real world topics (Giamatti, 1982, 1278).

A study by Samson and Karel (1993, 63-71) discusses these cultural issues and the tendency for one group to implicitly demand that the other should embrace its value system. Either the industry partner is expected to adopt a scientific ethos or the academic culture is expected to embrace an entrepreneurial mindset. Samson and Karel suggest that an organizational "clearing house" is necessary to translate and disseminate technical and commercial information, and thus research activity can be shaped and redefined by an evolving commercialization strategy informed by research development. The meeting of the academic and industry cultures might then have the capacity for learning and adaption instead of ending in collision.

6.7 Characteristics of successful partnerships

Etzkowitz (2001, 19) refers to the shift in academic-industry partnerships as a change in institutional culture that gives way to the rise of the "capitalization of knowledge." In his studies, Etzkowitz found considerable change in the norms of academic science, resulting in an environment much more conductive to industrially relevant work. He postulates that this

is in large part due to new forms of linkage arising from the externalization of industry research and various cooperative R&D organizations which have proliferated in the past decade. “Enterprise creation must become fundamental, not peripheral,” state Thorp & Goldstein (2010, 44). They assert that solving “big problems” should be considered core to the mission of the university and that enterprise creation must be supported and encouraged at the highest levels of university leadership (2010, 40).

Bander and Rosenberg (1997, 216) write of the necessity of “building bridges” between academia and industry. They state, “The durability of an effective bridge must be continuously tested against the openness of communication achieved against the need to respect proprietary concerns of the industrial party, against the agreements reached concerning ownership of intellectual property and those articulating the flow of funds for the effort. For the bridge to be viable there must be inventions to commercialize and rewards to be shared there from.” Citing as an example the partnership between Yale University and Bristol Myers Squibb, they comment that the relationship took fifteen years to fully develop. “It involved risk, uncertainty, debate, patience, and trust…… the relationship epitomizes the best in American medical research – creative basic science, effective technology transfer and committed industrial capability” (Bander & Rosenberg, 1997, 217).

Barnes et al. (2002, 5-6) studied six British collaborative research projects in the automotive and aerospace industries and identified the following factors as having a significant impact on the perceived success of the collaboration: trust and good interpersonal relations, the lack of hidden agendas, complementary aims and experience, the existence of a past collaborative experience and past collaboration partner, clearly defined objectives, clear responsibilities, realistic aims, clear reporting and good resource planning, the ensuring of

equality and mutual benefit, corporate stability, a clear proprietary benefit, agreed upon timescales and balanced priorities. Other themes which arose were a clear mission, a clear understanding of the resource allocation and rewards, accountability, communication, commitment, trust among partners, continuity of personnel and corporate stability.

The data regarding specific characteristics of academic-industry successful partnerships were consistent and several commonalities emerged. The following traits were observed:

6.7.1 Goal-related characteristics

1. Clearly defined objectives by each partner - The project manager in a successful partnership must be able to articulate clearly defined objectives, clear responsibilities of the team members, good project planning, realistic goals, and adequate systems for monitoring progress, clear reporting mechanisms and good resource planning. These are skills that may be more commonly utilized in a corporate setting than for an academician, so there must be a synergistic management approach that finds a way to merge the organizational mechanisms from both the commercial and academic spheres. The manager must be a "fund raiser, personnel manager, publicity agent and research director" (Anderson, 2001, 238). Slaughter and Leslie refer to this as "entrepreneurial expertise" that allows the manager to recognize commercial potential, protect that potential, cultivate commercial partners and negotiate contracts and other agreements (1997, 199). They state, "Entrepreneurship is the key to present and future institutional and cultural preference, approval, and legitimacy" (Slaughter & Leslie, 1997, 200).

2. Clear proprietary outcomes - Private sector companies are results driven and they cannot afford to be unfocused when it comes to making research investments and defining outcome goals (Melese et al., 2009, 504). Research collaboration must meet predetermined business objectives, must be specified in financial terms and ultimately must be accountable to the firm's shareholders. However, university researchers must be thoroughly engaged as well, so it is important for both corporate management and university faculty agree on the vision and goals for the collaboration. Academic researchers need to be prepared to think of new ways to scope, frame or describe proposed projects to align with industry's budgeting expectations and processes. Collaborative agreements allow each partner to work together to identify what innovation gaps exist in the development of new therapies, what needs to be accomplished and which party is best positioned to contribute value.

Successful partnerships are able to navigate their way through the maze of "asymmetric information" that may characterize these types of collaborations. Corporate partners may not be able to assess the quality of their research findings ex ante, while university researchers may find it equally difficult to assess the commercial potential of the research findings (Debackere & Veugelers, 2004, 325). Bailey et al. (1985, 22) writes, "for an effective technology transfer system to function between the educational community and the private sector community… the institutional thinking of both must change."

Melese et al. (2009, 506) recommends that both industry and academic partners manage their collaboration as they would an investment portfolio, where there is formal and transparent documentation and fully vetted expectations. They

recommend master agreements to assist in the streamlining of the process of establishing new collaboration and providing a foundation for creating a secure interface between the participating organizations. This will enable researchers to share knowledge, data, materials and resources freely and to develop a culture that fosters innovation. The National Council of University Research Administrators (2006, 13) point out that master agreements can help move the relationship from a tactical level to a strategic level. A master agreement can reconcile the goals of sponsored research and licensing operations into a single, coherent, institutional framework.

3. Conflicts of interest - Universities should find methods in which potential conflicts of interest are disclosed. Since 1995, the NIH has required academic investigators who receive NIH funding to disclose certain conflicts of interest and since 1998, the FDA has required researchers to disclose potential financial conflicts of interest. Harvard University requires universal disclosures of relationships between faculty and industry and prohibits faculty members from having "significant" financial interests in companies that support clinical or nonclinical research within the university (Blumenthal, 2003, 2456).
4. Making the interaction itself the defining feature - A willingness on the part of both partners to allow the interaction to be the defining feature of the research initiative rather than allowing prior theoretical platforms and assumptions to dominate the process allows partnerships to be open and interactive rather than stilted by a preconceived notion or finding (Jacob et al., 2000, 261). Lee (2000, 130) writes of the

nonlinear characteristics of academic-industry relationships, where emphasis and outcomes in one area serendipitously leads to another.

6.7.2 Mission-related characteristics

1. Equality and evidence of mutual benefit - The commitment to equality and the evidence of mutual benefit was found to be a key factor in successful partnerships (Melese et al., 2009, 504). The establishment of a productive collaboration mandates that potential partnerships understand and appreciate the value that each brings into the relationships. Corporate users may not always be predisposed to see universities as a source of relevant ideas. It is important to determine how each party's contributions translate to the rights to research outcomes in order to provide a basis for understanding how the arrangement is likely to satisfy each partner's institution's missions and priorities, and whether the rights offered to each partner are commensurate with the overall investment and specific contribution to the project (The National Council of University Research Administrators, 2006, 14).

   Academic-industry partners, at their core, are seekers of practical and profitable solutions that allow these "uneasy partners" to find opportunities for collaboration (Carayol, 2003, 892). By understanding the determinants of each partner's objectives, which goals of academia fit best with which companies and which collaboration arrangement is best suited to simultaneously serve these objectives, partnerships can be more effectively facilitated. Melese et al. (2009, 505) comment that society is a "tipping point that demands we reach across our organizations for the complimentary knowledge and resources required for tackling problems effectively." Partners must determine how they will value their assets, such

as materials, data, knowledge and expertise, versus the value of their partner's assets and in comparison to the potential creation of new value and allocation of the return on investment created through the collaboration. Value propositions are juxtaposed: industry places more value on a discovery or invention that can provide benefit when applied to real world problems. Academia places value on the discovery or intention that increases the depth of understanding in a specific area.

2. Ability to find complementary balance between basic and applied research - The choice of partners was important – partners must have complementary objectives, complementary expertise, and collaborative experience (Fontana et al., 2006, 314). Well-matched projects were usually non-proprietary and often had a longer lifespan than simply being tied to an individual project or research initiative. A study of 355 firms by Feller et al. (2002, 466-467) found that the research and technical match between the academic partner and the company was cited as the single most important factor in determining the magnitude of benefits achieved. Other factors cited by the study included responsiveness to corporate needs, efforts to stay in close communication, receptivity of company technical staff to ideas and results, the aggressiveness with which employees pursue collaboration and the ability to influence the research agenda.

   In the cases where the lead researcher took responsibility for managing both the research and the management of the researchers, there were fewer problems reported (Barnes et al., 2002, 11). It is also less likely that the work of the researchers will drift away from the main focus and objectives of the collaboration when the lead researcher takes responsibility for all research activities assigned to the university.

Shane (2002) studied the differences in technology licensing interactions between entrepreneurial companies as opposed to those with large, established organizations and found that entrepreneurial companies are less likely than established companies to engage in contract research. They also found that contract research with entrepreneurial companies is often contingent on the right to license exclusively (Shane, 2002, 539).

3. Avoiding threats to academic independence - Moses et al. (2002, 1373) studied academic-industry partnerships among medical centers and stated that open, informed and timely processes must be used to determine the terms of engagement. Protections are required to prevent excessive secrecy and threats to academic independence that allow academic researchers to publish and openly share their findings. Their findings indicate that current policies in many institutions leave many unanswered questions, especially specific means to implement guidelines. The needs of the industry partner to protect commercially feasible technologies, products or processes must be balanced with the university's public responsibility to freely disseminate scientific findings for the advancement of knowledge and the academic freedom of faculty and students to publish their research (http://sites.nationalacademies.org/PGA/uidp/PGA_049847).

6.7.3 Contract-related characteristics

1. Agreed upon timetables - An agreed upon timetable with fair and balanced priorities was a consistent quality of successful interactions between academia and industry. Corporate managers frequently reported that there was the perception that universities

operated on extended time lines and had little regard to the urgent deadlines of the corporate world (Liyange & Mitchell, 1994, 644).

Partnerships that found mechanisms to exploit the complementarities between basic and applied research were the most effective ones. The most sought-after academic scientists were those with the great capacity for transforming basic scientific knowledge into applied academic solutions for resolving industry's problems and academia's knowledge as a basis for future theory (Debackere & Veugelers, 2004, 327-329; Business Higher Education Forum, 2001, 42). The shift from industry sponsorship to industry partnership is a move toward the recognition of this notion that promotes joint problem-solving for empirical, pragmatic knowledge as well as conjectural, a priori knowledge.

2. Decentralized tech transfer offices - The decentralization of technology transfer offices within the universities appeared to be an effective means of insuring a successful partnership in establishing a sufficient level of autonomy to develop relations with industry in various sectors, albeit this is currently not a common practice in many of the United States' large research universities. The decentralization effort also seems to be instrumental in terms of providing a buffer between the potential conflicts which might arise between the commercialization process and the research and teaching activities (Debackere & Veugelers, 2004, 329).

Effective technology officers serve as the "gate keeper" and provide the bridge between academic and industry partners. Based on interviews at five major research universities, Siegel et al. (2003, 40) identified several critical organizational

factors for technology transfer offices, including adequate faculty tenure, promotion policies, adequate royalty and equity distribution systems, as well as characteristics of the staffing practices within these offices, including a proper mix of scientists, lawyers and managers acting within a highly professional environment (Debackere & Veugelers, 2004, 327-340; Washburn, 2006, 1). They also maintain that the structure of technology transfer offices must be complemented with the necessary processes at the interface level. There must be a well-balanced process to manage and monitor contract research, working alongside the necessary know-how and process for legal, financial and human resources management issues. The central tech transfer office must be able to support and coordinate the research process, provide assistance on management policy, be able to access additional seed funding if needed and provide necessary opportunities for networking among entrepreneurs and academics alike.

Thorp and Goldstein (2010, 35) write: "Research universities should worry less about the revenue their tech transfer offices produce and more about how those offices can be used as an instrument for faculty recruitment and retention. By making it easier for faculty to obtain patents and negotiate license deals and spin out companies, the university keeps faculty engaged and connected and therefore less likely to leave." They postulate that streamlining the commercialization process by deemphasizing concerns about financial returns and adopting a more uniform faculty-friendly approach will result in the creation of more companies in a timely manner and will increase the likelihood of commercial success.

The "Guiding Principles" of the National Council of University Research Administrators (2006, 13) recommends that academics and industry partners find

ways to harmonize goals and strategies between licensing technology transfer and sponsored research operations. Because sponsored research brings in over two times the industry funding as licensing revenues, it is important not to inadvertently damage the former while pursuing the latter. “Measuring technology transfer success by licensing activity alone dooms it to failure” (13).

3. Licensing strategies encourage openness as well as adequate reward structures - The success of the licensing strategies can be achieved by structuring agreements to encourage rather than suppress the widespread use of technologies while also providing just rewards to the industry partner. Companies are being advised to focus less on forcing their collaborators to adopt restrictive terms that will adversely affect the collaboration and more on terms that will allow all parties to achieve their goals. By working together to define mutually acceptable objectives and expectations early in the negotiations, companies and academic researchers can help to ensure that the process and the end product better meet the expectations of both parties (Melese et al., 2009, 504).

Stanford University and the University of California licensed their recombinant DNA technology on terms that included a small upfront payment and reasonable royalties, allowing the biotechnology industry to develop this technology in its early years, producing numerous life-saving contributions and eventually growing into a multi-billion dollar business (Blaug et al., 2004, 763). A study by Link et al. (2007, 653) suggests that universities should consider shifting the royalty distribution formula in favor of faculty members in order to elicit more invention disclosures and participation in formal university technology transfer. The article also

suggests that universities that have a high degree of technology transfer find some way to incorporate appropriate reward systems into promotion and tenure decisions (Siegel et al., 2003, 40). Using data on 113 U.S. technology transfer offices, the authors found that universities allocating a higher percentage of royalty payments tend to be more efficient in technology transfer activities.

4. A shift from policy-based negotiations to principle-based negotiations - Casey comments that the University-Industry Demonstration Partnership (UIPD) advocates a "paradigm shift" from a policy-based contract negotiation to a principle-based paradigm, one that is characterized by the partners determining the parameters that should be considered in selecting appropriate contract terms and conditions (Fitzgerald, 2008, 344). One of the most significant findings from the UIPD is that there are no simple template-derived or "one-size-fits-all" solutions for these partnerships.

   Contract negotiators need to fully understand:

   - Who originated the idea for the project
   - Who contributed background technology and background
   - The type and importance of non-financial contributions
   - The type and importance of non-labor contributions from the university
   - The nature of the research, whether fundamental or applied
   - The scientific disciplines involved
   - The likelihood and expectation of inventions resulting from the proposed project (Fitzgerald, 2008, 345)

They also need to know more about the proposed projects than just a written statement of work. For examples, contract negotiators need to understand:

- Why researchers want to work together
- Who framed the problem that led to the proposed project
- Who made the creative contributions to the statement of work
- Who has background IP that could have an impact on the proposed project
- Who has key information or materials or prior research results needed for the project (Fitzgerald, 2008, 344)

Contracts must be written in a way that reflects the project parameters and is viewed as a process, rather than a definitive solution. They must be interactive, encouraging discussion and input from all of the key stakeholders. They are also constructive and suggests terms that are fair and reasonable, which will result in less time for negotiation. The contract should seek to foster mission compatibility with the desired outcome of spurring future collaboration.

A study by Hall et al. (2001, 93) made several interesting conclusions regarding university technology transfer function. The study found that difficulties in the negotiation of IP were positively associated with the level of share in the project as well as the lead participants' prior experience with university partnership and negatively with the length of the project. It also observed that as the percentage of project costs that is funded by the academic partner increases, the probability that IP issues will create insurmountable barriers that inhibit the university from entering into a partnership also increases.

5. Disclosure of ownership rights - Transparent and unambiguous disclosure regarding property rights and ownership titles and an appropriate mix of incentive mechanisms was found to be a near prerequisite to a collaborative agreement (Debackere & Veugelers, 2004, 329). Balancing the need for university researchers to share their findings and the need for companies to protect the value of their investments through confidentiality agreements was also an important element for success. Well orchestrated negotiations need to assure that the value proposition for intellectual property rights is equitable, that all parties receive a return on their investment, and that the collaborators receive equity rewards that are consistent with their contributions.
6. Differentiating proprietary and non-proprietary research - Melese et al. (2009, 506) recommends researchers classify information into proprietary and nonproprietary categories and educate all parties as to the distinction between the two, enabling companies to share nonproprietary information with academic research partners without fear of jeopardizing future revenue and thereby increase the potential for innovation. New business strategies that promote value through open innovation research networks are more effective than traditional business strategies that promote the development of barriers to competition. New "open strategy" is being utilized which "balances the tenets of traditional business strategy with the promise of open innovation" (Melese et al., 2009, 506).

6.7.4 Personnel-related characteristics

1. Focus on long-term relationships - Academic-industry partnerships that are focused on long-term relationships are infinitely more successful than "one-off" ventures

(Geisler, 1986, 33; Giamatti, 1982, 1278-1280; Link & Tassey, 1989, 53). The National Council of University Research Administrators (2006, 8) states "the value of a long-term relationship can be greater than the sum of the individual transactions" or the results of one isolated project. Universities and industry should look towards establishing long-term multi-faceted relationships that maximize returns across a spectrum of interaction opportunities. Hall et al. (2001, 93) found that IP barriers are greater the shorter the length of the project. As project length increases from mean of 3.17 years to 3.67 years, the estimated probability of there being an insurmountable IP barrier decreases by 11.5%, with a standard error of approximately 6%. As academic-industry relationships are very complex, multi-faceted and diverse, feedback loops are the norm, with progressions from a single transaction to longer-term relationships occurring as trust and joint vision are developed (Bercovitz & Feldman, 2006, 182). A 2007 article in the Harvard Business Review had two phrases that sum up the goals of these collaborations: "Managing for the Long Term," and "Going the Distance." The article concludes that academic-industry collaborations depend upon critical long-term infrastructure developments (Fitzgerald, 2008, 333). Lee (2000, 127) found that the longer the duration of a project, the greater the benefits accrue to a faculty member in areas of research support, teaching function and entrepreneurial opportunity. Projects spanning at least three to five years or more tend to offer greater benefits in all counts: research support, pedagogical support and entrepreneurial opportunity. Projects of less than one year tend to produce the lowest benefits.

2. Partners with complementary scientific backgrounds and objectives - Successful partnerships also tend to create more value when partners are complementary in their scientific capabilities, when they substitute each other for lack of certain skill sets and when they complement each other with different types of knowledge, either diversified or specialized (Mindruta, 2009, 2).
3. Flexibility, adaptability and resilience - Academic partners who were flexible, adaptable and resilient to the changes that occur during the partnership were more successful (Liyange & Mitchell, 1994, 642; Hall, Link et al., 2001, 95). Similarly, corporate partners are becoming increasingly aware of the importance of focusing less on forcing their university collaborators to adopt restrictive and onerous contractual terms that will adversely affect the collaboration and instead focusing on mutually acceptable terms that will allow both parties to achieve their goals.
4. Strong support and commitment by senior administration - Partnerships are more successful when the senior administration of the academic institution indicated a strong commitment for these types of relationships. Internal advocacy and the emergence of a partnership champion were significant indicators of success (Powell & Owen-Smith, 2002, 25-26; National Council of University Research Administrators, 2006, 10). Without senior management's influence, lower levels of management are unlikely to give a collaborative project the required degree of commitment, attention and priority (Barnes et al., 2002, 275). Golob (2006, 686) interviewed academic entrepreneurs in the New York city area and found that universities with internal advocacy and support of university leadership are more likely to generate high tech enterprises than those that do not and cite the increase in

spin-off activity at Columbia University in the 1990s as a prime example. The president of the university should be responsible for establishing a cooperative tone toward academic-industry research collaborations and should align incentives to encourage and promote research collaborations. Likewise, the industry's CEO must establish the priorities and set the tone for successful partnerships. "The climate is set at the top," sated Hank McKinnell, chairman and CEO of Pfizer (Business Higher Education Forum, 2001, 83). Senior officials from each side of the partnership need to have a commitment to and see the value of external research. Commitment from senior management to honor these programs is critical since building technology transfer often takes years to achieve.

5. Atmosphere of mutual trust and transparency - An atmosphere of mutual trust, strong interpersonal relationships and the lack of hidden agendas were the most significant, overriding characteristics of successful partnerships (Davenport, 1999, 32; Jacob et al., 2000, 259). Developing trust is a lengthy process, sometimes requiring repeated collaborations. The University-Industry Congress's University Industry Partnership Project was formed in 2003 with the purpose of building trust and teamwork, after repeated comments that there was significant distrust among some of the participants, either based upon a general level or prior negative experiences. According to the National Council of University Research Administrators et al. (2006, 12), collaboration occurs across a continuum. The most important ingredients for success in this paradigm are trust and transparency.
6. Strong social relationships - Perkmann reports that most successful research partnerships are precipitated by strong social relationships between individual

university faculty members and members of the industry sector (Oliver & Liebeskind, 1997, 77; Perkmann & Walsh, 2007, 260; Siegel et al., 2003, 41). Some research has suggested that partnerships are most effective when there are previously known partners, when partners have a rapport and an effective channel of communication (Melese et al., 2009, 503; Schartinger et al., 2001, 266). "A partnership heavily relies on the strength of personal relationships" (National Council of University Research Administrators et al., 2006, 9). The loss of the key researcher from either side will typically terminate the collaboration, along with the hope of future collaborations. Since these collaborative projects are dependent upon mutual trust and understanding between the partners, the injection of new personnel into an existing partnership or ongoing negotiation can derail a well-thought arrangement. A study by Link et al. (2007, 645) indicates that social networks play an important role in technology transfer processes. These social networks allow knowledge transfer to work in both directions. Academic scientists indicated that interactions enabled them to conduct better basic research. A National Academy of Engineering study (Grossman et al., 2001, 146) indicates that informal alliances are a crucial source of technology spill-overs.

Colyvas et al. (2002, 67) , in an examination of 22 case studies from Columbia and Stanford Universities, found that in all but one case, researchers involved were members of a network of scientists that included industry professionals. In the single case where there was no academic and industry scientist linkage, there was no technology transfer.

7. Strong communication skills - Strong communication between the partners is necessary for the longevity of a collaborative partnership (MacPherson, 2002, 122). Building a continuous dialogue is significant in this process of interaction in which both partners transfer knowledge to each other in a mutual learning process. Lee (2000, 127) refers to these partnerships as a "body contact sport." The more frequent the contact, the greater the discussion of knowledge and technology. Lee found that faculty-firm interaction positively and systematically affected the benefits faculty experienced from collaborations with industry. The "Guiding Principles" from the National Council of University Research Administrators (2006, 11) recommend that universities and industry create events where researchers can readily intersect and interact with their industry counterparts in order to foster new collaborations. They state that communication is "the most critical management issue in collaboration," and that there should be pre-specified points of formal contact and frequent informal exchange to keep the relationship in real time. Communication should be clear, straightforward, organized and honest (2006, 12).
8. Interdisciplinary partnerships - Successful academic researchers involved in industry partnerships tended to be more interdisciplinary in orientation and more supportive of extension-oriented educational programs. They also tended to be less concerned or worried about the seriousness of conflict of interest issues or divided organizational loyalty, but instead called upon the ability of the researchers to work with others across a broad spectrum of disciplines. A university environment which adheres to rigid disciplinary boundaries in funding research projects will inhibit these

interactions and therefore limit collaboration opportunities (Bercovitz & Feldman, 2006, 184; Debackere & Veugelers, 2004, 320).

Table 15 summarizes the characteristics of successful academic-industry partnerships:

Table 15: Characteristics of successful academic-industry partnerships

Goal-Related	Mission-Related	Contract-Related	Personnel-Related
•1. Clearly defined objectives by each partner •2. Clear proprietary outcomes •3. Conflicts of interest •4.Making the interaction itself the defining feature	•1. Equality and evidence of mutual benefit •2. Ability to find complementary balance between basic & applied research •3. Avoiding threats to academic independence	•1. Agreed upon timetables •2. Decentralized technology transfer offices •3. Licensing strategies encourage openness as well as adequate reward strategies •4. A shift from policy-based negotiations to principle-based negotiations •5. Disclosure of ownership rights •6. Differentiating proprietary and non-proprietary research	•1. Focus on long-term relationships •2. Partners wtih complimentary scientific backgrounds & objectives •3. Flexiibility, adaptability, & resilience •4. Strong support and commitment by senior administration •5. Atmosphere of mutual trust & transparency •6. Strong social relationships •7. Strong communication skills •8. Interdisciplinary partnerships

6.8 Conclusions of the literature review

University and industry partnerships that expect to achieve successful results must first recognize that there are disparate characteristics, goals and organizational qualities and find ways to respect and merge these traits while working toward common objectives.

This literature review has shown that these naturally heterogeneous members of successful partnerships look beyond the differences in culture, management and orientation and instead focus on commonalities and potential to achieve innovation that can provide significant benefits for both the partners and society. For purposes of this review, success is

measured by a) the ability to maintain a sustained and ongoing interaction between the university and industry partner, b) the ability of the partnership to deliver concrete solutions in real time to meet the specific needs of each partner organization, c) the ability to generate results that create knowledge both for the partnership but are generalizable to the world as well and d) an ability to generate enough income to cover the operating costs of maintaining the research team.

In conclusion, the research indicates that there is historical evidence that the university has become a dynamic partner of industry and society in the effort to achieve both health and economic objectives. The shift to neotransferism has encouraged a return to the land-grant philosophy, which emphasizes the transfer of knowledge, technology, know-how and trained people from the university to industry, all in the interest of economic renewal and development (Krumbolz, Ross, et al.., 2007, 120). According to the Triple Helix thesis (Duval, 2006, 1809), the university is "increasingly central to the discontinuous innovation in knowledge-based society, superseding the firm as the primary source of future economic and social development." Interaction among university-industry-government partners can be the impetus of the development of incubator movements, interdisciplinary research centers and venture capital, regardless of whether that interaction is private, public or social. All wish to achieve innovation, though they may differ on the means to arrive at that goal.

6.9 Limitations of the literature review

Measuring successful academic-industry partnerships is often not quantifiable as the definition of success may encompass much more than a review of funding dollars, licenses or patents issued. Many partnerships between academia and industry involve the improvement

or enhancement of an existing technology. Many of the partnerships offer non-financial support in the form of internships for students or job opportunities for future graduates. Successful partnerships can result in philanthropic activity, such as endowments or other capital gifts. They can also evolve into long term relationships where research dollars are funneled to the university for both basic and applied research initiatives.

Much of the literature reviewed is both non-specific and anecdotal. Additionally, it appears that many of the more successful academic-industry partnerships are oriented toward long-term relationships as opposed to project-specific enterprises, thus limiting the data to anything more than an abstract measurement of success. The literature review concludes that measuring "success" in terms of licensing revenue or technology transfer fails to recognize many of the more substantial attributes which may contribute significant long-term value.

7.0 STUDY DESIGN AND METHODOLOGY

The study methodology applied will address this study's key research issues:

1. What are the characteristics of successful academic-industry partnerships?
2. What barriers can be identified that cause these partnerships to falter or fail?
3. How can this knowledge be utilized to develop better strategies for either industry or academic partners in their pursuit of future partnership relationships, in terms of developing long-term partnerships, project specific partnerships or other research related partnership initiatives?

7.1 Theoretical approach to the research questions

This section describes the theoretical approach to the qualitative design which was employed. Qualitative research methods allow the researcher to open a window into participants' attitudes, experiences, actions and opinions and to examine the participant's individual responses in the context of his or her organizational setting. Likewise, these methods afford the researcher a comprehensive examination of an individual's intent, actions and understanding and allows for a sound assessment of the context in which these actions occur (Patton, 2002, 20-28). The study design was framed in the social ecological model of research whereby the researcher focused on individual participants' interpersonal, intrapersonal and societal factors while still acknowledging the societal, institutional and organizational influences that occur. Qualitative research has at the heart of its methodology:

1. The need to get out in to the field to discover what is really going on.
2. The relevance of theory, grounded in data, to the development of a discipline as a basis for social action.
3. The complexity and variability of phenomena and of human action.
4. The belief that persons are responsive and take an active role in dealing with problematic situations.
5. The realization that persons act on the basis of meaning.
6. The understanding that meaning is defined and redefined through interaction.
7. Sensitivity to the evolving and unfolding nature of events or process.
8. An awareness of the interrelationships among conditions (structure), action (process) and consequences (Strauss and Corbin, 1990, 9-10).

Qualitative research is positivist and based upon modified grounded theory, in which "data collection, analysis and theory stand in close relationship to each other" (Strauss and Corbin, 1990, 24). It focuses on the environment of the subject, on collecting information in the context of that subject's perceptions and attitudes and on open inquiry as a method of determining the meaning and purpose behind those perceptions, attitudes and actions. Through this insight and enhanced understanding, one can develop a meaningful guide for future action that can have positive impact. Mintzberg (1979, 587) described the contributory value of qualitative research in the following way: "For while the systematic data create the foundation for our theories, it is the anecdotal data that enable us to do the building. Theory building seems to require rich description, the richness that comes with the anecdote. We uncover all kinds of relationships in our hard data, but it is only through the use of this soft data that we are able to explain them."

Traditional grounded theory calls for research that is emergent. Glaser and Strauss (1967, 33) state that the goal of pure grounded theory is to discover the theory that is implicit in the data, with no preconceived theoretical hypothesis offered by the researcher. The authors add that that, in reality, it is very difficult for a researcher to ignore all preconceptions and theories prior to gathering the research data. Because of this, a modified version of the grounded theory has been developed in which the process of inductive and deductive thought can be simultaneously utilized.

The modified grounded theory allows for the development of theories and categories prior to the interview and coding process (Perry, 1998, 785). New categories are likely to emerge during the interview process, but the modified grounded theory and pre-categories will allow for reexamination, enhancement, fine-tuning and elimination or inclusion of these preconceptions. The benefit of the grounded theory approach lies in the fact that it will allow for linking existing theory (the literature review and other key document review) with key informant interviews and analysis from the grounded theory approach.

7.2 Study design

The study design selected for this research employed a combination of methods involving the collection of both primary and secondary data. Primary data collection consisted of a series of 57 key informant interviews which were conducted through a purposive sampling of semi-structured interviews and a case perspective analysis of two of the academic-industry partnerships.

7.3 Key informant interviews

Key informant interviews are in-depth, semi-structured interviews with selected individuals who are well-informed regarding a specific topic, have some level of expertise in a specific subject, and can effectively articulate that knowledge (Patton, 2002, 341-348). The key informant interviews were conducted in order to supplement the literature and document review and to obtain additional insight into the issues regarding successful academic-industry partnerships and barriers to obtaining and maintaining these partnerships.

The primary data collection consisted of key informant interviews of selected individuals from public universities, including land grant and traditional institutions, private universities, industry and institutional settings. Industry participants included large industry as well as start-up companies, as these companies are often thought of by the venture capital community as among the best in innovation and forward thinking. The genesis of many of these start-up companies is directly linked to their relationships with a research university.

7.4 Recruitment of study participants

The initial list of potential study participants was developed from contacts within the UNC system, through the researcher's work at the North Carolina Research Campus, and through contacts from both academia and industry that the researcher made as a result of participation in the University Industry Demonstration Project and other academic and industry organizations. The list of potential participants was developed using criterion sampling in order to select participants with the experience and credibility to contribute to the relevance of the research. The intent of the key informant interviews was to establish a method of gathering data across a broad spectrum of industry types, including food

companies, pharmaceutical companies, agriculture companies, large established public companies and small start-up companies, as well as different types of academic institutions. The potential list also included affiliations of various types, ranging from research scientists, technology transfer officers, senior research leadership and senior administration officials within academia, as well as research scientists and senior research executives within the industry sector. The final sector of potential interviewees included representatives from institutional and not-for-profit sectors.

Study participants were recruited through communication by email and telephone. In the email (See Appendix A), I explained the nature of my research and asked if the potential participant would be interested in participation in the study, pursuant to the recruitment format that was approved by the University of North Carolina Institutional Review Board (IRB). Information was provided regarding the purpose of the study and the objectives of the research. Follow-up phone calls were made to each potential interviewee to schedule a time for either a personal interview or a telephone interview.

Study participants included individuals who were directly involved in the selection of and or management of partnerships with academia and industry. 57 individuals were contacted, all of whom agreed to participate in the study. All of the informants had experience in the subject area ranging from 4 years to over 30 years. In selecting the informants, consideration was given to geographic, industry and academic representation in order to assure a high level of credibility. Table 16 lists the key informants and their professional affiliations. Tables 17-20 provide information as to the professional background of academic informants, academic informants by type of academic institution, and the professional affiliation of industry informants.

Table 16: Key informant interview participants and affiliations[2]

Participant	Position	Affiliation
Connie Armentrout	Director, Technology Licensing	Monsanto Company
Margaret Bath	Vice President, Research, Quality & Technology	Kellogg Company
Roger D. Billingsley Ph.D.	Sr. Vice President, Research & Development	Dole Food Company
Elaine L. Brock, J.D., M.H.S.A.	Research & Sponsored Projects	University of Michigan
Molly Corbett Broad	President	American Council on Education Former UNC President
Christopher S. Brown, Ph.D.	Vice President for Research & Graduate Education	UNC General Administration
Robert A. Burhman, Ph.D.	Senior Vice President for Research	Cornell University
Bernard C. Brigonnet	Vice President - Research Administration	Carolinas Healthcare System
Robert M. Califf, M.D.	Vice Chancellor for Clinical Research; Director, Duke Translational Medicine Institute	Duke University
James J. Casey, Jr., J.D.	Executive Director, Office of Grants, Contracts & Industrial Agreements	University of Texas – San Antonio
John Cavanagh, Ph.D.	William Neal Reynolds Distinguished Professor, Department of Molecular & Structural Biology	North Carolina State University
Victoria Christian	Chief Operating Officer	Duke Translational Research

[2] Position and affiliation at the time of interview

		Institute
Steven D. Colman, Ph.D.	Genomics Consultant	RTI International
Theodore Crosbie, Ph.D.	Vice President of Global Plant Breeding	Monsanto Company
Joel Cutcher-Gershenfeld, Ph.D.	Dean & Professor, School of Labor & Employment Relations	University of Illinois, Urbana-Champaign
Hamed Faridi, Ph.D.	Vice President, Research & Development	McCormick & Company, Inc.
Nicholas D. Gillitt, Ph.D.	Director, Dole Nutrition Institute	Dole Food Company
Judy Heylmun	Vice President- Strategic Business Development	Sensory Spectrum
Lane Johnson, Ph.D.	Director of Agricultural Research	General Mills Corporation
David Johnston, Ph.D.	Vice President & Global Head of Clinical Trials	Laboratory Corporation of America
Stephen Kresovich, Ph.D.	Vice President for Research	University of South Carolina
Steven Leath, Ph.D.	President	Iowa State University
Peter B. Liao	Office of Technology Development	University of North Carolina – Chapel Hill
Mary Ann Lila, Ph.D.	Director, Plants for Human Health Institute	North Carolina State University
Terri L. Lomax, Ph.D.	Vice Chancellor, Office of Research, Innovation, & Economic Development	North Carolina State University
Steven A. Lommel, Ph.D.	Assistant Vice Chancellor for Research, William Neal Reynolds Professor	North Carolina State University

Gary W. Luce, Ph.D.	External Research Liaison	Eastman Chemical Company
Michael A. Luther, Ph.D.	Senior Vice President, Global Discovery Research	Charles River Laboratories
Susan A. MacIsaac, Ph.D.	Site Lead- NCRC	Monsanto Company
Carl P.B. Mahler II, J.D.	Executive Director, Office of Technology Transfer	University of North Carolina-Charlotte
Catherine Maxwell	Executive Director of Development, College of Agriculture & Life Sciences	North Carolina State University
James T. McDeavitt, M.D.	Vice President & Chief Academic Officer	Carolinas Healthcare System
Ronald McDermott, Ph.D.	Vice President – Advanced Innovation, Research, Quality & Technology	Kellogg Company
Nicole R. Mercier, Ph.D.	Business Development Manager, Office of Technology Management	Washington University
Barbara B Mittleman, M.D.	Director, Program on Public-Private Partnerships	National Institutes of Health
Jennifer O. Murphy	Executive Director – Office of Technology Transfer	George Mason University
David C. Nieman, Dr.PH	Professor & Director, Human Performance Laboratory	Appalachian State University
James L. Oblinger, Ph.D.	Former Chancellor Former President	North Carolina State University DHM Research Institute
W. Phred Pilkington, D.P.A.	Chief Executive Officer & Public Health Director	Cabarrus Health Alliance
Kenneth Piller, Ph.D.	President Associate Professor,	SoyMeds, Inc. University of North Carolina-

	Department of Biology	Charlotte
Alan D. Roses, M.D.	Jefferson Pilot Professor of Neurobiology & Genetics, Director, Deane Drug Discovery Institute	Duke University
John A. Ryals, Ph.D.	President & Chief Executive Officer	Metabolon, Inc.
Wendy R. Sanhai, Ph.D.	Senior Director, Regulatory Policy & Advocacy	GlaxoSmithKline
Tobin L. Smith	Vice President for Policy	Association of American Universities
Gerald Sonnenfeld, Ph.D.	Vice President for Research	Clemson University
John C. Steffens, Ph.D.	Director of Plant Molecular Engineering	Chromatin, Inc.
Jeffrey Steltzer, J.D.	Director, Office of Conflict of Interest Management	Georgia Institute of Technology
Andrew G. Swick, Ph.D.	Former Senior Director, Obesity & Atherosclerosis Translational Pharmacology Director, Obesity and Eating Disorders Research	Pfizer Global Research & Development UNC Nutrition Institute
Holden H. Thorp, Ph.D.	Chancellor	University of North Carolina at Chapel Hill
Theodore J. Torphy, Ph.D.	Chief Scientific Officer & Head of External Research	Johnson & Johnson Pharmaceuticals Group
Mary Wagner, Ph.D.	Senior Vice President of Global Research & Development	Starbucks Coffee Company

Tony G. Waldrop, Ph.D.	Provost & Executive Vice President	University of Central Florida
Robert Wilhelm, Ph.D.	Vice Chancellor for Research &Economic Development	University of North Carolina-Charlotte
Leonard L. Williams, Ph.D.	Professor & Interim Director, Center for Excellence in Post Harvest Technologies	North Carolina A&T University
Randy Woodson, Ph.D.	Chancellor	North Carolina State University
Kathy Young	Director of Research & Sponsored Programs	Illinois State University
Steven H. Zeisel, M.D., Ph.D.	Kenan Distinguished Professor of Nutrition; Director, UNC Nutrition Institute, NCRC	University of North Carolina at Chapel Hill

Table 17: Analysis of key informant interview participation

Affiliation	**Number of Participants**
Agricultural Industry	4
Food Service/Processing Industry	8
Chemical Industry	1
Pharmaceutical Industry	6
Institutional/Not-for-Profit Organizations	7

Academia – Senior Administration	5
Academia – Sr. Research Officer	9
Academia – Tech Transfer Staff	11
Academia – Scientists/Researchers	6
TOTAL	57

Table 18: Professional background of academic informants

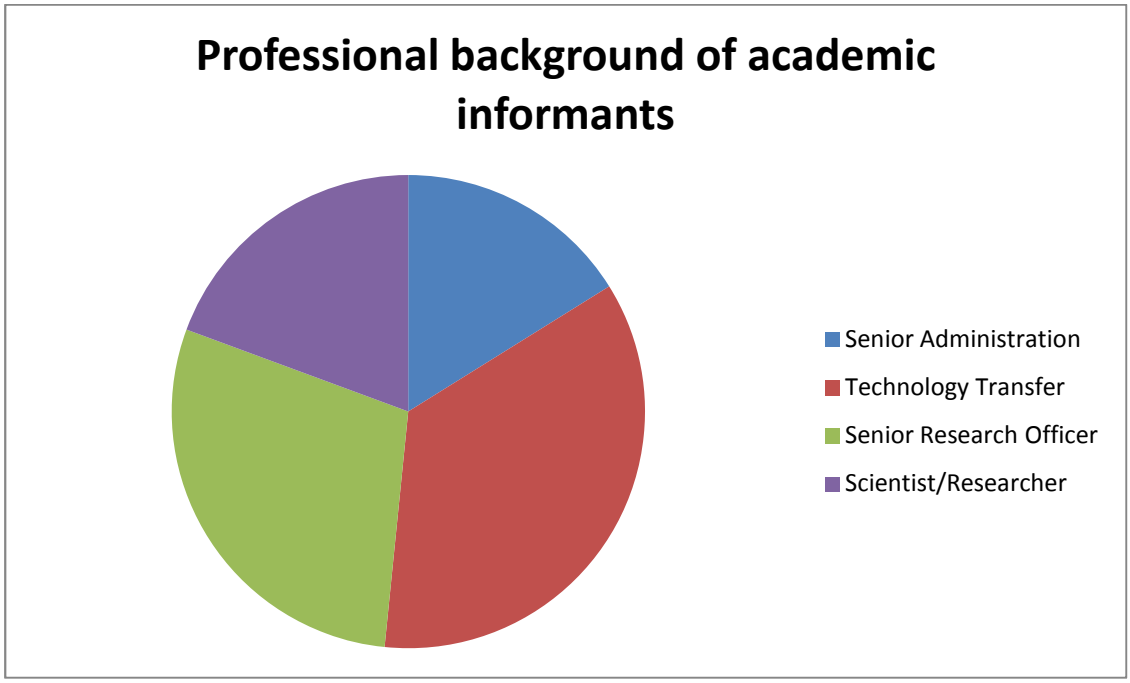


Table 19: Academic informants by type of academic institution

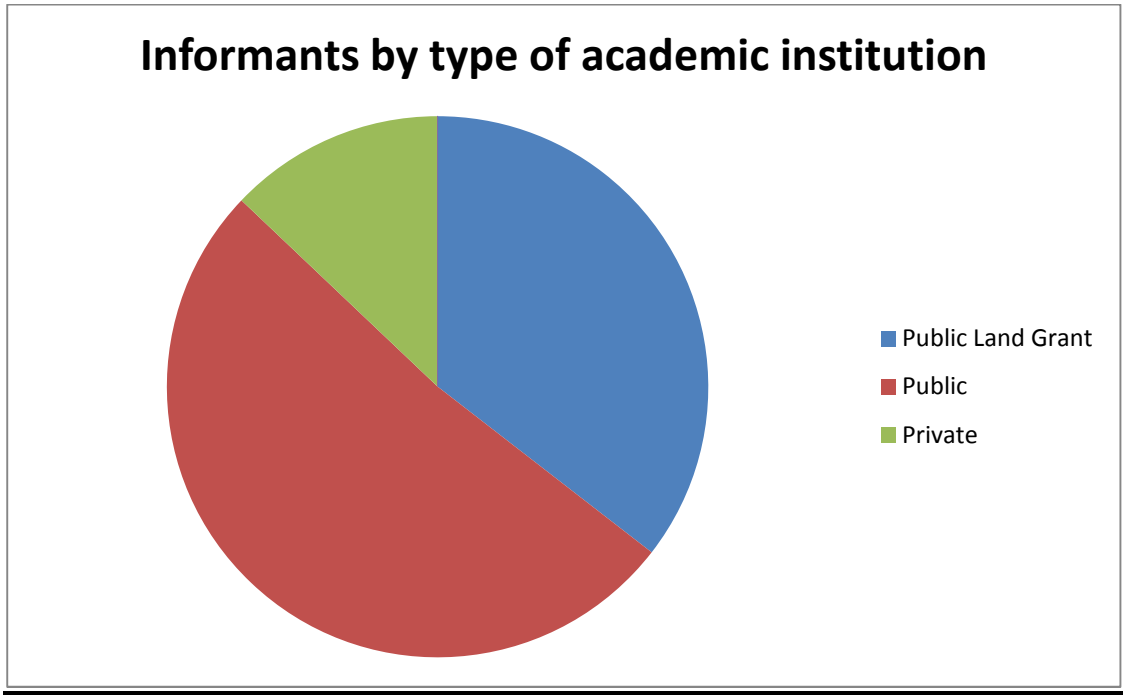
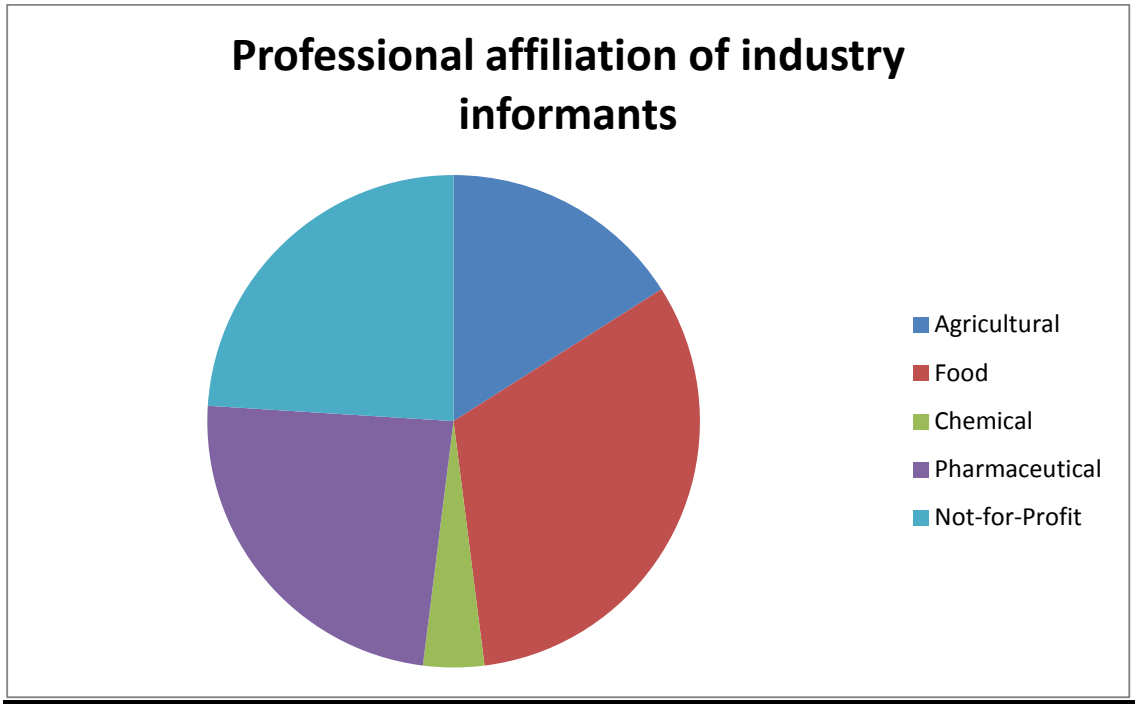


Table 20: Professional affiliation of industry informants



7.5 Key informant interview format

Following the response indicating their willingness to participate in the study, appointments were made with each of the participants to allow adequate time for a discussion either in person or by telephone. The interview questions that were developed to address the research initiative followed a thorough review of the literature and the available documents that are part of this review, the nature of which helped to shape and influence the questions that were a part of the interview discussion. Questions were tested in a mock interview with an academic researcher who agreed to assist in testing the effectiveness of the script and the probes, making certain the time requirement for the interview did not exceed what had been asked of participants in the initial email.

Participants were asked both structured and open-ended questions following the format that was approved by the Institutional Review Board of the University of North Carolina (IRB). The questions were primarily designed to facilitate an open dialogue and encourage the participant to reflect on his or her own experiences and how these experiences affected his or her work. It was anticipated that the questions would provide the researcher with an overview of organizational practices (both successful and unsuccessful), effective strategies for negotiating partnerships and information regarding perceived barriers, pitfalls and problematic issues. Appendix B contains the general script for the questions that were asked of interviewees.

A total of 57 semi-structured interviews were conducted with informants reflecting a diversity of knowledge, backgrounds and perspectives across academic and industry groups.

Interviews were conducted by telephone and in person between September 2, 2012 and January 29, 2014 and ranged from 32 to 71minutes, with an average of 43 minutes.

At the beginning of the session, participants were read the consent form and asked to give verbal consent prior to the beginning of the interview. Participants were informed that their responses to the interview questions would remain confidential unless they provided their written consent to have comments directly attributed to them. They were also informed that if they had specific concerns about a topic and they did not grant permission for attribution of statements, then the confidentiality of the data would be maintained by the removal of any identifiable information from the interview records. All informants gave permission to digitally record the interview session.

Participants were informed of the additional privacy procedures which were implemented:

1. The researcher was the only person who had access to information that associates the individual participants and the interview information.
2. All participants were asked for permission before information in the final research report was attributed to them.
3. All interview records were stored electronically and in password protected files on the researcher's personal laptop computer.
4. Participants were audio recorded only after providing consent at the beginning of the interview session. Participants also were informed that these audio recordings were to be transcribed and that the digital files were to be destroyed upon transcription.

5. Interview notes were digitally recorded for the purpose of inscription and analysis. Detailed interview notes were taken by the investigator. At the conclusion of each interview, notes were transcribed and compared to the audiotape recording for verification.
6. Any transcriptions or other hard copies of information from the interviews that could be linked to individual responses were kept in a locked desk drawer in the researcher's office, which was also kept locked.

Interview questions were primarily open-ended and were developed with an approach to social constructionism in mind, which holds that meaning is created not by individual cognitive processes but as part of a social exchange. The questions were designed to understand the experiences from the point of view of those who live them and participants' responses are a reflection of their social context within a specific community (Crotty, 1998, 52).

All of the interview sessions were conducted by the researcher. During the interview session, the researcher wrote informal memorandums which were later used to validate the audio recordings of the interviews. In order to address concerns of reliability, sessions were digitally recorded using two separate recording devices. To assure a high level of accuracy, interviews were recorded verbatim. After the interviews sessions were completed, audio recordings were transcribed, printed and checked for accuracy by the researcher. Each informant was assigned an alphanumeric code in ensure confidentiality and to ensure that specific comments could not be linked to the data (See Appendix D). The printed interview and interview notes were put in a notebook, which was kept in a locked desk drawer in the researcher's office. After the recordings were transcribed, they were erased from both

recording devices. Any potentially identifying information was redacted from the printed transcripts.

All of the informants were receptive to the interview and candidly answered all of the questions addressed to them. They were equally willing to share in a discussion of the issues addressed in this research project and to share their ideas about their personal experiences and their ideas for potential improvement in the development of strategic partnerships. The data that were collected during these interviews contained both depth and richness.

Although the experiences and backgrounds of the informants were diverse, similar themes were recognized and theoretical saturation (Glasser and Strauss, 1967, 112) was achieved through the process of conducting the interviews, which enabled the interviewer to note the prevalence of dominant themes and concepts.

At the conclusion of the interview session, participants were advised that they may be asked for follow-up information or clarification after the initial interview was completed.

7.6 Document review

At the completion of the key informant interviews, the secondary data collection consisted of a document review of publicly available information regarding academic-industry partnerships. These documents included technology transfer documents, study results which were available through the university's public documents, including websites, annual publications, journal articles, policies, procedures and guidelines regarding the development of these relationships. Much of the information regarding technology transfer and intellectual property was confidential and thus proprietary and could not be disclosed. However, study participants did provide other support information and suggested materials

that were publicly available that provided insight for this study. Standard agreements and contracts were frequently used merely as the basis upon which initial discussions were held and were indicative of the wide variability and the lack of a consistent method of entering into and managing academic-industry partnerships.

Meeting notes from conference, roundtable discussions and project summits such as the University Industry Demonstration Project, the Government University Industry Research Roundtable, the National Academies of Sciences "Catalyzing University Research for a Stronger Economy" and the Research University Futures Consortium were also included in the review. A review of university and company websites, annual reports and other publicly available information was conducted. Although most companies did not have written guidelines for entering into and conducting academic partnerships, several had marketing materials and website information that promoted future partnerships and collaborations.

7.7 Case perspective analysis

Upon completion of the key informant interviews, two were selected for an in-depth case perspective discussion, allowing for a more focused understanding of the partnership through the words and experiences of the interviewee. The case perspective narrative and analysis provided temporal and special orientation based on the experiences of the interviewee. Information in the case perspective will provide themes about what has been said, the structure of how the story is told and chronology through epiphanies and events. A review of the characters, setting, problem, action and resolution will offer a unique perspective of the academic-industry relationship. Therefore, the case perspective was selected as part of the study design in order to enable the reader to gain additional perspective

to the partnership being described by "allowing the investigator to retain the holistic and meaningful characteristics of real-life events" (Ying, 2009, 4).

The case perspective's qualitative approach assists in providing a unique understanding of the real world dynamics underlying a relationship, that is "the why of what is happening" (Eisenhardt, 1989, 542). Stake comments that the real contribution of the case perspective is "particularization, not generalization. We take a particular case and we know it well, not primarily as to how it is different from others, but what it is, what it does. There is emphasis on uniqueness, and that implies knowledge of others that the case is different, but the first emphasis is on understanding the case itself" (Stake, 1995, 8). However, case perspective strategy does recognize that this type of research is bounded by time, activity and actors which are involved (Creswell, 2003, 15).

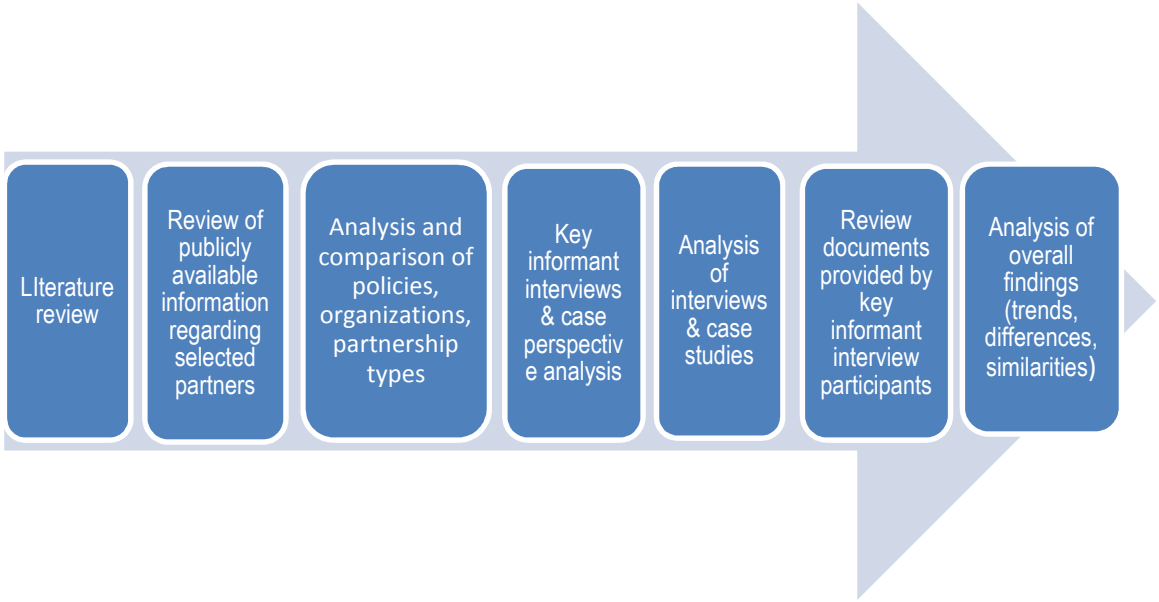
Through the observational methods used in the key informant interview and the case perspective techniques, the research questions were examined and refined to substantiate their meaning, referred to as "progressive focusing" and involving a process that is "patient, non-interventive, empathic, reflective and willing to see another view." Qualitative case perspective research attempts to preserve the "multiple realities, the different and even the contradictory views of what is happening" (Stake, 1995, 12).

7.8 Data analysis

Both primary and secondary data were collected and analyzed as a part of this study. The sources for the primary data were the key informant interviews and case studies and the analysis of resulting themes, patterns, similarities and differences. The secondary data analysis consisted of a comprehensive literature review as well as both publicly available

documents regarding university and industry partnerships and procedural, organizational or institutional documents which are acquired as a result of the key informant interviews. An overview of this data analysis may be depicted as follows in Table 21:

Table 21: Process for data analysis



After the key informant interviews were conducted, audio recordings of the interviews were reviewed and transcriptions of the interview sessions were analyzed for accuracy. The investigator conducted a thematic analysis using the notes, memos, transcriptions and digital recordings in order to identify differences and similarities. The transcriptions were analyzed using coding to identify pertinent themes, patterns, ideas, concepts, behaviors, interactions, incidents, terminology or phrases used. The analysis was used to compare and contrast responses from the various interview sessions.

Charmaz (2006, 42) states that coding works to "disassemble and reassemble data" and the codes serve to "summarize, synthesize and sort the many observations made of the

data." Coding becomes the fundamental means of developing the analysis. The analysis of interview data and identification of codes is an iterative, progressive and non-linear process in which categories may need to be adjusted or new categories added to accommodate data that do not fit existing codes. The coding process consisted of a combination of a priori codes, which were developed before analysis of the data, and inductive codes, which were developed as the coding was performed. Main categories of data were analyzed into smaller, more defined categories which allowed for greater discrimination and differentiation, allowing for the identification of patterns and more meaningful analysis of the responses. In large part, the assessment itself of the relative importance of different themes and the recognition of subtle variations can potentially be an instructive aspect of the analysis.

The coding of thematic categories indicates that some themes occur consistently across the data, which will help to explain the "why" in certain successful, or unsuccessful, partnerships. The analysis sought to inform how these things relate, what data support the interpretation and what additional factors may be contributing factors. Likewise, the analysis sought to understand examples or events that run counter to prevailing themes and what may be suggested by these countervailing responses. It is significant in the coding portion of the analysis to understand items that do not fit the categorization system as those that fit clearly into prescribed categories.

Data coding was accomplished utilizing MAXQDA, a qualitative data analysis software program developed in Germany in 1989 by VERBI GmbH. MAXQDA was developed as a method of finding deep patterns in qualitative or mixed methods research data, and to provide insight into the complexity of the research data by enabling the researcher a method of systematically evaluating and interpreting text.

Analytical coding was employed in the data analysis, in which new categories were created based on concepts that emerged as a result of further reflection on the data. Line-by-line coding was initially conducted with each of the interview transcripts, which identified over forty codes. The themes that were included in the coding process represented the collective knowledge, perceptions and experiences of the researcher as well as the key informants, allowing for a robust analysis of the research questions. Appendix E lists the codes and number of statements per theme that were included in the analysis. Many of the passages cited by informants had more than one code assigned to them.

Once the coding of the data was completed, the analysis was used to consolidate the data employing the emergent themes, trends and overarching connections to explain the findings. In some cases, responses were quantified and the themes were coded and weighted, either by relative importance, through frequency of responses or the number of unique respondents who refer to certain themes; or through the identification of common topics, themes, observations or comments. After the interviews were coded, the interviews were read a second time and excerpts were extracted that were thought to be exemplary of the various codes that had been established. These quotations and excerpts from the interview transcripts were recorded and were grouped by category using an Excel spreadsheet. This method of theoretical sorting to classify the categories, connect categories to one other and support codes with dialogue and quotations provided grounding to the categories produced. This process of theoretical sorting "gives you logic for organizing your analysis and a way of creating and refining the theoretical links that prompt you to make comparisons between categories" (Charmaz, 2006, 115).

The data were then analyzed by asking the following questions, using the conceptual framework depicted in Table 2 as a theoretical guide and lens for analysis:

1. How do the categories fit together and relate to each other?
2. What data seem to be more important?
3. Are there exceptions or critical cases that do not seem to fit? Are there alternative explanations?
4. What paradoxical information, conflicting themes or other evidence may exist that might challenge or contradict the interpretations?

The interpretation of the coding data brings meaning and signification to the analysis by answering the following questions:

1. What are the key ideas being expressed within the category?
2. What are the similarities and differences in the way interviewees responded, including the subtle variations in comments?
3. What are the major lessons identified in the comments?
4. What comments have application to other settings, studies or situations?
5. What will those who read the results of this research be most interested in knowing?

At the beginning of the research project, it was anticipated that the information which was obtained from a review of the literature would be reinforced and substantiated by key informant interviews and the review of existing policy manuals and publicly available information regarding academic-industry partnerships from the university and industry participants. The data analysis did not show inconsistencies to the literature review, but did

offer a greater depth of understanding of the current thought process by industry and academic experts as to the future strategic direction of these partnerships.

7.9 Limitations to the methodology

The most obvious limitation to this study lies in the anecdotal nature of the responses obtained from key informant interview participants and the lack of evidence gleaned from either the primary or secondary data analysis in the measurement of "successful" academic-industry partnerships. It is unlikely that a quantifiable, definitive measure of success can be obtained. What is considered "successful" in one relationship may or may not be considered successful in another. Some forms of success consist of intangible and even undefinable components. Likewise, the cost of measuring a successful academic-industry partnership may not show value in terms of return on investment (ROI) but may lay the groundwork for future success that is immeasurable.

Other limitations to the study are more general and may include the following:

1. The quality of the information that is obtained from the interviews, which is subject to accuracy, a complete knowledge of the overall organization or comprehensiveness. The researcher relied strongly upon the knowledge and expertise of the informants.
2. The sample size, sampling methodology and participation may have been subject to selection bias. This was at least partially addressed by the inclusion of representatives from several academic categories, both by type and geography, as well as different sectors of industry.

3. The lack of available information or documentation on “best practices,” due to confidentiality issues, industry proprietary information or trade secrets.
4. Potential bias or personal opinion of the interviewee or interviewer.
5. Variability in the interviewees’ ability to fully communicate to the researcher answers to the questions that are being asked. These limitations were addressed by validation techniques, including the triangulation of data sources.
6. The lack of generalizability, as the perspectives and beliefs of the informants can be attributed to those individuals, in their specific temporal, socio-cultural, political, geographic and economic situations. Additionally, interviews were conducted only once and thus the interview data represent the informants’ views at a singular point in time.
7. The researcher’s role in these partnerships and affiliation with the North Carolina Research Campus may result in participant-observer bias both in the interpretation of the interviewees’ responses based on pre-existing ideas or goals, and because informants might respond to questions in a way that is biased.
8. Since the majority of the informants knew the interviewer, there was the potential for response bias.

8.0 FINDINGS AND RESULTS

The goals of the research project were to obtain a better understanding of the following questions:

1. What are the characteristics of successful academic-industry partnerships?
2. What barriers can be identified that cause these partnerships to falter or fail?
3. How can this knowledge be utilized to develop better strategies for either industry or academic partners in their pursuit of future partnership relationships in terms of developing long-term partnerships, project specific partnerships, or other research related partnership initiatives?

The study results were developed through the use of emergent themes that resulted through the iterative process. The findings are data-driven, and since the thoughts and words of the study participants are the primary source of data in this research project, the language and choice of words of the participant are thought to be the most effective means of displaying these results. Therefore, the researcher has chosen to present those quotes as evidence of the actual themes that have emerged. Quotations have been identified as belonging to “academic”, “industry” or “institutional” key informants. Permission was obtained from informants to whom quotes have been attributed.

8.1 Why academic-industry partnerships exist

> "If the goal of the university is to translate ideas into actions and change the world, then industry partnerships are necessary. If the rules are right, then they can be highly productive without any compromise of the academic mission." - Robert M. Califf, M.D., Vice Chancellor for Clinical Research, Duke University Medical Center[3]

Although much of the literature focused on measurable results in terms of patents, intellectual property, and new spin-off companies, none of the informants listed these as primary motivators for forming partnerships.

> *"Intellectual property is way down on the list of reasons we partner – but the ability to leverage that money, to place our students in meaningful positions, to provide relevance, and to ultimately get gifts – these are some of the reasons we partner."* (Academia)

Academic informants, particularly those from land grant institutions, noted that from the perspective of the development of intellectual property, the partnerships might have been considered failures. By other measures, however, there were areas of immeasurable success and long-term benefit to the researcher, their department and the university in total. While some industry informants spoke of deliverables and successful and measurable outcomes, academic informants almost universally saw benefits were beyond that which could be realized from commercialization or intellectual property opportunities.

> *"Oddly enough, there was not a single invention that came out of that partnership, but there were multitudes of great publications, and there were at least ten students that we hired and brought in; a great talent recruitment. So that ended up having a very different focus, because the first question that was heard from senior management was "how many inventions came out of that and were licensed?" Well, none, that one had a very different ending." (*Industry*)*

1. ***Partnerships offer opportunities for early introduction to industry for students; Industry gets an early look at talent within the university as potential employees***.

[3] Permission has been granted by key informants to whom quotations have been attributed.

Academic informants and industry informants alike saw the value that partnerships offer in achieving the mission of the university to provide opportunities for students. Students benefit from real-life opportunities in the workplace, and companies have the opportunity to get early indications of well-suited students who could be recruited as potential employees.

"It was definitely a quid pro quo there. It was almost like writing a paper together; the industry had to put the energy and effort into training the student, and the student got training in cutting edge technology that made him a valuable potential employee. The industry got to pick the brightest and the best." (Academia)

"People would get a firsthand look at a really promising student and say, 'gosh, that person would work for us'." (Industry)

"The one thing that universities don't take full advantage of is the fact that industry is hungry for human capital and talent. The fact that the universities represent the generator of future employees is one of the biggest things of interest to industry." (Academia)

"It provides opportunities for students in terms of being able to have opportunities for jobs through the contacts they've made, through internships, being able to work in labs and research areas while they are in school, and overall it gives them a whole new perspective about research and about the field they are considering entering. Students see and appreciate the different opportunities available to them by having some connection to the industry train of thought." (Academia)

2. ***Ability to refine academic curriculum to better prepare students for real world experience in the workplace.***

Faculty can see the value of partnerships because they potentially offer them the opportunity to refine and tailor their curriculum in a way that better represents what students will encounter in real-life work settings, leaving them better prepared upon graduation.

*"Students get a lot of work done and we can test drive them so we can offer them jobs when they get out. They also learned how companies work and they would take that knowledge back to their labs." (*Industry*)*

"My contacts within the university would tell me about how they had changed the way they trained their students and how their labs operated because of what the student interns brought back. The most valuable piece to them was the interaction that students had with real life science and being able to bring that back and put it to work. And you could see the same thing with university faculty who would come back from sabbaticals in an industry setting. They would come back and their programs would be changed forever based on those experiences." (Industry)

Dr. Joseph Simone, a professor in the department of chemistry at UNC-Chapel Hill, believes that the industry sponsored work he does makes his science better. He observes that academic scientists are "poor judges of the impact of their research and that the private sector can offer academic science the kind of feedback that can come only through interaction with customers and the marketplace. When the process of collaboration works correctly, there is a free flow of information that makes both academic and commercial science better" (Thorp & Goldstein, 2010, 33).

3. ***Enhanced faculty retention as a result of opportunities for industry collaboration.*** The connections with industry are beneficial to the university in attracting and keeping valuable faculty members. Faculty members are drawn to institutions which provide them opportunities to bring their research to market or further their research through industry funding and cooperation.

"For our university, being connected with these partners, whether they are medical institutions or engineering companies helps us get the best faculty and the kind of faculty that we want. We want faculty who want to translate their work into results – to put their knowledge to work. We want faculty who want to work on teams; who want to work on hard things that no one has ever talked about before. This interchange with the companies and with the different entities outside the university gives us a leg up on recruiting and keeping the best staff." (Academia)

"These partnerships provide for a more sophisticated faculty. I think it's important for faculty not just to do ivory tower research, but to have a nice mixed program where they do research for companies so that they can see that research does have a goal and at the end of the day a deliverable that provides value to society." (Academia)

4. Economic development opportunities.

Academic informants recognized the role of academic-industry partners as a key component of economic development in the communities in which they were located, an important piece of the university mission. Public universities were particularly more attuned to this than were private institutions, likely because they are accustomed to the accountability that is associated with receiving public funding for operational support. Land grant institutions commented on the importance of fulfilling this part of the original land grant mission. Academic-industry partnerships provide a perfect opportunity to marry theory and practice, and to create new economic opportunities by stimulating the drive and passion of scientists from both academic and industry.

"Economic development is always one of our goals. We want our students to succeed. We want our students to be the next generation of leaders in their fields." (Academia)

"When the university was established it was well-stated that we should be a high seminary of learning – but that we should also contribute to the well-being of the people in the state, which gives us the task of economic development from the very beginning. So if we can work with companies in the community and find ways to partner with them, we are doing what we can to help the people of our state to prosper." (Academia)

"If we are helping industry prosper, then we are fulfilling our mission. As a land grant institution, this is an important part of our heritage." (Academia)

"In developing these relations with industry, the recruitment of future employees is a critical part of economic development. Industry says the main reason they relocate is workforce, workforce, workforce. Our job is to build those bridges that link the research partnerships with economic development." (Academia)

"It's our dream to have some impact on the economic wellbeing of the region, as well as the state and the nation. If we can work with big companies as well as small companies that we start up and grow into something bigger, then that's one of the things we are charged as a university to do. To have an economic impact, it happens, but it takes a long time." (Academia)

"Every nation has figured out that investments in higher education by industry translate into new and innovative industry applications. And this is central to the journey for building a world class economy and being successful in the global economy." (Academia)

"One of the huge selling points that our state uses for getting companies to come here, stay here, or expand here is our wealth of talent in the university system. There's not always an immediate funding opportunity for scientists to do their work, but the benefit of having companies locate here to have access to faculty expertise is huge." (Academia)

5. ***Harnessing of intellectual capital of academic scientists to help industry achieve novel solutions and speed to market.***

Industry informants recognize the value of being able to harness the intellectual capital of academic scientists in a way that enables them to achieve faster, more cost-effective results, and in many cases achieving novel solutions from innovative and forward-thinking academic scientists.

"We're getting highly educated and highly trained talent from the university, and we are making sure we are working with the premier researchers who are out in the field, out in front, looking at things that maybe we haven't thought about yet. We make sure that we have the capabilities of working with these folks as we become aware of new ideas; that we know where to go and find the best people to work with." (Industry)

"These partnerships bring together people who would not be able to do it alone. By working together, we get additional benefits by making fractional investments and we get more of a return." (Industry)

"Very often we will identify a professor who we tap as an industry expert in an area where we don't have as much internal expertise. As a company, it makes tremendous sense to leverage one of the hundreds of thousands of university experts who could be helping us out."(Industry)

"There are universities with centers of magnitude employing excellent scientists, many of whom are working on things that could lead our company to the next new big product. And if we don't reach out and collaborate with them, we are going to miss a tremendous opportunity. Plus, from a cost efficiency perspective, why do we need ***to*** *have our own bricks and mortar and our own people developing every new idea when there is infrastructure around the country in the university systems? The universities have programs and equipment and dedicated research going on; brilliant people working in areas that we can tap into with the right kind of collaboration."* (Industry)

"I think you are seeing open innovation coming from these partnerships with universities. It's a casting of a very wide net to garner that research and supplement our development capabilities. If you look at drug discovery over the last fifteen years, you would see that very few drugs were actually internally developed or discovered. Most of them came from some sort of open innovation."(Industry)

"If you are a research intensive university you have to have industry relationships. If you are going to make an impact by translating what you do out in the public you need to work with industry to be able to do that. We're here to facilitate our incredible faculty to do the best they can with their research."(Academia)

"If you are on the industry side, you are getting work done at a discounted, almost subsidized rate. You are getting the benefits of all our facilities, our faculty, our students, and you are paying a lot less than you would for a contract research organization arrangement. At the same time, our university benefits because we get the funding and the resources to educate our students, and we continue to be leaders in development and new technologies." (Academia)

6. ***The ability to marry the basic research of academic science and practical application of industry commercialization***.

Academic and industry informants both acknowledge the fact that these partnerships can assist in taking the basic technical knowledge that is generated in academic laboratories and help transfer this to solve practical, real world problems.

"Publication should not be the only end product. There is a tendency for academics to think that, if you have the science figured out, that is adequate and the rest of it is whatever. It's like in Amadeus when the King comes to Mozart and asks if he has the opera finished yet and he says 'it's all here in my head; the rest is just frivolous.' Well the scribbling is important. If you don't write it down, the musicians can't play it and the singers can't sing it in song. So the same thing is true with a lot of technical advances. The technical part is really, really important. But if nobody takes it and does anything with it, it might just sit there". (Industry)

7. ***Enhanced educational opportunities for students.***

Overarching all of these comments is a strong desire to conduct partnerships that will benefit the university's most important asset: its students. While there are many reasons to partner, offering enhanced experiences and future opportunities for the students seems to be the most compelling argument. This was the most frequently mentioned reason for partnerships by academic informants.

"The educational programs at our university are intertwined with industry in a very detailed way. If we didn't have good partnership with industry, I don't think we could do our job in either research or education." (Academia)

"I think a lot of times people think about the research activity we do with companies and they think- is it the research or is it the students? The only reason we are doing this is for the students."(Academia)

"In a perfect world at a university it's the educational component that is really important. We want to find those opportunities with industry and convey to the sponsor that there's value in educating these students. And maybe those people will be the next employees the company might hire once they become educated as a part of the process." (Academia)

"There are winning aspects to these partnerships, but the best is the educational advancement of our students. Yes there is reputational advancement in the scientist's area and the institution gets recognized for having excellent people working in these areas. I get recognized for doing good science. But most importantly is that the students get trained so they can get jobs and build their reputations as well. And industry wins because they are using the data or products or processes immediately and then we have real potential for long term opportunities for research with these sponsors." (Academia)

"Our interest is not so much in protecting our financial position with intellectual property. Our interest is to make sure we are protecting the intellectual position or our faculty and our students. We want our faculty and students to come up with good ideas and build on those over years. When students come here, our message is – this is a place where you can try things out and fail. If you have a good idea, there is an opportunity for you to work on that with the partners we have developed. Our biggest interest is to have this broad colorful fabric that our students, our faculty, and our partners are working on and mixing up all the ideas that are there." (Academia)

Informants spoke of the benefits of these partnerships as being multi-dimensional, often with benefits that were unanticipated to both partners. The spectrum of benefits ranged from short term success to the development of long term partnerships. The benefits were described as being relational and strategic as opposed to being associated with a singular event or partnership opportunity.

"What was really exciting was the number of levels of activity that occurred. They got good public relations out of it; they got research at a very high value. It would have probably taken them $20 million had they done it in-house. And they got a professorship in their name that will bear their name forever." (Academia)

"Our job is to train students to go out there and do the work of the world. We need industry partners to hire them. It's our job to identify the compelling challenges and problems in society and find the answers to them through research and then put these answers in the hands of the people who need them. Our industry partners help us commercialize these ideas and scale them up and complete that process of making the world a better place. So it's really a part of a continuum. There are so many ways we

fit together beautifully because of the very nature of the academic environment. We have the ability to explore something that might not be immediately commercializable. But our external partners have the ability to do things we can never do. And if you put us both together, it's a pretty amazing thing." (Academia)

"The research partnership sometimes leads to a very robust exchange of opportunities. Sometimes these things are not even related to research: goodwill, grants, endowments, and contributions to campus fundraisers for this, that or the other. The race to cure this or that. They become partners with the university."(Academia)

"It's of mutual benefit – there is a common denominator. The corporations are quite interested in the students that they had access to and the presence of students, both undergraduates and interns. People would get a firsthand look at a really promising student and say 'gosh, that person could work for us.' So it was great for the students. And at the graduate level the students had the opportunity to be involved in some really pioneering research. The university was capitalized on as a result of the partnership concept." (Academia)

The reasons given by informants for academic-industry partnerships are summarized below in Table 22.

Table 22: Summary of reasons for academic-industry partnerships as cited by informants

1. Partnerships offer opportunities for early introduction to industry for students; Industry gets an early look at talent within the university as potential employees.
2. Ability to refine academic curriculum to better prepare students for real world experience in the workplace.
3. Enhanced faculty retention as a result of opportunities for industry collaboration.
4. Economic development opportunities.
5. Harnessing of intellectual capital of academic scientists to help industry achieve novel solutions and speed to market.
6. The ability to marry the basic research of academic science and practical application of industry commercialization.
7. Enhanced educational opportunities for students.

8.2 Barriers to successful partnerships

The informant interviews identified twelve primary barriers that inhibit successful partner relationships. Some of the barriers are considered to be orientation-related barriers, such as cultural differences, communication styles and differing priorities, while others could be characterized as transaction-related barriers, such as contractual disputes concerning intellectual property and project deliverables. These barriers are discussed below and are discussed in order of the frequency in which they were mentioned as part of the interview process.

Barrier #1 - Discussions regarding intellectual property rights and ownership often prohibit partnerships from ever getting off the ground.

> "Many universities approach partnerships as though they are in one direction. They are seeking funding for research. We approach them more as a partnership, a mutually beneficial relationship. What I think we have done differently here is to work hard to keep the barriers to collaboration as low as possible with the expectation that the collaboration itself will be beneficial. What gets a lot of universities in trouble is that they think they need to own everything and they do not give the partner any ownership of the IP. For us, we approach it almost like we are in a direct working relationship with the industry." - Chancellor Randy Woodson, Ph.D., North Carolina State University

Industry informants indicate that the discussions regarding intellectual property (IP) rights are often tedious, one-sided and inflexible. Industry partners perceive that universities are unwilling to take any of the front-end risk and want to be compensated even before there is clear evidence that the partnership will generate any measurable IP that has value. They report that universities have been concerned about what they are giving up in terms of IP rights, sometimes without a strategic vision of what a long-term relationship can offer. Informants lament the huge amount of man hours expended at the onset of a partnership

trying to resolve who gets the IP rights, how much it will cost, how it will be disclosed and in which area the IP can be utilized. On the other hand, industry partners, eager to quantify financial risks and rewards, have had difficulty accepting the open-ended nature of IP agreements and the unknown aspects of them. Both sides of the partnership concur that there has been an inordinate amount of time expended trying to figure out all the potential IP and commercialization opportunities that might possibly come out of a partnership. Academic informants see this strategy as one that has not worked well in the past and agree that a new way of dealing with IP must emerge in order to forge successful relationships.

> *"One of the biggest roadblocks to making university corporate partnerships work is that universities worry too much about giving up too much and not enough about what the ultimate goal might be. The arguing over the amount of money that is going to be paid upfront thinking there is going to be some huge payoff at the end may mean that there are years that go by before an agreement is reached."* (Academia)

> *"A lot of universities think they are going to make a lot of money from patents and IP. Very few actually do. So for us, we think it's more important for the technology to get out the door and into the market place. Industry is the best way for that to happen."* (Academia)

> *"In a lot of cases the fights that people have had are really for nothing. They don't end up with the big blockbuster products that are going to make the universities a lot of money."* (Industry)

> *"Faculty are interested in seeing their research applied and valued, from whatever audience is supposed to find value from that invention or technology. If that is going to be through a company, then we have to live and work by industry parameters and models, and that means patents, licenses and money. It's all well and good to put something out there in the public domain, but if it's going to take industry investment to do that, you have to have a commercial model that works for them. They need some exclusivity and to be able to have a competitive advantage. That just makes sense in the business world."*(Academia)

> *"Selecting universities that are open to not having to own all the IP, and are open to digging a bit deeper in terms of the relationship and the research we need – that's who we try to align with."* (Industry)

> *"Patents are of no interest to me. So much wasted time and money go into turning it into a provisional patent then a full-fledged patent, and all the legalities and the many years it takes to actually convert the patent. In most cases, there is no bang for the*

buck at the end. Most patents that are out there don't ever end up being profitable." (Industry)

"The concept of fighting over intellectual property and research agreements is not really effective. We're not doing that anymore. We are trying to interject practicality into these negotiations." (Academia)

"These are just show stoppers –discussions about things that maybe never see the light of day. So it just stops the research in its tracks rather than saying, 'you know what, if we really look at our grant income, it's not that great. It's cutting off your nose to spite your face. Most of this stuff is never going to be a commercial product. Why are we getting into arguments with our best donors over stuff where 99% of it will never see the light of day?'" (Academia)

"The universities often don't have a great awareness of how early most of this technology is, how much risk is in the technology, and how much has to be invested in order to bring something to the market. I've never seen a university professor have something ready to sell. There is always going to be investment required and most products are always risky. Is it going to make it? Is it going to work? Is it going to work technically? When you do the initial license, you don't know what the regulatory hurdles are, and you don't know how good the IP is. However, when the university is working on it from their side, they assume they've got the best thing since hot dogs." (Industry)

"It's totally ludicrous because most of the time, a university in a twenty year period will have one good idea that will result in a good royalty- bearing project." (Industry)

"You have to evaluate whether you want to have a million dollar research contract or come to blows over $100,000 in revenues that you may get in fifty years." (Academia)

"IP is probably the one thing that people waste the most time on. I use the word 'waste' intentionally here. The fact of the matter is that it is very rare for a company to give us a project that is going to generate IP that they are going to be able to turn around and use immediately." (Academia)

"The number of hours that get spent arguing over who's going to get IP rights, how much it's going to cost, how are we going to disclose it to each other, how are going to make sure it doesn't go to anybody else – it's just a tremendous loss of man hours, man years probably, negotiating for what is an extremely small payout for everybody involved. We need to come up with a simple "what we invented is ours, what you invent is yours, and what we invent jointly we own jointly, and we'll give you an option to take a license on something in the rare event that something is of interest to you. That's usually where you end up anyway, but it can take hours and hours of negotiation to get there." (Industry)

"A lot of universities spend too much time worrying about IP. It's a whole lot better to get $500,000 in sponsored research from a company than to get a $100,000 contract and hope that you're going to be able to generate licensing revenues from it. It's a whole lot more certain that you're going to get sponsored research than you're ever going to get licensing income." (Academia)

"There are some times when you are trying to license or buy IP that you get so frustrated you want to say the hell with it. If I'm trying to buy IP that they think is worth $10 million and I think it's worth $200,000, we have a serious problem." (Industry)

"The problem is the unknown. Industry has a difficult time, both time-wise and expense-wise, wrangling IP out of the university. They don't like that unknown aspect of it. A few faculty members get this, but most of them didn't become university faculty because they thought a whole lot about licensing. It is foreign and it's a big hassle." (Academia)

"Why should we battle over intellectual property that we can't possibly put a value on? Because we don't know what it's worth or even if it's going to be worth anything. On the other hand, sometimes we get concerned about not negotiating a commercialization agreement early enough, because once you commercialize something, then all of a sudden it can be harder to negotiate because now you've got the finished product. Things can move a lot faster if we don't spend all of our time trying to figure out the potential commercialization and IP opportunities that can come out of a particular research project." (Academia)

"A lot of start-up companies have a dilemma: you believe you've got the greatest thing ever and you want to retain as much of the IP and potential profit stream as possible. At the same time, the University wants to keep a good chunk of that. The balance of making both parties happy is incredibly important, because if you don't get that right, you can have a very divisive relationship from day one and it will rarely improve."(Academia)

Barrier #2 – University researchers often have difficulty meeting the time tables and schedules required by industry partners, creating issues of accountability and reliability.

> "To make industry happy, you have to communicate carefully what the boundaries are. You have to listen to what is important to them, and then deliver it. You can't take the money and not deliver. With industry, it is more akin to a contract, and you must deliver what you promise." – Steven H. Zeisel, M.D., Ph.D., UNC Nutrition Institute

Industry informants indicated a high level of frustration with academic partners over unmet deadlines and lack of adherence to agreed-upon schedules. They note a perceived lack of urgency on the part of academic partners to meet deadlines or address potential delays with the partner. This difficulty in meeting schedules and deadlines may come in part from a propensity by the academic partner to give priority to NIH and/or other government-funded

projects, which may be more lucrative in the short-term or may often be perceived as a milestone from tenure and promotion. Academic partners, to a lesser degree, expressed frustration about not being able to communicate with their industry partners in a timely manner. A 2000 study by Parellada and Sanroma studied the perceptions by industrialists of academic researchers and found that universities were perceived to have an overly theoretical approach to doing research and that they had clumsy, unresponsive management styles that were not conducive to healthy partnerships (Ankers and Brennen, 2002,16). Academic scientists who partner with industry are likely to find that industry partners will insist upon measurable goals and specific time frames that provide a more precise focus than may be the standard in academic environments. Academic projects which are guided by an external donor tend to "house a culture that focuses on outputs and results and therefore increases the impact of the work that is being supported" (Thorp et al., 2010, 33).

> *"It's both university and industry. I have been called by companies saying 'I can't get an answer from them. When I ask why, I find out it's been a day or two or even a week and they didn't hear from the company for three months. Then I hear times where the university has not responded in a timely fashion either."* (Academia)

> *"There is urgency in timing and deadlines and often companies are frustrated when we ask for a third time extension on the project. Faculty members don't rise to that level of concern."(*Industry*)*

> *"Time is money and I think the universities don't appreciate that at all. If I want something concluded this month and it's not, then it's going to have much less value to me. What is important to me in terms of getting a product to commercialization is not as important to them as getting tenure or getting bigger lab space or getting the next NIH grant. So my interests are kind of at the bottom of the totem pole. That can lead to delays and research milestones not being met."*(Industry)

> *"It comes down to faculty learning to communicate and understand the timetable. Then staying in contact. It doesn't do anybody any good if you call a month after the report is supposed to be there and it's not there and you are angry about it. You should know how to keep in touch with the investigator and keep the calls regular so that you know the reports will be on time."* (Academia)

*"A lot of people don't realize that there is a certain time that something has value and beyond that time it may not have very much value anymore. We know we've got a window of opportunity of maybe two years, and if it isn't done by then, it's not going to matter because something else is going to be out there and we will have lost our competitive advantage." (*Industry*)*

"Sometimes the pace of education and the atrophy associated with it causes the university to be slower than the industrial partner would like. So there is a fine balance of achieving what the industry partner wants but still making the relationship of value to the university's primary mission of education. The timing can get out of kilter based on the disorganization of having new students and getting them up to speed and functional." (Academia)

"Academics, most of the time, don't understand how important it is to deliver and adhere to milestones and agreements they've made in a research plan."(Industry)

"Often there isn't the sense of urgency within an academic program. You will find out, 'well, we were going to put this graduate student on your project, but he's doing another rotation, and so he's not going to be able to start your project until next December'."(Industry)

"Corporations get frustrated when universities don't complete the work on a timely basis, but with some of the research, you don't know what path it's going to take when you agree to launch it. When it takes a path that is not the one you anticipated, it's not surprising that it takes longer than you thought and is not quite as crisp as what the corporation was looking for."(Academia)

Barrier #3 – The culture of academic and industry scientists is inherently different.

"The culture of people who work in industry is very different from those in the academic world: it's a culture where time is everything and getting a product to market and trying to understand an ROI versus the way the university people think, where there aren't those kinds of demands, becomes a very critical barrier." – John Ryals, Ph.D., President and Chief Operating Officer, Metabolon, Inc.

Much has been said about the different cultural values exhibited by industry and academic researchers. Organizational culture can be defined by looking at functional assumptions through values, behavioral norms, and actual patterns of work behavior and customs (Chatman & Jehn, 1994, 524). The backgrounds of academic researchers encourage the exploration of theories and models to explain realities, not necessarily the research that is designed to develop useable and economically viable products and technologies. The two

worlds often clash in understanding the end result, the critical time factors, and the process for development that is being undertaken. Pavitt states (2003, 795): "The main purpose of business research and development is to design and develop producible and useful artifacts. These are often complex, involving numerous components, materials, performance constraints and interactions, and are therefore analytically intractable. Theory and formal models are an insufficient guide to, and predictor of, practice. Knowledge is therefore accumulated through trial and error. As a consequence, the methodologies of 'experiments' in the two types of laboratories are often very different." A study of 400 engineering and science PhD students found that there was a very different cultural attitude in those students who lean toward employment in industry in that there is a diminished interest in pure science and a stronger proclivity toward salary level, access to resources and downstream work as compared to the students who prefer academic careers, who appeared to be more motivated by a desire for independence, the ability to publish, peer recognition, and an interest in basic research (Roach and Sauermann, 2010, 422).

Cultural differences discussed by informants included work ethic and orientation, strategic focus, differing styles in communication, attention to detail, pace of work, risk-taking, flexibility and the ability to work with others and collaborate as part of a team and to work on critical deadlines and timetables. What appeared to be remarkably clear to one partner might mean an entirely different thing to the other partner. What was commonplace in one setting was unusual for the other partner. Performance expectations seemed to mean something to one partner and an entirely different thing to another.

> *"What you are essentially doing is getting people together who really speak different languages. We all speak English but what we actually use as the meaning of a word is quite diverse."* (Industry)

"The culture of the two is so different – it would be very useful if we could just spend the time to figure out what it is that motivates the other side. For universities, researchers believe that people coming from industry are only used to thinking about profit, money. And for industry, they fail to recognize that there are other motivations here at the university. For us, recognition is often times more important than money." (Academia)

"Faculty members are independent artisans. They operate on their own rhythm, and their own cycles, because they are teaching classes, serving on committees, as well as doing research. They have not been in a culture that requires completion deadlines or the types of reporting protocols that industry requires. So it doesn't surprise me that corporations get frustrated when universities don't live up to their expectations." (Academia)

"Partnerships need somebody on each side who can bridge the cultural gaps. You have to actively listen and understand the process and try to understand what the values are on the other side, what the culture is from the other perspective and what the expectations are from the other side. It's very difficult for a pure academic researcher to put himself or herself in an industry researcher's shoes." (Academia)

"I think when you look at the responsibilities of the faculty, even if they are mostly researchers, they still have students, and they have an obligation to nurture those students. That's not to say that people working in industry don't have other responsibilities. The university researchers work more in the mode of independence. They are collaborators, but they are really their own entrepreneurs. 'I am a professor of this, I work on that,' whereas in industry there is always that drive. 'We want to make the best widget in this arena and we want to make money on it.' So that is how they see things differently. There is little top-down instruction in the academic setting and there is much more of that in the industry setting." (Academia)

"We, in business, are sometimes a little more acclimated to be disciplined than those in academia, where things are not necessarily quite as pressured in terms of timing and deliverables. They don't have the same competitive demands that we face." (Industry)

"From a cultural perspective, it wasn't the lack of communication. It was the French talking to the Germans. We didn't understand each other nearly as well as we should have and we didn't understand where the other side was coming from." (Industry)

"It's really a question of whether a faculty member or an administrator has an entrepreneurial vent, has the ability to understand the private sector and has the experience to truly do so. And again, it all comes back around to the cultural thing. The faculty members who work a lot with industry get it. They lay out that time line up front, they meet their benchmark, and they get it done." (Academia)

Industry informants also stated that the culture of communicating research findings was vastly different from that of academic researchers and they generally had a negative

perception of the communication style of academic partners. The most frequent comment related to the use of the writing style, which was described as being grandiose, unnecessarily complicated and filled with technical jargon that was not comprehensible by the user of the information. It was preferred that the style of written communication be more straightforward and more geared toward the results of the research project as opposed to the research process itself.

Barrier #4 – Technology transfer offices are often under-staffed or staffed with individuals who have little experience with the commercialization process, often making the documentation process to establish a partnership cumbersome and lengthy.

> "One of the problems universities have with their tech transfer offices is that they hire people who really don't understand what the commercialization process is all about. They end up continually encumbering the development of technology into a product." – John Ryals, Ph.D., President and Chief Operating Officer, Metabolon, Inc.

The process of documentation involved in memorializing a partnership can often be long, cumbersome and filled with issues that seem difficult to resolve. Academic informants observed a sense of entitlement on the part of industry since they are the funding source of the partnership, and feel that industry negotiators are surprised when the university asks for more aggressive terms. "Research universities ought to worry less about the revenue their tech transfer offices produce and more about how those offices can be used as an instrument for faculty recruitment and retention. By making it easier for faculty to obtain patents and negotiate license deals and spin out companies, the university keeps faculty engaged and connected and therefore less likely to leave. Faculty retention is an important measure in evaluating the effectiveness of a tech transfer office and metrics should e established to determine how well the goal is being achieved" (Thorp, 2010, 35).

> *"A lot of times the company doesn't view us as a peer as far as business-to-business negotiations are concerned, and they feel they shouldn't have to negotiate with the university. The company should just be able to come in and get whatever terms they want, like they are doing us a favor. They are taken aback when we start asking for more and acting businesslike; there is the possibility that we can just walk away from a deal. People think we are difficult to work with. Well, no, we are just acting like anybody who is doing business as usual." (*Academia)

> *"The tech transfer offices overvalue what they have and this is the biggest stumbling block. Many times I hear industry investigators say 'I tried to get this out of the university for five years; I couldn't get my company started because it took so long. I had an agreement with the PI, but I couldn't get the tech transfer office to agree."* (Industry)

Industry informants also describe the academic documentation process as unwieldy, slow, and bureaucratic.

> *"We didn't understand the myriad of numbers of people we would have to go through in the university system. We went to the school, and then it went to the office of grants and literacy, and on up the ranks and then it worked its way back down again. It took us quite a while to get an answer. And they won't do anything without a lawyer documenting the 'who does what, who gets paid when' and all those kinds of things."* (Industry)

Both academic and industry informants point to the fact that tech transfer offices are often grossly understaffed or are staffed with unqualified employees who have little experience with commercialization or technology development. This leads to the frustrating conclusion that the partner either does not understand the technology being negotiated or there is a greater value being attributed to that technology than the other partner deems appropriate. Thorp and Goldstein offer a sobering description of the tech transfer offices in many research universities:

> *"Tech transfer is usually a group of small offices or cubicles and the desks are piled high with thick files of patent applications, license agreements and memoranda from the university counsel. Sitting at the desks are young professionals trained as scientists or engineers who have become adept at evaluating the commercial potential technology of all kinds. They look tired because the office is chronically understaffed and overworked. They are almost always on the telephone mediating between university professors who are convinced their discovery will be worth at least a billion dollars, university administrators who want the institution to get its fair share in the*

unlikely case that the professor is correct and outside business interests convinced it is impossible to enter into a commercially viable relationship with a major research university. It wouldn't be unusual for the head of the office to be huddled in a small conference room, meeting with several university trustees or alumni who have ideas about how tech transfer should reorganize itself to generate more revenue from intellectual property created by the university. You might find the Lucite cubes you are looking for displayed on a shelf in the biggest office in the suite but only because tech transfer effectively accomplished the second function in its name: 'transfer.' Tech transfer usually gets involved at the end of the process once an idea has been created and has become a candidate for enterprise. Despite efforts to assess and reward tech transfer based on the number of patent applications and the amount of revenue generated, the office most often gets involved long after a climate for impactful research has been created – yet, paradoxically, tech transfer is often held accountable for the results of the process" (Thorp, et al., 2010, 39).

"Many tech transfer offices at public institutions or universities are not as far along as they could be. Sometimes it seems as if even the tech transfer people don't understand the university's strategic plan or the more far-reaching opportunities they have." (Industry)

"There are definitely things that are suboptimal as far as turnaround in any organization, especially within the university. We have very full plates in our office. There are five project managers and we each have 250 technologies to manage. It's not uncommon for universities to under-resource tech transfer for the amount of technologies they manage." (Academia)

"Things fall apart because they (the university) think they've got something great and you are trying to explain that it's really early. They come back thinking you are negotiating when that is not really the case. Most of the time, you are just trying to explain that this thing is not worth $5 million out of the box. Some of these guys are better than others, but often you're dealing with a low level manager in the tech transfer office when you are having these negotiations, so it can take a while." (Industry)

"Faculty members had done a lot of talking with the science person in the company. And the science person in the company had likely already engaged their contract person before anybody in either sponsored programs or tech transfer knew what was going on. They were far down the road and we didn't even know if it was acceptable." (Academia)

The partnership document itself is often complicated and the process of finalizing the legal documentation is tedious. Often the agreement is full of legalese and contemplates every conceivable possibility, to the detriment of the execution of the agreement. Informants from all categories felt the documents are more designed to protect against future liability

and disputes than to facilitate an active and robust research agenda. The negotiations were described as being more about the documentation than the technology.

> *"There are all kinds of boiler plate documents out there but almost none of them work. I've spent a lot of time on this in my career. Everybody complains about it, and if you ask whose fault it is, it's about one-third the academic institution, one- third industry and one-third the investigators themselves."* (Industry)

> *"From the point of view of the university board of trustees, they could care less about each individual contract. The lawyers are typically hired to protect the university from a disastrous event. If it slows things down, or takes forever, that's not their problem. They don't get rewarded for getting more contracts done. They get rewarded for protecting the university."* (Academia)

> *"On the industry side, it has gotten more and more complicated. In the past, they would keep hiring different lawyers who would forget everything that had happened in the past and we would have to start over with every contract. They would try to sneak things in that would be in favor of the company."* (Academia)

Barrier #5 – Unrealistic expectations, due to a lack of clarity of goals and objectives, time frames and other deliverables, often cause the relationship to collapse.

> "Controlling expectations is a huge part of building the relationship, so that you are not setting yourself up for disappointment or frustration, or having your partner say, 'that's not at all what I thought we were getting, because nobody ever communicated it to me,' and then finding that you will never get another chance with that partner again." – Connie Armentrout, Director, Technology Licensing, Monsanto Company

Both academic and industry informants report a break-down in the partnership relationship as a result of a failure to understand what is expected from each partner. Often this takes the form of missing project deadlines, not properly understanding the research protocol, or simply not adequately communicating the project's goals and objectives. The clash of different organizational methods and culture of the two partners may also result in conflicting management styles in developing and managing the research project. The expectations of the results of the partnership can and often are quite different, leaving partners frustrated and without the desire to continue the research initiative.

"I've actually found that in some cases the professor really doesn't even know what's in the contract because you talked to him and got some general terms, and then you started working with the university's counsel and get the agreement signed. Then as you get further into the project, there can be misunderstanding because it turns out the professor really wasn't concerned about the legal terms. He was just trying to get through them, get his research dollars and get to work. He really wasn't focused at all on what the contents of the contract were all about." (Industry)

"I think the biggest problem has been that the expectations are not clearly mapped out on both sides by the partners." (Academia)

"People didn't realize how big the gulf was between the complexity of the problem and the gulf of the disciplines they were trying to bring together. The expectations were much greater than what was possible to achieve." (Industry)

"Half the time the data that you generate is not what is expected. And this is where it has to do with the maturity of the investigator. You should contact the partner immediately and let that person know that the data is sending you in a different direction or giving you an early answer that's not what you expected. What often happens is people are afraid of losing their money and they say anything until the end. You have to manage the relationship, keep in touch and send signals that things are not going the way you thought. We won't be able to make the deliverable the way you want. Or the data we generated just actually disproves your idea completely. Because it it's an honest, credible answer, the corporations understand that." (Academia)

"Expectations and milestones. I just wanted to know what they expected and to understand whether or not I could achieve them." (Academia)

Because of the difference in orientation that academic and industry scientists bring to a project, the motivation for doing the project, as well as the expectation of the end results, may have different meaning to the two partners.

"There are investigators who think there are companies that want to put money into something just because the investigator has an interest. In a successful agreement, the investigator is able to communicate where the practical application is so if you discover something in basic science and it becomes a useful platform for screening future active agents that can become products, a company can understand that and see the benefit to them. But just to say 'let's run some basic science because it's interesting' is hard. That doesn't identify any target for the company to see as an opportunity for business success." (Industry)

Unmet expectations are often the result of a lack of clear channels of communication on the part of both partners and the inability to understand the perspective and views of the other side.

> *"Often we don't understand the limitations and expectations of the other side. You have to appreciate the other side's point of view. You have to be willing to try and find solutions that are going to work for both sides."* (Industry)

> *"We would do a better job if we trained our young faculty what industry expects in a relationship. Things like communicating with them, having specific goals, determining what the right personnel to hire for an agreement, budgeting the agreement, and just good management practices."* (Academia)

> *"You just can't talk about this enough. There are usually multiple entities you interact with in the organization. You have to understand the interaction between the various people you are working within the organization. Some of them might have a different perspective, and you hope that within the organization, they are communicating clearly. But with all the people you have to interact with in the organization, you need to make sure that one person doesn't speak for the entire organization. You have to make sure that all the players you interact with know what the expectations are, what the deliverables are and what their level of freedom to do the research is."* (Industry)

> *"Understanding the limitations and expectations from the other partner is very important. Like any sort of two-sided deal, the more you can appreciate the other side's view point and be willing to try and find solutions that are going to work, the more successful you will be."* (Academia)

Often the two partners have different perspectives on the schedule of the research project, milestones for progress and deadlines for deliverables and project completion.

> *"We gave you this money six months ago and you haven't started doing anything yet? That kind of thing happens a lot, and really tends to be just a difference in how people are thinking and the different expectations. The key is to make these issues clear ahead of time."* (Industry)

> *"Expectations and milestones are very important. I want to know what they expect from me and whether or not I can achieve that. It's not a successful partnership to me if I get one or two years of funding and then it ends. I always want to know what the milestones and goals are. I need to be able to figure out what it would take to go beyond this project and continue on with another one. Even before I have the first project in hand, I try to look down the road with the understanding of the sponsor's expectations so that I can begin looking at the next generation of problems or opportunities."* (Academia)

In his or her zeal to establish a partnership, a partner may often over-promise and under-deliver on performance goals, time schedules and potential research results. Conflicts of interest can arise when academic partners feel they must agree to certain predetermined results that they believe are desired by the industry partner. They may also feel the need to

agree to a time schedule that is more aggressive than they feel is required in order to perform the tasks necessary or to perform the quality of work that should be accomplished. Careful consideration should be given by each side of the partnership during the development of the research agenda to assure that no compromise is made that would threaten the integrity of the partnership.

> *"You have to be upfront about what you can and can't offer and you just have to make sure that you strike that balance. You have to make sure that everybody is as informed as they can be and understands what has been discussed, what might be a possibility and where that line is. When you are excited about what somebody wants to accomplish, it's very easy to fall into the trap of just trying to make them happy. You don't want to lead someone down a road where he is not going to succeed and have him disappointed."* (Academia)

Barrier #6 - Overhead rates are a source of misunderstanding and misinterpretation and greater transparency is needed to avoid potential conflicts.

> "Industry needs to understand how overhead revenue is distributed by the universities such that the benefits to both parties are readily apparent." – Connie Armentrout, Director, Technology Licensing, Monsanto Company

Academic partners often maintain that the NIH and other federal funding agencies will not permit them to vary overhead rates for industry funded projects versus federally funded grants, restricting any flexibility they might have to negotiate favorable agreements with potential industry partners. Overhead rates can vary dramatically from institution to institution, and the complex formulas used to calculate these formulas are often the source of confusion and misinterpretation by companies with whom these universities do business. Some academic informants reported that they are required by their universities to charge at least the same overhead rate to private companies as they do for grant funding they receive from the federal government, so as to make the grant funding received equitable between public and private sources. Other academic informants felt that this requirement by the

federal government gives certain academic institutions with lower overhead rates an unfair advantage over others in terms of being able to attract private research investment. One informant commented that the federal government's control over establishing acceptable, predetermined overhead rates gives the university little incentive to control costs. In fact, if the university overspends, they may even be afforded an advantage on future rate negotiations because they can point to the high cost of doing federal research.

Industry informants discussed the murkiness and lack of clarity of the overhead rates that are charged by their university partners. Some industry informants reported that, upon making inquiries as to how overhead rates had been established, they were told this information was proprietary and that the university would not disclose what expenses the rate included. Upon closer examination, it was not the overhead rates themselves that were the issue; industry partners perceived these rates to be confusing, not justifiable and not quantifiable. Industry informants reported that they had no problem paying overhead rates, but would like to see more transparency in terms of what comprises overhead costs, how these costs were calculated and how overhead funds can be used.

> *"I think if the university could come up with a way to be more transparent about why there is overhead, first and foremost, and then explain where it goes, and how it contributes to the research project, then the question would eventually go away."* (Industry)

> *"Overhead rates seem to be perceived as more of an obstacle than they really are, but I will caveat that by saying that if rates are explained property, then there is no problem. People I have talked to in industry say 'we don't mind paying overhead, but we want to know what it is, and we want it to be transparent.' They want to know what their costs are, and when it's a big scary number and nobody can explain it that is the issue."* (Academia)

> *"Universities need to be a little more open about what they do with the overhead. They need to be more transparent. Transparent is a big word at our company. I will grant you that your definition of transparency is different than mine, but we still use transparent as a really cool word. So universities should just be a little more transparent about what they use that money for."* (Industry)

"Most people in academia still don't understand this. If you go to XYZ Company and you say,' okay, the direct cost of this research is a million bucks and our indirect cost rate is 54% so it's going to cost you $1,544,000 to do this research', they'd become hysterical. If you go to XYZ Corporation and say, 'we have an employee base that has this amount of labor costs, we have management costs, we have a gross margin and a net margin and our cost per employee plus supplies totals $1,544,000 to do this research, and here's how we got to that number', then they say 'well, gee, that makes an awful lot of sense.' So is it all about the term 'overhead rate' or is it just a matter of being transparent with people and not trying to gook it all up with this number that they don't understand?" (Industry)

"We hate to have to go in and start negotiating overhead every time we work on signing another contract. It seems that everybody is unique and every university has its own rate. This just makes it more challenging for us to do business. We end up spending our time trying to negotiate that stuff which is in my mind a little bit of a waste of our time. And there is a lot of variation. So you can't just look at what a university says their overhead is and assume that's the rate you're going to get. Because you can often times end up striking some deal that's better and that can be pretty significant because this is the kind of thing that can really affect the long term relationship." (Industry)

Academic informants indicated that often they feel industry informants think that because it's the university they are partnering with, and not a commercial enterprise, they should get a cheaper price, and that overhead rates are unfair and excessive.

"It just costs what it costs. Companies have mark-ups and margins; they have to pay bills, too. The universities have set rates that are established when we have federal funding, and we have to charge for things that we have to pay for ourselves." (Academia)

"If you're on the industry side of things, you are getting a discounted rate, almost a subsidized rate, for your sponsored research here. You are getting the benefit of all of our facilities, our faculty and our students and you are paying a lot less than you would for a contract research organization with the same kind of arrangement. So the company benefits, and at the same time, the university benefits because we get the funding and resources to educate our students and continue to be leaders in the development of new technologies." (Academia)

"I understand how the money is being used, and so I take the time and make every effort I can to educate the people within our company about what that money is used for, so hopefully it's not as irritating as it is for those folks who just don't get it. I remind my industry colleagues that there is no way on earth they would go out and do research for another organization without having some profit margin added in." (Industry)

Some industry informants indicated that they had become so frustrated with the high overhead rates being charged that they look for ways to enter partnerships that will not require an overhead allocation, such as grants, gifts or other types of contributions in return for being able to influence the research agenda. Both industry and academic partners can face potential ethical issues when the distaste for paying for indirect costs through overhead rates causes partners to look for ways around university regulations and government requirements to fund research initiatives.

> *"We find ways to get around the issues with overhead rates when we can – so it's basically a gift; a contribution to the university. It gets me there faster and I don't have to pay all of the extra charges. We have even had professors do a certain amount of consulting on the side in order to avoid paying these charges."* (Industry)

> *"We've had some programs in which I've given the professor an annual gift for work that's being done. It's in the form of a gift and therefore it sort of gets you around that overhead."* (Industry)

Industry informants state the need for clarity and accountability. There have been occasions where they felt overhead charges were used to pay for costs that had nothing to do with the specific research project but were directed toward other purposes.

> *"It's not a contentious issue if the overhead is really going to the overhead of your project and not being spent elsewhere. We've had situations where we paid for equipment like sequencing machines that were needed, but when the project was over, you don't see them anymore. And we paid to upfit space and for capital improvements or other building improvements, which is kind of silly."* (Industry)

> *"We look carefully at how labor and costs are allocated to that specific project. There've been a lot of examples out there where investigators have put things in their proposal that really weren't specific to our particular project."* (Industry)

Barrier #7 – Partnerships will not survive if the publication rights of either faculty or students are jeopardized.

> "You have to protect publication rights because of the students. If students can't publish, it's going to make it very difficult for them to enhance their reputations in the academic world and in the job market. So there have to be agreements in place that state how long information can be embargoed before it can be published. Your first responsibility has to be to the students of the university." – Tony G. Waldrop, Ph.D., Provost, University of Central Florida

Academic informants indicate that this is a problem which has diminished in recent years. However, it is perceived as a "non-starter" by most of the academic informants who were interviewed. The ability to publish freely and without limitations is a critical component to the world of academic researchers and if this right is inhibited by the partnership, the relationship cannot exist. However, the pressure that some academic researchers can feel to write grants and obtain external funding for the operation of their labs could potentially create conflicts of interest in this area if agreements are made to delay publication of research findings in order to accommodate the commercial goals of the industry partner at the expense of academic freedom and the need for both faculty and students to publish. A clear understanding of the embargo that industry places on the disclosure of research results must be delineated at the onset of the partnership in order to avoid these conflicts and misunderstandings.

> *"People really have to gauge the impact and outcome of publishing as it relates to timing. Clearly there are areas in which delaying publication is not acceptable if you are going to advance your science."* (Academia)

> *"In the world of academia you might have lower salaries but we come here because of the freedom to pursue our dreams and our research interests. The ability to publish and to have that outreach to the world is critical. This is our currency, and we are judged by our peers, the administrators and our deans on the quality and quantity of our publications and presentations."* (Academia)

> *"Universities must maintain their ability to publish freely. Most researchers are willing to accept some time limitations to give the company time to review the information. But from the university's perspective, this is a deal-breaker. There has to be that ability to publish."* (Academia)

Both academic and industry informants indicate that this is an issue that must be addressed at the onset of the partnership. Clearly delineating the restrictions on the release of information and the timeframe for doing so can alleviate the frustrations which can arise from the discussions.

> *"The challenge is figuring out what we are willing to let be published and to make sure that the university feels that they are able to get out of the relationship what they need other than just monetary remuneration." (*Industry*)*

> *"With every relationship you have to figure out 'what is it that is okay for a graduate student or post doc to publish? What is it that you would like to manage internally?' With different universities the rules can be very, very different in terms of ownership of that information." (*Industry*)*

> *"This can be one of the stickiest points. Very often there is something very proprietary in what you're doing. Yet at the same time you recognize that the university needs to publish that work. So it's really good if you can sit down ahead of time and do a good job defining that space so that everybody can be happy about the outcome." (*Industry*)*

> *"Clearly this is an issue that needs to be discussed upfront and worked out. A three month delay is not unreasonable. Potentially even a six month delay is not unreasonable. It has to be considered case by case."*(Industry)

8.2.1 Case perspective #1

When research findings and industry expectations clash[4]

Dr. Jonathan Simone is a respected researcher at a mid-sized university not known for its prowess in research but respected in other areas of curriculum and education. Due to his own publication success and strong industry connections, he has developed a good

[4] All names and places appearing in this case perspective are fictitious. Any resemblance to real places or real persons, living or dead, is purely coincidental.

reputation for working with industry and has been successful in avoiding many of the pitfalls that some of the larger, more bureaucratic institutions have reportedly encountered with such relationships. In fact, Dr. Simone has managed to bring in over $6 million in research funding since the early 1990's to a university not generally recognized for its research capabilities. Members of his department credit Dr. Simone for building a reputation with his field of nutrition and for his ability to develop attract research projects that would typically be awarded to more prominent universities.

What sets Dr. Simone apart in his ability to partner with industry? "Relationships," commented Dr. Simone. "Whether you are talking about relationships with companies or relationships with individuals, it's critical to make sure that you are living up to expectations with your partner and that with every individual project in which you participate you are still focused on looking toward the long term relationship. We want the company to think of us first when they start a new project, so we always focus on developing that strong personal relationship." According to Dr. Simone, his long term relationships with several industries initially began because of his scientific papers, as he has averaged about one paper per month since the early 1990's. "It's all industry related research," says Dr. Simone, "and there are always some people who think, 'well, if you do industry related research it is not high quality enough for publication or you aren't able to peruse the scientific questions consistently.' I think that is just nonsense." Dr. Simone says he has managed to work within a system that is sometimes contentious and irritating to industry. But more than anything, he says that learning to take the long term approach to a partnership is the most important lesson learned in his journey. "I have had companies come to me to talk about their research and I listen to them and give them

advice but they didn't have the money to do the trials. I had one company that finally got ten million in investor money and then suddenly we were off and running. But if hadn't sat and patiently listened to this guy for ten years then we wouldn't have eventually gotten the funding to do the work with them."

While there are always potentially contentious issues that arise, Dr. Simone says that for the most part he has experienced a real desire from the companies with which he has worked to uncover the truth about their research initiative. "When I worked with some of my best partners, they honored academic freedom. We could publish our results – negative, positive, whatever. They wanted to know the truth. They didn't want to push forward with any product other than something that would actually benefit the consumer, something that really, really worked. And they had some of the best scientists in the world working with them - every top guy from every country. So there is no way that they were not going to advance the truth. It's interesting, because there was even an article in the Wall Street Journal about this company that said one of the reasons for their success was because they actually had good science behind their product."However, early in his career, Dr. Simone experienced a dilemma that tested his reputation as a scientist and a faculty member. "About ten years ago I did a study with a well-known food corporation (Company X), who as you know has a popular breakfast cereal for kids. It was one of their top brands at the time. The company had what they called an immune nutrient mix and they wanted me to test it in children eating two cups of the cereal daily versus children not eating the cereal. It was a double blind study that extended over a two month period in the winter. The hypothesis was that the cereal would help reduce infections by strengthening the immune system of the growing children." "First of all,

we knocked ourselves out in that study. It was a high level study and had never been done before. We did a multitude of immune assays and infection monitoring and the data were of very high scientific value. We did a great study, and when we finished the results, it was a very difficult situation. The immune mix in the cereal just didn't do anything for the children. We did every immune function test imaginable, and there were absolutely no differences in the control group and the placebo group."

The contract that the university had entered into with Company X had been negotiated through a third party consultant. Dr. Simone and the consultant had developed a strong personal relationship and both were stunned when they were told by the company that not only was the study not going to go forward, but that their interpretation of the contract was that they had the right to forbid the university from publishing their conclusions. The consultant was particularly surprised by the company's position as he had met on the campus with Dr. Simone, the tech transfer office's legal counsel, and others within the department. The discussions and the contract clearly gave the university academic freedom. This forced Dr. Simone to face a difficult decision. While there was a signed agreement giving him the academic freedom to publish, he recognized that he was jeopardizing a potentially lucrative and long-term collaboration with a well-known and powerful corporate partner. "They were a big company. They had all their attorneys working on this." And to further complicate the discussions, suddenly the consultant with whom Dr. Simone had negotiated was no longer representing the company.

Dr. Simone met with university administration, who concluded that the university could not afford to fight this large corporation on an issue that would most certainly

involve costly litigation with less than certain results. Although Dr. Simone believed that his contract did in fact give him the right to publish, he, after much consternation, came to the conclusion that since there was nothing potentially harmful to consumers in the study, he would not publish his results. In his opinion, there was nothing to be gained in angering a potentially long-term partner over the publication of one study.

Because of Dr. Simone's focus on long-term partnerships, this particular situation was vindicated due to a curious turn of events. Ten years after the study was completed Dr. Simone ran into one of the collaborators in the original study and he pulled him aside and asked if they company would revisit the situation and allow him to publish his findings. He agreed. Dr. Simone received an email a few weeks later saying that the company had decided to go ahead and allow him to release his research findings. The rationale for this decision was not completely charitable. One of Company X's major competitors had just launched a popular advertising campaign in which they touted a nutrient mix that could support the immune system against influenza. The company had just been named in a lawsuit and had received a slap on the hand from the Food and Drug Association due to the fact that this claim on their cereal boxes saying that their product would "help you get through the flu season a little healthier" represented a false and unsupported health claim by the company. Dr. Simone was able to publish his results, albeit ten years later in a study funded by Company X, saying there was no connection between the cereal product and immune system protection. The company had a big win because they were able to state that their chief competitor was making false claims about a product that had no scientific proof. And they were able to take it a step farther and say that they had proved themselves that the claim was false. "I did feel vindicated in some

respects when the study was published saying that we had shown that the immune system was not improved and that risk of infection was not lowered with these kind of immune nutrients. However, companies should never block scientific progress. The university system has made it clear now that a contract cannot be signed unless there is full academic freedom," stated Dr. Simone.

Dr. Simone, because of his ability to see the big picture and understand the importance of a long term collaborative relationship, was able to maintain a partnership with Company X that has funded his research on multiple occasions over the years. The relationship and the collaborative model they established still exist over ten years after the initial partnership project.

In a separate research relationship with a well-known international food company, Dr. Simone did a study which, although contrary to the company's original hypothesis, showed no correlation between the daily consumption of bananas and a lower incidence of cardiovascular risk factors. Dr. Simone did not publish the results of this study. His rationale? He felt that even though this study did not show positive results, bananas did not offer any negative health benefit and, in fact, offer many other nutritional benefits. "The study would have hurt the company, and I was convinced that a much longer term study might have had a different outcome. We have an ongoing relationship with this company and we are doing regular studies together, and for me the whole context of the cardiovascular study was to learn about things for the future. You have to be able to be astute enough to understand that academic freedom needs to be practiced within the context of longer term relationships with companies."

While fully acknowledging that the university will not allow researchers to execute any contract that does not permit total academic freedom, Dr. Simone crystallizes this point with his contact at the company in the context of a partnership. “I tell the primary investigator that we are going to work together on this. I’m going to show him the data. We are going to be very transparent and open and we are going to learn from this. And if, in the end, the data are simply going to hurt you badly and we learn from this and decide to continue the research into another phase or look at the data in a different way, they know I’m not out to hurt them. And that one distinction of working as a partner – that is the thing that sets us up to enter into another contract with them or work with them in taking a second look at their data.”

Dr. Simone sites yet another situation involving research he performed for a medical device company. The company had developed a handheld device that measured an individual’s metabolism. The first validation study showed that the sensors had a problem. The sensors degraded over time, so that by the fourth week of the study it had degraded to the point of total ineffectiveness. “I could have published that. It would have destroyed the company. But the company said, ‘Okay, we learned. Let us redo the study with some new software that they developed to control the degradation.’ We redid the study and it worked. We published the results of that study. And that’s how I look at this – we are in the business of publishing data to advance science. But once again, we have to use common sense as we apply that to the bigger picture. It takes repeat studies and sometimes looking at the data from another angle. Without industry funding, there would be no study. And so you don’t turn off the company by publishing something that really could be just step one in the longer process of scientific discovery. In the end, I simply

want to know the truth about any issue. It just takes time to sort out the truth," commented Dr. Simone. About his experiences, he commented, "You can hope you have a cure for cancer or a benefit of a food for cholesterol reduction or other disease prevention, and sometimes it doesn't happen. Sometimes in writing up the results of that study, there are broader implications or interpretations and I think we don't have control obviously on the final results. The company might provide input on the design of the study and set that up, but the researchers write it up. Sometimes I think industry, and they have to get better at this, has to close its eyes, take a deep breath, and say the chips may not always fall on the side we want them to be, but we need to understand that and be better prepared for that."

Barrier #8 – A change in personnel among either side of the partnership threatens the continuity of the research initiative.

"You have to be strategic and elevate the relationship in the organization beyond the individual level so that staff changes don't throw a wrench in your relationship." – President Steven Leath, Ph.D., Iowa State University

Academic and industry informants report that the tendency for researchers from both sides of the partnership move around to different positions in different companies causes a discontinuity in the research project. Priorities can shift in the face of new management and leadership that may occur as a part of merger and acquisition activity. Informants report that there is a need to develop stronger alliances with more than one member of the partnering organization in order to keep the strategic commitment strong and not too dependent on a single individual.

"We have deals fall through where we've been negotiating or we've been working with one person and then they leave or move on. We have to start fresh with somebody new who hasn't been excited or who even knows about the partnership, or who doesn't understand or believe that there is value in partnering with the university." (Academia)

"It is very common in working with industry that we spend a lot of time developing the relationship, then that person moves on, and there is no one who fills the vacuum or even has any history of remembering the relationship" (Industry)

"The trouble with working with industry is that people move around a lot, much more than in academia. So often you do all that cultivation and they move to a new position. The nice part is that they almost never leave the related industry and the end up as a director of research of another company and you can resume the relationship. Usually it is very worthwhile to cultivate that relationship." (Academia)

"Often it's difficult because you start working with a researcher within a company, and because companies like to move people around, all of a sudden you find yourself working with somebody new and either they don't have the same passion for that particular research objective or research initiative, or it just sort of falls through the cracks and they are left floundering. This is a legitimate complaint. It happens a lot." (Academia)

"It's different now than it was fifteen or twenty years ago. What's happened in industry is that people don't stay in companies. It used to be that if you worked for XYZ Company, you could count on the same person being five or ten years later, so you built trust in the company. The probability that the person you are dealing with will be there 2 years from now is pretty low, so what you have to do is build trust with people and then you work with them wherever you go." (Academia)

"A major problem occurs when a partner who had something important to contribute ends up leaving his company or leaving his position and then the availability of that resource changes and the new person doesn't have the appetite for it." (Industry)

"One of the biggest obstacles is that there is so much movement of people in industry. You could find you're involved in a project and then all of a sudden that person is transferred and the new person either has a different perspective, they're not interested in the same thing, or their whole research initiative is different, and it can cause things to just totally fall apart." (Academia)

Barrier #9 – Changing priorities by either side of the partnership may threaten the research initiatives by making the project irrelevant.

"Research projects in industry can start and stop based on changes in strategies, either portfolio-based or due to company direction. These changes in strategic direction are beyond a research project's control and can at times happen quickly, and beyond the project team's control." – Michael A. Luther, Ph.D., Senior Vice President, Charles River Laboratories

Depending on the length of the research project, market demands, competition or change in direction or in management, there is the potential that the industry partner may change its strategic focus, making the current research project uninteresting to the company. Many factors can contribute to the change in strategic focus, including internal restructuring as well as merger and acquisition activity. While this is unavoidable and difficult to anticipate, maintaining strong interpersonal ties with industry partners and building long term relationships with the industry partner can assure the academic researcher that there is the probability of additional research in the future.

> "*You get so far along in a project and then there is a change in focus and all of a sudden the company doesn't have the same interest and the project dies on the vine."* (Industry)
>
> *"Things are handed off, and a lot of projects don't go into the third or fourth year because the technical interest of the company has changed."* (Academia)
>
> *"The company alleged that the university had dragged its feet so long in negotiations that the market had changed and they no longer were interested in that particular area of research."* (Academia)
>
> *"She (the partner) did some good work, but none of it ended up being really relevant to us. The priorities changed. We had to say, 'you know, we're sorry, but we are interested in this area, not that area'. And so she was just kind of left to try to figure it out."* (Industry)
>
> *"I would have to say that a change in strategic direction can be very detrimental. You need to have one clear aim when you are moving forward. We had the time, the determination and the dedication of our scientists and the leaders who were working on the partnership. And we all saw the benefits. But unfortunately, politics took a hold and there was a complete change in strategy from the top leaders."* (Industry)
>
> *"Sometimes things just happen on the inside that you have no control over. The strategy changes and that can happen no matter if you are doing a good job or you are right on target with your milestones."* (Academia)
>
> *"You get a new person who is hired and they either have a different perspective, they're not interested in the same thing, their research initiative is different, and this can cause things to just totally fall apart."* (Academia)
>
> *"When I tell someone I need to get something signed by our year's end in order to get the money or the money is lost, I'm telling them the truth, because that is really what will happen. Our focus changes from year to year with our market goals and objectives, and we may decide to go down a different path."* (Industry)

Barrier #10 – Internal issues and intra-organizational struggles, conflicts and shifts of power may hinder the execution of the project goals and strategies. Bureaucracy, either with the university hierarchy or the corporate organizational structure, makes it difficult to communicate issues and problems.

> "It's very difficult getting through the university bureaucracy. You're dealing with a scientist, his dean then going through the provost and the leadership of the university. Sometimes I think people just get fed up and they throw up their hands and say it's not worth the hassle." – Judy Heylmun, Vice President, Strategic Business Development, Sensory Spectrum

Both industry and academic partners become frustrated when there is not a clear chain of command for the research initiative. It complicates the process when there is not clarity as to who should receive periodic milestone reports or who to go to if there are questions or issues to resolve. There may even be conflicting agendas or objectives within the partner organizations. Both partners reported "researchers telling management how to do their job," and complained that partners did not meet deadlines or complete the research within budget. When these problems arose, there was no clear indication of how to resolve them in a meaningful way.

> *"When we're working on deals supporting clinical trials for pharma companies, many of these pharma companies have outsourcing procurement departments that are run by really young, inexperienced MBAs fresh out of grad school without technical backgrounds. Often they don't have a good operational knowledge of their own company. And they certainly don't understand the complexities of the science behind supporting drug development. So when they get a protocol from their scientists and they're trying to be the gate keeper they don't understand how to have a scientific dialogue and work through the issues with us."* (Academia)

> *"The academic partnerships create so many hurdles that unless you are really determined to make it work, you get to the point where you are so disgusted you are ready to throw your hands up and walk away. You think they want to move on it, and the researchers do, but it's that bureaucratic apparatus of the university system with no identifiable person to talk to who can make the final decision. And if I ask who is holding up this project at the university level, no one can tell me. They can't give me a name, they just say it's moved up the chain, but it may be here or it could be there."* (Industry)

Academic informants indicate that within the university institution itself there is often a lack of communication and coordination with respect to research projects, potential partners or strategic direction.

> *"I can see it being a real challenge for companies saying 'I thought I was talking to the right person but now they have handed me off to a whole new group of people within the university."*(Academia)

> *"The problem we have had is that we had some advocate really pushing for us to do a project, but there were many other layers of people involved who were so distant from the science itself, or maybe they were too worried about how the project would impact them. There were just too many people making decisions or we were just working with lower level people with no authority. There was no emotional investment, no intellectual investment. They would just look at it like 'if this works, we can make X amount of money and that was it.' To some degree you have to have some flexibility and a way to work out issues with your partner, and there was none at all."* (Academia)

> *"It's frustrating in situations where a drug company wants to have a drug they want tested in a given patient population and they send it to whoever they think is the right person and they don't get a call back. Then the IRB takes six months and then the contracts start and that takes another six months. They can't get any sense of enthusiasm or urgency from us. You lose opportunities there."* (Academia)

Interorganizational procedures and conflicting management styles differ in academia and industry. And although both partners acknowledge that the interactions between them has become more subject to formal, contractual discussions, academic and industry partners tend to have different operational routines and practices . Both partners advocate for a convergence in attitudes, common management practices, and a mutual understanding of the nature of the research initiative and the methods employed in order to achieve the goals of the both partners.

> *"The system in the university is not streamlined in a way that allows things to be moved along as part of a process. I got so frustrated when I was at XYZ University that I found the fastest way to get anything done was to put it my hand, walk it to the provost's office, and say 'I need this today and I will stand here and wait on it until you bring it back to me'. Because if I put it into the system, I may never get an answer. It got stuck in the system."*(Industry)

> *"The university system needs to work on its cumbersome and burdensome bureaucratic process and insane rules. The aspects of contract management are extremely bureaucratic. Nobody can give you a yes and you can be sure that somebody above them is going to give you a no."* (Industry)

Silos exist within the universities that discourage open dialogue regarding on-going research. Cross-disciplinary initiatives are often stymied as a result of the proprietary attitudes of some faculty members. Companies seeking to partner with the brightest and best that the university has to offer benefit from the cooperation that extends across departments and various disciplines.

> *"It is essential for us to get different units within the university talking to each other about their relationships with these industries. Often industry partners find that we are discombobulated in this way."* (Academia)

> *"Academic scientists may like each other as colleagues, and they may go to each other's seminars, but they're really not working toward common goals with respect to the university. And it creates this little microcosm of competition between different academic labs. The problem is that when you try to tie those things together with some sort of structure and process, now you're involving yet another player, the tech transfer office, which is trying to work towards a common goal but also trying to get money for the university. The academic investigators and the inventors are always a little skeptical of them. And you know there's a few of them who feel they have been cut out of the deal somehow. So navigating that piece of it on the academic side is very challenging."* (Industry)

> *"You think that people communicate, but just because they work in the same institution, they don't necessarily share the information they have. If we could get rid of the siloing, I wonder how many more partnerships might be formed if everybody was just talking to each other."* (Academia)

*"*High impact innovation requires an entrepreneurial mindset that views big problems as big opportunities. Academics still too often equate entrepreneurship with opportunism or commercialization in a pejorative way" (Thorp et al., 2010, 6).

Barrier #11- Confidentiality issues may impact the development of partnerships because of the fear that proprietary information may not be adequately protected.

> "Companies start from the standpoint that everything is confidential except what they say is not. Universities start from the standpoint that nothing is confidential except the things that really are." – Elaine L. Brock, J.D., M.S.H.A., Research and Sponsored Projects, University of Michigan

Industry informants expressed concern over the inability to control potentially sensitive or proprietary information that is being shared with their academic partners. The concern did not seem to be directed toward the academic faculty partner, but related to the ability to control the type and amount of information that was shared with junior faculty, research staff, post docs and students who are working on the periphery of the research.

Academic informants feel the pressure of balancing the university's mission of open innovation and educating students with the proprietary nature of contract work commissioned by industry partners.

> *"I have a fear of working with graduate students because I was exposed to all the information that was propriety to the company and of course everyone talks. Confidentiality is an acute issue."* (Academia)

> *"There's a huge divide between what we believed was confidentiality and what the university defined as confidentiality."* (Industry)

> *"We accept confidential research on an absolute needed basis. We promise to put forth the best faith effort to keep it confidential, but it's a challenge when you have so many different people working on a project. It's not an intentional breach, but students like to talk about their work."* (Academia)

> *"Sometimes the whole confidentiality issue will come back to bite us. And often it's a problem on our (the university's) end. There's a confidentiality clause, sure, but then some faculty member will write a poster and go to a meeting and blurt it all out."* (Academia)

> *"So there have been cases when confidentiality was a problem when it really shouldn't have been. And that was really the fault of the people involved with the negotiations. Because you can insist on confidentiality in certain areas and if someone signs then they commit to that. So it's all a matter of dotting the I's and crossing the T's in a timely and careful fashion."* (Industry)

Barrier #12 – The University's mission of providing academic freedom to its faculty and students to perform basic research cannot be compromised.

> "Researchers come to academia because of the freedom and ability to pursue their dreams and their research interests. We have to have the ability to publish and be able to extend those findings out into the world. That is our currency and our superiors on the main campus, our deans and our peers judge us by our publications, our grants, and our national and international invited presentations." – Mary Ann Lila, Ph.D., Director, North Carolina State University Plants for Human Health Institute

Academic informants report that the university researchers who are involved in academic-industry partnerships understand the boundaries that exist and which must be protected in order to preserve the university enterprise as a safe haven for open and free-spirited debate and discovery.

> *"There's no doubt that if you actually look at the faculty who are getting involved with corporate partnerships, they have become much more mature and knowledgeable over time. If you look at the faculty as a whole, there are still those who would have some of the antiquated ideas of 'let's not get involved with corporations and get our hands dirty. We don't want to do this because it will spoil academic freedom.' But the people who are working with industry and who have good ideas and want to do research are pretty in tune with the times now."* (Academia)

> *"The agreement they sent to us was a total squelch of any kind of publication with no ongoing rights to use the data. So when I saw the agreement, I sat down and told her we wouldn't be able to take the data to the NIH down the road. She went to the Dean and was very, very upset with me. But we were just too far down the road. She had already given them everything they wanted and there was nothing I could do."* (Academia)

> *"The publication rights are nearly always sticking points because these guys get tenure and get paid on how many publications they have."* (Industry)

> *"You have to protect publication rights primarily because of students. If they can't publish, then it is going to make it difficult for them to get their first jobs. So there has to be some agreement as far as how long something can be embargoed before they can publish."* (Academia)

> *"I absolutely must have editorial rights over our publications. I can't have the company stopping people from putting things in their theses. All these are serious show stoppers for us."* (Academia)

"There are an awful lot of companies out there that want to try to control the publications." (Industry)

"In most academic-industry collaborations you have the industry partners saying 'don't let any people know this, you can't publish,' and, of course, all we want to do is publish! That is what we have to do, because students' careers depend on having their papers published in good journals." (Academia)

"The challenge, then, is figuring out what is it that we're willing to let be published. And we need to make sure that the university program, as a result of the publications, is able to get what they need out of this relationship other than just money."(Industry)

"And with every relationship you have to kind of figure that out. What is it that is ok for a graduate student or postdoc to publish? What is it that you'd like to manage internally? And then with different universities the rules can be very, very different in terms of what they will allow you to do." (Industry)

"The issue of how long you would be willing to hold off on the publishing of corporate sponsored research is an interesting policy issue that most campuses try to address. Usually this is a predetermined policy that limits the amount of time that you can have between the completion of the work and the publication of it. But sometimes it can lead to some very contentious discussion, particularly if there are graduate students working on the project." (Academia)

The greatest source of debate and consternation comes not from the faculty who are involved in the research; it comes from their colleagues who are not involved in the research arena. These faculty members criticize those involved in industry research for corrupting the "pure" science of basic research by accepting funding from industry partners for sponsored research. Academic informants report that they have heard colleagues state that industry funding might result in scientific direction being dictated by commercial partners whose profit motives are contradictory with the values of the university.

Table 23 summarizes the twelve barriers to successful partnership which were identified in the key informant interviews.

Table 23: Barriers to successful partnerships

1. **Discussions regarding intellectual property rights and ownership often prohibit partnerships from ever getting off the ground.**
2. **University researchers often have difficulty meeting the time tables and schedules required by industry partners, creating issues of accountability and reliability.**
3. **The culture of academic and industry scientists is inherently different.**
4. **Technology transfer offices are often under-staffed or staffed with individuals who have little experience with the commercialization process, often making the documentation process to establish a partnership cumbersome and lengthy.**
5. **Unrealistic expectations, due to a lack of clarity of goals and objectives, time frames and other deliverables, often cause the relationship to collapse.**
6. **Overhead rates are a source of misunderstanding and misinterpretation and greater transparency is needed to avoid potential conflicts.**
7. **Partnerships will not survive if the publication rights of either faculty or students are jeopardized.**
8. **A change in personnel among either side of the partnership threatens the continuity of the research initiative.**
9. **Changing priorities by either side of the partnership may threaten the research initiatives by making the project irrelevant.**
10. **Internal issues and intra-organizational struggles, conflicts and shifts of power may hinder the execution of the project goals and struggles. Bureaucracy, either within the university hierarchy or the corporate organizational structure, makes it difficult to communicate issues and**

problems.

11. **Confidentiality issues may impact the development of partnerships because of the fear that proprietary information may not be adequately protected.**

12. **The university's mission of providing academic freedom to its faculty and students to perform basic research cannot be compromised.**

8.3 Characteristics of successful partnerships

> "The innovation pipeline starts in basic research, moves into the applied research phase and then is shared with an external partner or partners who help test the technology. They then may or may not be in a position to help commercialize a successful technology. We don't have time to work sequentially any more. We need to work in parallel to make sure we are identifying the problems that are important to industry and society – each bringing what we do best to the research process, the commercialization process and the educational process to get solutions out there in a timely manner." – Catherine Maxwell, Executive Director of Development, North Carolina State University College of Agriculture and Life Sciences

Fifteen characteristics were identified from the key informant interviews. These characteristics are listed below in descending order based upon the frequency of which they were mentioned in the interviews.

Characteristic #1 – Long-term partnership relationships are more successful than short-term projects.

> "The long-term relationship is what we are looking for. The key thing is for us to be true partners and therefore have a variety and a whole menu of ways we can interact: sponsoring research, sponsoring internships, faculty interaction, teaching courses, athletics and philanthropy. But none of this happens without a true partnership." -Terri L. Lomax, Ph.D., Vice Chancellor, North Carolina State University

This singular focus appears to be the most critical characteristic for successful partnerships – the ability to look beyond the transactional approach and move toward a relationship approach. Informants mentioned this quality almost twice as much as any other attribute. While past efforts toward developing academic- industry partnerships focused primarily on individual research projects with the goal of producing intellectual property or spin-off companies by faculty members, the consensus of informants was that a more strategic approach with the goal of developing a long term relationship with multiple components held a higher likelihood for success.

> *"It's a long term approach rather than just one individual trying to get funding for a specific lab or a specific initiative. You are taking a broader approach and saying this is something that, if handled property, can benefit the university for a long time. We look at it more like a marriage. There's give and take the entire way but you know you are going to be much better off over the next twenty years if you work as a true partner."* (Academia)

> *"All of the other things are important, like the gifts the industry partner gives to athletics and the opportunities they provide to students. They hire more of our graduates than any other university. It's a myriad of things that really can't be measured in terms of dollars and cents. It's about total impact, not individual, specific acts."* (Academia)

> *"This is really about the university taking the long term view. It's not about how many projects we can license. That's great, but how many of them really come to fruition? It's more about the continuum of developing a long term relationship that offers lots of different opportunities."* (Industry)

> *"Our goal at our university is to take the long view. You have to understand that in building the relationship you can be penny wise and pound foolish."* (Academia)

> "*I think the only thing that keeps partnerships from happening is that we aren't always real good at identifying at a high level the areas where we can collaborate. Most industry partnerships are driven by an individual; a researcher in the company having knowledge of a researcher here at our university. I think we need to increasingly take the partnerships to a higher level, where it's a broader set of collaboration among the partner and the university and not just a one off/one person that's here that knows somebody at Company X".* (Academia)

A 2009 report issued by the UNC system entitled "The UNC Vision for Innovation and Technology Development stated that "… the pursuit of robust, high-value public-private partnerships ... presents a significant departure from the normal mode of one-off technology commercialization transactions," and therefore "… enormous potential can be reached through emphasis on long-term and multi-faceted relationships with industry partners. These are the relationships that have the potential to generate the most benefits to all involved parties, and potentially to society" (UNC, 2009, 9). The more collaborative the project and the relationship is, the higher the opportunity for successfully engaging the partnership beyond a single transaction and toward a long-term association. These long term associations exist on multiple levels, lessening the likelihood of a fracture over any one aspect of the partnership. Dr. C. Daniel Mote, former president of the University of Maryland, stated regarding his tenure there, "I was much more inclined to build relationships with industry rather than build revenues. I wanted to create an entrepreneurial culture with lots of opportunities for interactions between faculty, students and companies" (Malakoff, 2013, 5).

> *"I'm a person who looks at long term versus short term success. You can have short term wins and say 'thank you very much, we've fulfilled our contract, now here is your check, and move on'. But the best partnerships are the ones that go on and on."*(Industry)

> *"People are shocked when I tell them the key to a good relationship is not to say, as academics, 'well, industry gave us a bunch of money, that's what we're after,' but to become business partners with that industry. That's really all it is."* (Academia)

> *"I could be looking for a technology, find it on your campus, buy it and transfer it in and basically license it into technology and be done with it. But I think true partnerships go beyond that; it's looking at what else you have on the shelves and what else you are working on that's of interest to us. How can we maybe guide the research, or maybe make it more appropriate to us, or make sure that it's relevant and bring a point of view from industry or from our world to the researcher and the researcher bring an understanding to us? So we can be thinking about not just what comes out the back end of the discovery process. We can take a look at the output and say, if you had only done X instead of Y, it would have been a lot more useful to us.*

So having that upfront engagement and that relationship over the long term is where we want to be if possible." (Industry)

Academic informants who have been successful at developing long term partnerships site the need to take the long view and to be willing to sacrifice upfront commitment in order to gain the industry partner's success and trust. Building trust and good will and demonstrating credibility and scientific expertise allows the industry partner to see the value in a potential partnership.

"We try to be helpful without payment in the beginning. If the company has a problem, we help them think about it, give them good advice and we don't take anything for it. Eventually, they will come back and ask more from you and pay you for that advice. You just can't be too mercantile about it. If you can do the cultivation, they tend to come back." (Academia)

"It doesn't make much sense for us to invest all the hours it takes in putting together a sponsored research agreement if it's only going to be a one-time thing and there's only going to be a payment of $10,000 or $20,000. It makes a whole lot more sense for us to put the time in and to get to know the company better and let them know us and then let it develop into something where hopefully we are going to be doing multiple projects for them over multiple years. That's where it's going to pay off for everybody." (Academia)

"*I can't overemphasize the importance of developing a relationship that is long-term. This is true whether it's a partnership with an industry, another university, or another country. When you create these long-term partnerships, you benefit immensely."* (Industry)

Partnerships in which both sides look at the needs of the other side and try to structure the relationship in a way that addresses these needs tend to be the ones that survive over time.

"We want our industry partner to think 'we need to keep funding work at XXX University because they will keep changing to serve our needs.' And we want them to be willing to give back to the university in whichever area they want, whether its scholarships, faculty or professors or whether it's pure research money, we want them to come back because the relationship is so good they know they are going to get what they need out of us as their partner." (Industry)

"Industry wants a relationship where they are partners with the university, not funders of the university." (Industry)

"Philosophically, our goal is to take the long view. We understand when you build a relationship you can short-change yourself by being penny wise and pound foolish." (Academia)

8.3.1 Case perspective #2

From mediocrity to excellence[5]

Egelloc University has developed a national reputation for reaching beyond boundaries and developing cutting edge and innovative industry relationships. One of the nation's leading agricultural and engineering schools, Egelloc has been a breeding ground for new technologies and industry partnerships. But this has not always been the case – and the road to achieving this level of success has been long and met with many challenges. One of the tipping points for change began in the 1970s, when Egelloc was fifth from the bottom in external funding out of about sixty leading agricultural universities. Egelloc made a conscious decision to approach Affront, one of the country's leading agricultural companies, to discuss how they could enter into a successful relationship that would allow the company to keep control of their intellectual property as well as to have a major role in the priorities of the research. In part due to a conscious decision to engage with industry in a more open and cooperative way, the university went from fifth from the bottom to first in funding of all agricultural universities. Not only did funding increase, Egelloc began to see more endowed professorships, unrestricted gifts and, according to Dr. John Lane, former head of research, changed the way the university was to look at public-private partnerships in the future. Dr. Lane stated, "They saw our

[5] All names and places appearing in this case perspective are fictitious. Any resemblance to places or to real persons, living or dead, is purely coincidental.

capability in turf grass production. Previously, they had not seen administrators willing to basically throw out the rule book. It wasn't so much selling them on our scientific capability; it was convincing them that we would work with them in a different way. There was pushback from some administration that we were giving up too much control. But it worked so well, there was no choice for them to see this was a better way of doing things."

Egelloc is one of many universities whose faculty and administration point to a lack of internal communication among faculty, administrators and tech transfer office as an area of needed improvement and a potential cause for fractured relationships with industry partners. Dr. Lane points to an interesting partnership relationship that nearly collapsed because various entities within the university were not communicating properly. He commented: "I still remember going to a meeting with General Corporation when I was a researcher in the College of Agricultural Sciences. General was the number one benefactor of the university and our college. We had sixteen General endowed professorships, tons of money funding crop breeding and even a sponsored program to develop young farmers. There was the implicit understanding that Egelloc would be doing General's crop research for many years. They trusted us so there weren't many strings attached and they invested millions of dollars annually in specialty crop research. We both honored our agreements and they saw that we invested our own funds in what they were interested in, above and beyond what they were funding through grants."

"In this particular situation, General was interested in getting the rights to some relatively inexpensive IP for which they had already developed an alternative. Our tech transfer folks beat them up so badly in the IP negotiations, they were just stunned. Never

mind all these other things they had done for our college, the athletic program and the university in general. All over a one-off deal where we tried to beat the tar out of them on a deal they had an alternative to already. General finally called the University president and said 'we can't believe this, with all we've done in terms of professorships, student support, youth leadership programs and athletics. Your tech transfer group is beating the hell out of us for something we don't even have to have,'" said Dr. Lane. The College of Ag Sciences faculty member who had the relationship with General heard about the combative negotiations third-hand from one of the industry officials not even directly involved in the negotiations. The College responded passionately: "'What are you talking about?' We didn't even know it was happening. We intervened and said 'You folks are way overvaluing this. These people (General) have an alternative. They don't even have to do this if they don't want to'. The whole premise that one part of the university was completely ignorant of all our partner had done in a relationship of over fifty years was just wrong."

Dr. Lane credits this near-disastrous encounter with a long-term partner as the beginning of a revamping of the way industry relationships were handled within the university. "Part of the problem was that the tech transfer office, like at many other universities, was funded with a totally ineffective model. The tech transfer employees were worried about and getting a deal done that would put money into the tech transfer office rather than about the overall good of the partnership. We were all looking for another Gatorade."

When Egelloc began the overhaul of its tech transfer process, most of the perspective came from the researchers within the university. "We asked our researchers,

'How shall we do this differently? What makes more sense to you? What do you think makes more sense to the company?'" added Dr. Lane. Egelloc scientists had never had a relationship where the companies with whom they worked felt like full partners. All of sudden they had companies willing to donate time and commitment and some even embedded senior executives in the university. "When we started to look at what made sense, for the first time we actually had arguably the most innovative company in the world, the company who held more patents than any other company in the world, sitting at the table saying to our researchers 'this is how it ought to look from an industry perspective.' That was huge," Dr. Lane stated. This conscious effort to ask the industry partner for their perspective in the actual design of the research agenda was quite a different way of doing things for Egelloc. Because the relationship with Affront worked so well, Egelloc went to small and large industry partners and asked for their input as to how they should reframe themselves. "It was a totally unique experience for many of these industry partners because they saw that we must really care about what we are saying. It's not just another university paying lip service. They clearly want to get this right. It made a huge difference when our industry partners really felt they had a seat at the table, we wanted their input, and we were actually willing to do things differently" added Dr. Lane.

Dr. Lane described the change in philosophy in industry relations as one that looks more toward the long term relationship. "We are changing our research and partnership capabilities to fit their needs, yes, but mostly because that just makes for a long term relationship. We are not really worried about IP anymore. The relationship is just more important than that. We're even starting to ask our industry partners for their

input on changes in our curriculum so it makes more sense when they hire our students."At the center of the success of Egelloc's relationships with industry is the notion that they don't really care what form the partnership ultimately takes. "We want a company to say Egelloc is our best university partner and the way to move forward is for Egelloc to move forward. If they think that is to give us an unrestricted gift, or to endow a professor to work in a certain area, or student support so they can hire more qualified employees, we are happy to cooperate with them. We want them to be willing to give back to the university in any way they want – whether it's scholarships, faculty professors or pure research money, because the relationship is so good they know they are going to get what they need out of us as a partner," stated Dr. Lane.

A good example of how Egelloc has made a conscious effort to develop long term partnerships lies in their applied breeding center, in which faculty trained as plant breeders interact with industry-funded graduate students. The program has created a pipeline of plant breeders and the industry partner is able to "try out" potential employees by having them work in their laboratories during their rotation semester. "This is a win-win for us. Egelloc has put its stake in the ground that we are going to be one of the best in the country for training plant breeders. It's a key technology. We get to do our science, train grad students, and publish papers. Our partner gets trained, well-qualified employees. And they get to capture the best of the potential workforce because they are funding the program," stated a faculty member. While there is not tremendous revenue being generated for the university, it achieves one of its clear goals: providing the best possible educational experience for the student. "There are very clear goals. They (the industry partner) have a need for plant breeders. We have a need to do research and

training. Everybody understood each other's needs. There's no downside. It's a great win," the faculty member continued. Dr. Elizabeth Connor, Egelloc's Vice President of Research, believes that companies view Egelloc as a university not only willing but focused on developing industry partnerships. Dr. Lane was quick to add that Egelloc's philosophy of a more open relationship with industry is no longer unique. "There are lots of universities behaving that way now. It's new territory for some of the companies and the companies are responding well." Egelloc provides an example of a university that has understood the importance of being strategic in its approach to dealing with industry. According to Dr. Connor, "the successful university today has to look more closely at tailoring its programs, whether it is undergraduate curriculum, research or extension, to meet the needs of its partners. We must expand our mission to make sure that when we talk about serving the state as a land grant, this includes not only developing IP but economic development, job creation and pushing out our innovation as a fundamental part of our mission. In the past, we might have measured success with royalties, licenses or patents. We need to be more upfront and recognize that research can lead to improved quality of life for our citizens. Economic benefits are actually something that must be recognized as vital when we develop our research agenda priorities."

In keeping with this broader and more strategic view of industry partnerships, Egelloc recently announced a strategic alliance with a major pharmaceutical company. The new policy now dictates that if the industry funds the research, they will own the technology and the ability to patent it. This is expected to facilitate future negotiations, making entering into academic-industry partnerships much easier. Dr. Lane commented, "In the past we tried to control the process by owning the patent and requiring an

exclusive license. Most companies couldn't abide by that because they didn't trust our ability to control the patent. If they have a technology and they don't control the entire constellation of patents around it, some other company will find a wedge into that and will break open their control of the technology, causing the company to lose their position." Egelloc's new policy on industry collaborations will allow the university to benefit from a share of the royalty revenues once they reach a predetermined trigger point. "One in one hundred patents is a homerun. We will get a piece of that action. But we no longer allow these patent bullshit arguments that we used to throw up in front of the companies to keep the deal from getting done," added an administration official. "I give a lot of credit to our tech transfer office for being really creative in the way we structure agreements so we can just get it done and move on. A lot of universities think they are going to make a lot of money from patents and IP. Very few actually do. So for us, it's more important for the technology to get out the door and into the market place. Industry is the best way for that to happen."

Various faculty members at Egelloc credit the Vice Chancellor of Research as a person who has been able to sell the entire university in aggregate, not individual investigators or research programs, which they point to as the key to Egelloc's success. Helping potential industry partners see the university's vision is essential in developing a long term relationship built on trust and mutual goals. The Vice Chancellor offered this analysis of the university's strategic vision: "Everybody in our organization is working toward the goal of being the easiest university to work with. Our researchers bring connections and we try to make them work so it can be easily funded and those partnerships can take place. On the innovation side, it is very important that we are trying

to boost licensing our technologies directly to industry or startup companies. It's the full relationship, not the transaction that we are looking for." Egelloc has navigated the difficulties that other universities have encountered by taking the long term view. Instead of thinking about how many technologies they are able to license, they have focused on the continuum of developing a long term relationship that offers many different facets for both partners. From the bench scientist to the head of the university, there is the unified approach that industry relationships should be an integral part of the DNA of Egelloc. The President of Egelloc added this observation: "We really want to be the easiest university in the country for industry to work with. The reason we think that's important is because the work we do is more tied to industry than a lot of universities, and we are more dependent on industry for research funding than a lot of universities are. So we have made our licensing agreements simpler. We don't have big, upfront negotiated payments. We don't get into long negotiations. We basically say it's within both of our interests to work together. If something significant comes out of it, then we can work together to figure out how we both benefit from that. We are not going to let negotiations get in the way at the beginning."

In the future, Egelloc expects to increase the number of industry partnerships as a result of reducing bureaucracy and making it easier for companies to enter into partnerships. The university's strategic plan embraces measuring research funding from industry as a good indicator of successful partnerships. They support and believe that the technologies that make it to the market place will have at least part of their origin in the labs and field at Egelloc. "We expect to see more startup companies and more technology in the marketplace because we have lowered the barrier for licensing and have made a

strategic commitment to these partnerships. We are looking to develop more partnerships like the one that grew from $10,000 a year in research funding from Affront to what is now over $500,000 a year in plant breeding. Those are the kinds of partnerships we want." Dr. Lane offered a word of parting advice for universities: Be more aggressive, be less constrained by the way you did things in the past and be more open-minded about how you go forward in the future. Look at it as a marriage. There's give and take the whole way but you know you are going to be way better off over the next twenty years if you work as a true partner."

Characteristic #2 – A strong element of trust exists between the partners.

"Trust is the foundation on which every kind of collaboration, formal or informal, is based." – Former UNC President Molly Corbett Broad

The majority of the informants, both academic and industry, indicated that trust was the single most important characteristic of a successful partnership. This was considered to be an essential and critical prerequisite for the development of a partnership relationship. When asked to rank "trust between the partners" from 1 to 5 in terms of importance in developing a partnership, 94% of informants ranked "trust" as a 5, and the remainder of the informants ranked it a 3 or a 4 in terms of importance. When describing the importance of trust, informants used descriptors like "critical," "extreme," "essential" and "crucial."

According to a sample of 3,431 individuals involved in collaborative projects funded by the Engineering and Physical Sciences Research Council, trust is especially important in facilitating university-industry links. According to this study, "a collaboration that is characterized by low levels of trust will result in a partnership where partners are less likely

to be forthcoming about the knowledge and information required to make the collaboration successful. Therefore, higher trust between partners stimulates the rich social and information exchanges and encourage partners to exchange more and valuable knowledge and information" (Bruneel et al., 2009, 861). Brunel concluded that "building trust between academics and industrial practitioners requires long-term investment in interactions, based on mutual understanding about different incentive systems and goals. It also necessitates a focus on face-to-face contacts between industry and academia, initiated through personal referrals and sustained by repeated interactions, involving a wide range of interaction channels and overlapping personal and professional relationships" (Bruneel et al., 2009, 867).

> *"Trust between the parties, is extremely important – you've got to have great trust if you are going to work with someone and think about being in a partnership with them."* (Industry)

> *"First and foremost is trust. You have to be able to trust your partner, both the institution as well as the individual. If you have the feeling that someone is shaving and cutting and not doing what they promised, that just creates a bad environment for everyone."* (Industry)

> *"The people you end up contracting occurs because you've had other relationships with them where you developed a level of trust and respect and you know that both sides are working toward the same goal."* (Industry)

> *"You have to have a sense of trust. So by the time we got into discussions about overhead or if there were questions or issues that had not been clarified, we were willing to move forward because we felt we had a partner who wasn't going to pull the wool over our eyes."* (Industry)

> *"During the partnership formation stages, trust plays a crucial role among the principals, because you don't have the institutional arrangements in place. Even when the institutional arrangements do get in place, trust still plays a key role because issues always arise."* (Academia)

> *"You have to develop a level of trust with your partner before you can continue in any kind of working relationship. So the interpersonal piece in developing that trust and that camaraderie with someone is extremely important. That's why you sometimes start small and build those relationships, which can lead to bigger things. So you don't sacrifice the relationship just to try and get higher revenues."* (Academia)

"You develop this trust. And if you think about the fact that you're trying to work with totally different cultures on the other side of the world. Without that, the other stuff is just not going to work." (Industry)

Characteristic #3 – Clear alignment of goals and overlapping missions.

> "We begin with the assumption that each stakeholder has both common and competing goals. There will be opportunities to enlarge the proverbial pie and, at times, to divide the pie. These initiatives work best when there is a shared vision of success. That doesn't mean that everyone has to have the same meaning of what success represents for them, but there has to be enough area of overlap that the vision of success is truly shared -- that there is something in it for each of the parties. Beyond the vision for success there are issues of governance, operations and sustainment." – Joel Cutcher-Gershenfeld, Ph.D., Dean, School of Labor & Employment Relations, University of Illinois, Urbana-Champaign

Both academic and industry informants agree that it is important to spend time early in the relationship understanding that the goals of both partners are aligned. The internal missions, the objectives of the partners and the research agenda need to be synchronized in order for the partnership to be successful. Often this requires a good deal of time- consuming, yet beneficial, dialogue in the early days of the relationship in order to fully understand that the goals of the two parties are aligned and not headed in contradictory directions.

"There is always a risk that the academic partners feel like they're on a different mission that the company. The way that the funding can be used - such as research, training, or equipment – is sometimes not clarified and the purposes are not aligned." (Industry)

"You really do have to have clarity in terms of what the expectations are. Because so often that's what leads to huge misunderstandings." (Industry)

"We all understood the boundaries and laid them out on the table. 'This is what I'm going to do and this is how far I can go. This is what you are going to do. This is how far we can go.' So you have a very clearly delineated idea of who did what from the very beginning. Both partners need to fully understand the output and what type of information is going to be collected." (Academia)

"The less successful partnerships are ones where the investigator delivers contract research that he really did not want to do but he got a little money to fund some of his staffing and overhead. These usually fall apart after a while when the investigator gets other money to do work that interests him or when the company doesn't find the research terribly inspiring because it is predictable. It is usually better not to take on

a study just for money but instead because there is a goal or a benefit that resonates with both parties." (Academia)

"The biggest single thing that people can do is sit down and talk to one another and find out where you have commonalities and where you can actually leverage each other's strengths, see if there are ways to collaborate, and prove your worth and abilities to each other and move on from there." (Academia)

"Making sure your goals are aligned is crucially important. That discussion should take place up front and there needs to be agreement at multiple layers. It needs to take place among the senior leadership, the front line scientists and the operational people who are handling the project need to buy into it. It has to be hashed out and validated at multiple levels." (Industry)

"The development of specific goals and objectives, from the perspective of both parties, is essential. It's a legal contract and we are very dependent to the legal department when we write up projects and objectives because you have all kinds of crazy behavior. I've had people who are consultants come back and say they want a piece of the pie for a product. So we review the contract and say that's not in the contract. You have crazy behavior when people get into a project and they see the benefit of it. It's just the strangest thing. You wouldn't think that happens but it happens all the time." (Academia)

"I think the project worked because there were common goals between the sponsor and what I was trying to do in the science conceptually. They wanted to understand how much diversity there was in corn and what the genetic basis was for useful traits there were in corn, like disease resistance or drought tolerance. They also wanted to know how to discover those genes and how to move those genes. I had similar interests. I didn't have a focus on a particular organism but I was interested in how population genetics and genomics could be used to discover useful genetic variations. So I think it worked because we both had similar interests and training. Their goal was shorter term and my goal was longer term but we had to follow the same path independent of where we were going." (Academia)

Characteristic #4 – Partnerships provide a win-win situation.

"We recently had a company visit and our investigators thought carefully about how that company could benefit it they invested in our research. The company had been in previous meetings in which the presenters did not prepare at all and they gave them presentations as if they were at a scientific conference of their peers. The company didn't connect the dots with those people because they didn't have a deep enough understanding of the science to do that. But for the people here who spent the time saying 'this is where I can imagine my work would be useful to you,' it at least opened a conversation in which we were talking on the same level. We helped them understand 'here is the win-win,' as opposed to 'here is what I do, take it or leave it.' So for successful people, in forming collaborations, you need to start out by being able to think from the other person's perspective." – Steve H. Zeisel, M.D., Ph.D. Director, UNC Nutrition Institute

Informants reported that even if the participants have similar research interests or if all the other elements of a successful relationship seem to be in place, the partnership will not be successful unless there is the feeling that both parties can benefit from the relationship. If there is the perception that one party benefits more than the other, then the relationship will break down. There must be a perceived value proposition from both sides of the partnership.

> *"In dealing with industry partners, you may find that they have already invested a lot in the methodology or technology so they are concerned about recouping that. Or they may be thinking of what their return on investment is going to be. All they are thinking about is 'what is the deal for me.' In those negotiations, you have to think about what works for both parties. What is the big picture?"* (Academia)

> *"No one will ever fund a product-specific piece of research unless the company that can benefit from it. Science funding does not work that way. Yes, the university benefits from doing the work but the company has to see the benefit for them as well."* (Academia)

> *"You have to let people know that you hear what they say and that you are really listening to the other side. A very important component in developing successful relationships is to be able to communicate that to people and have them know that you are not just in it for what you want but that you are trying to look at what would be a win/win for both partners."* (Academia)

> *"If there is truly a win-win situation, then those relationships always work. The investigator is highly motivated to deliver, there is data they are generating that is intellectually interesting to them and that they can build other research projects on, and the company clearly gets something they consider valuable to their product. And usually they will want to invest more money to make their product more valuable to them."* (Academia)

> *"You have to understand where the industry's interests lie and get to the point where there is a shared understanding of the other sides' needs and where you can find that win-win for both sides."* (Academia)

> *"You're never going to get very far if what you are doing is only at the expense of the other party. It might be good one or two times but then you are going to run out of a relationship."* (Industry)

> *"You have to be able to leverage the strengths and assets of each partner in a way that allows both people to win."*(Industry)

> *"The valuable partnership is the one where both parties are benefitting from it. And they are not in it just for the sake of their own goals. If they are in it for the sake of the shared goals, it is going to work for everybody's benefit."* (Industry)

"Initiatives that work the best deliver on both ends. They have to deliver both on the separate interests of each of the parties as well as their shared interests. If you are just asking people to contribute to the collective good then it is a form of charity and it is limited on the impact and the scope people agree on." (Industry)

"Partnerships work because you are able to define problems in a way that helps people understand why it's important to them and how, working together, you can find to a solution that benefits everybody." (Industry)

"We try to go into the partnership with the thought that it needs to be 50/50. You need to get as much out of it as I do. Because, guess what? If we end up being really good at negotiating and we negotiate a better deal, you're going to feel like we took advantage of you. And then our relationship isn't going to work. Likewise, if we feel like you're taking advantage of us, we're not going to be happy. So right at the get - go, we sort of take the philosophy that we really want to split this down the middle. We want to make sure you get as much out of it as we get out of it. Period. And if you start that way, usually the negotiations go a lot better." (Industry)

"So this is really a win-win for us. Our university has put its stake in the ground that we're going to do plant breeding. It's very valuable science. It's a key technology. If companies don't do it then they need to hire their plant breeders because they need to incorporate transgenic traits. So this is really what I call the perfect win. There's a very, there's a very clear goal. Our industry partner has a need for plant breeders. We have a need to do research and training. Everybody understood each other's needs. There's no downside. It's a real win for both parties." (Academia)

Characteristic #5 – Effective communication skills

"It is critical that you let people know that you hear what they are saying and that you are considering both points of view with respect to issues. A very important component in developing successful relationships is the ability to communicate with other people and be able to let them know that you are not just protecting your interests, but you are trying to find a result that will benefit both partners." – Steven Leath, Ph.D. President, Iowa State University

Because industry and academic partners sometimes have different perspectives and management styles, it is important to develop an open stream of communication from the onset of the partnership.

"It makes sense to take some time, in the beginning, to invest the energy to cultivate and understand the industry partner. In one case, we set up a simulation to show how their R&D team thought about an idea, and how it became a product they could take to the market. The teams worked with faculty members and went through an idea and asked 'is this worth investing more money?' That gave the faculty some valuable insight into what thought process industry uses to decide "is there is a link here for

us?'. Once you understand that, you can figure out what is needed by understanding how they work, how much regulatory control exists, what the safety issues are and what investment is needed to bring a product to market. Most importantly, does it fit into our mission statement or does it force us into a new area we don't want to get into?" (Academia)

"One of the most important things is for both sides to listen to each other, and to agree on what the goals and needs are, and have people who are willing to do things maybe a little bit differently and work together in a new way." (Industry)

"You have to be able to come to the table and look at a potential partner and say 'I'm at this end of the spectrum and I can see that you're at the other end of the spectrum. How do we get to the middle?' So having the tools to help us get to that middle ground is just critical."(Academia)

"You don't want the contract to be the underpinning of the relationship. You want that good relationship to be based on communication and what is going to happen all the way from compliance to the reporting standpoint." (Academia)

"If you are having open and straightforward communication early on and it is clear the parties are not aligned, then you are not going to put much time into the project. Basically, if you only find out after you spend a lot of time trying to get something off the ground that you are not compatible, you didn't do proper communication up front."(Academia)

"We spoke the same language in science but in a sense we had a similar vision of an outcome that was beneficial. Having similar backgrounds was definitely helpful so we could speak the same language."(Academia)

Characteristic #6 – Interpersonal relationship or prior experience with the partner.

> "We tend to find programs where we can go back to the same well again and again. Because we know and trust the players. Our lawyers might be familiar with their legal staff. So you can move quickly and efficiently and you have that relationship. We end up seeing the longer term relationships becoming more important, and a big part of this is due to the social relationships we form that make it easier and more enjoyable to do business." – Lane Johnson, Ph.D., Director of Agricultural Research, General Mills, Inc.

Informants report that the existence of a prior relationship, whether personal or professional, tends to make the development of a new partnership more likely. Partners are drawn to those with whom they feel a level of familiarity and trust, and the prior relationship allows the party to move forward with greater ease, speed and efficiency. Not only does the

existence of a positive interpersonal relationship assist in the development of the partnership, it helps navigate difficult situations if problems or incongruities arise during the scope of a particular project. Many informants indicated that the relationship with the partner was actually the element that made the project successful.

> *"It was a case where we had a good enough relationship with some of the people in the company that we could say, 'we need to find another way to do this,' and we were able to go another way that worked for everybody."* (Academia)

Informants indicated that taking the time to get to know the partner on a personal level paid huge benefits in the development of future projects. Feeling comfortable discussing problems, conflicts or issues becomes easier once the partners have developed a personal rapport.

> *"The reason we have been able to grow and flourish is because it was pushed by the scientists themselves – it was basically the relationship that they established that made it successful."* (Academia)

> *"We had a very good relationship, and partly because of that I gained a much better view of what their company needed, what their limitations were and how I could fit in and contribute. And that made me feel more motivated to work with them."* (Academia)

> *"It's all about networking. My network is my most valuable asset. After 35 years in the industry, I can call somebody and they will connect me to somebody who can solve my problem if they can. I think the relationship in a network and the credibility through the network are the most important things in a partnership because I would never partner with someone I didn't know."* (Industry)

> *"I think people underestimate the importance of personal relationships. I can virtually guarantee there is hardly anything that my contact at XXX University and I cannot solve. If we didn't have that relationship then it would be just another business transaction. I think that past relationships really matter and it takes the universities to cultivate those relationships. That means the universities need to do things that they didn't used to do – they basically have to court the relationship."* (Industry)

> *"It's a whole lot easier to work out a problem when you have some sort of relationship with that person than to go in cold and not know anything about him."* (Industry)

> *"It all goes so much better if you spend time getting to know somebody, actually developing a friendship, identifying where you've got areas of mutual interests,*

> *technically, but also identifying teams or groups of people that you can feel like you can actually get al.ong with and work comfortably with so that you can make that phone call and say 'you know I'm kind of waiting for that information. Where is it?' We want to be able to interface with people directly one on one and not just make phone calls or send emails. To actually get to know people makes a lot of those things work just a hundred times better."* (Academia)

Thorp and Goldstein write the "relationships are always at the heart of the work" (Thorp et al., 2010, 78). To emphasize this point they tell the story of Dr. Jim Spudich, a biochemist at Stanford University, who was building a prestigious center aimed at translating his work in the biosciences to human health solutions. Stanford's President, Dr. John Hennessy, called Dr. Spudich to tell him that the laboratories were substantially over budget and that there needed to be reductions in the building costs. Therefore, the decision had been made to eliminate the cafeteria in the basement of the building. Dr. Spudich did not hesitate in his reply: "Cancel the laboratories and build the cafeteria" (Thorp et al., 2010, 78). Building these connections, encouraging dialogue, and fueling collaborations, albeit in non-professional or unlikely settings, and establishing relationships are critical components to the success of any potential partnership.

Characteristic #7 – Reputation and expertise of the partner

> "Relationships are key components of forming academic- industry partnerships. If I know somebody who actually knows what they are doing, I am going to try and partner with them. If I have worked with someone in the past and I totally respect that person; if they deliver and they know what they are talking about, that's what motivates me to form a partnership." – Mary Wagner, Ph.D., Senior Vice President of Global Research & Development, Starbucks Coffee Company

Knowing the level of technical expertise, scientific background and reputation allows the partnership to develop in a way that can clearly delineate roles, responsibilities, potential outcomes and desired endpoints. Often these contacts are made through the sharing of

research interests at scientific conferences and meetings, through publication of journal articles or simply through informal contacts with associates or colleagues. Informants site the level of technical alignment and capabilities as one of the primary drivers of the partnership. Academic credibility, reputation, respect and expertise are all important components in the selection of a potential partner. Informants report that the selection of a partner with complementary expertise as well as similar interests is equally important.

> *"I could tell immediately that he understood university-oriented science and he was a very broad thinker; a curious guy; a really smart guy; he was a perfect person to interface with and his level of expertise created a very warm relationship. I liked him personally but more importantly it was clear that he saw value in what our lab was doing and how that value was useful to his company and his research."* (Industry)

> *"We saw great value in bringing people together who may not have been able to do it alone. By identifying these people with good expertise in our area of interest and by working together with them, we get additional benefits. By making a fractional investment, we all get more on our return."* (Industry)

> *"There has to be some mutual respect and mutual understanding of each others' capabilities and expertise and how putting those together creates something bigger than what each of us brings to the table."* (Industry)

> *"The relationship was driven by the scientists themselves, because of the mutual understanding, interests and respect for each other. It turned into a fifteen year, really productive partnership."* (Academia)

> *"I choose partners who I respect – the people I want to work with are those who others perceive as being at the top of their game. It's like baseball – I want to work with the Yankees, no matter if it's an industrial sponsor or some kind of governmental program; I want to work with the good team."* (Academia)

> *"I ran into people at scientific meetings for a year or so before we sat down. They heard my presentation, and after it was over, we would talk about common goals and interests in what we were doing. Subsequently, they invited me out to visit the company and give a seminar there. And then I invited them to our lab. They saw what was I was doing and from there we sat down and said let's try out some research projects together."* (Academia)

Characteristic #8 – The ability to iron out problems at the beginning of the partnership

> "We make it very clear up front that we have certain restrictions and we explain exactly the perimeters of the project. We have the partner sign off on the major points so they will understand the critical restrictions, like timing, confidentiality and publication rights. We try to mitigate these problems by getting things out in the open at the beginning so they don't become big issues later on." - Steven Kresovich, Ph.D., Former Vice President for Research, University of South Carolina

Informants indicate that spending the necessary time at the beginning of the relationship to identify and work through potential problems is a worthwhile endeavor. A period of cultivation in which the partners begin to understand what is driving the relationship can save valuable time and money later by helping keep the focus narrow and the mutual goals intact. Both sides of the partnership have to be willing to keep working until all of the issues have been discussed and uncertainties addressed.

> *"We prepared the faculty. We put together a master time sheet, a one-page hand out. We put together a packet of our standard templates of the sponsored research agreement that included confidentiality terms. We also had a separate reciprocal NDA. Because what we found more often than not was that faculty were out talking and would agree to things before they even realized what they were agreeing to. That's where we had some of the biggest issues. We would have to retrace their steps and make them do what they had promised to do. So I think forewarned is forearmed."* (Academia)

> *"The key is trying to spell out these things upfront so you can address them early on rather than having them become problems. We just try to nip it in the bud by thinking of as much as we can to iron out before we get started. We do all that homework upfront."* (Academia)

> *"Potential stumbling blocks must be addressed upfront in the contractual document so that everyone knows what to expect. The most important thing you can do is to address everything up front."* (Industry)

> *"The more you can agree on terms upfront before you even have something to discuss regarding intellectual property, the better off you are."* (Industry)

> *"You have to spend the time early on to find out what it is that motivates the other side."* (Academia)

"In my experience, it's better to have that first meeting and say 'we're not comfortable even having an agreement at this point. Let the other party know that you're just not comfortable sharing that much information yet. If we can work through some initial issues, then we will go forward and arrange a second discussion where we put a CDA in place and start digging a little deeper. This ends up giving us a lot more flexibility and it lays troublesome issues out on the table from the onset so we can deal with them." (Industry)

"One of our more successful partnerships occurred as a result of someone I had met early in my career. We got together at dinner and we began to lay out some basic groundwork with a term sheet discussion, not even getting into the real agreement yet, just talking about the basic principles that we both wanted to get out of the transaction. When we came together for the final negotiation, which included representatives from the company, the subsidiary they had just acquired, our office of technology management and the dean of the department, we had a ninety minute discussion that resulted in the final execution of the contract. We sat together face to face and worked through the issues, which we thought was really important." (Academia)

"It's really good when you can sit down ahead of time and define the boundaries and space so that everybody can be happy about the outcomes." (Academia)

"Nothing is an insurmountable obstacle as long as it is communicated upfront." (Industry)

"We took a lot of time to sort of lay out anything that might have come up as a conflict and tried to iron that out from the beginning."(Academia)

"We take the time upfront to negotiate master agreements so that we get an overall agreement which handles the business terms between the organizations. Hopefully, this agreement articulates the philosophy and the spirit of the collaboration and then the subagreements and specific scope of work can be executed as simple work orders without the potential to damage the relationship." (Academia)

Characteristic #9 – Flexibility

> "You want your partnership to be structured in a manner that enables those relationships to be developed, generally on a one-on-one basis: very customized, fairly articulated, but most importantly, very flexible." – James L. Oblinger, Ph.D., Former Chancellor, North Carolina State University

Although the terms and conditions of the partnership may appear to be clearly delineated at the beginning of the partnership, it is important to keep an attitude of flexibility throughout the project. Research is often a fluid endeavor and may require partners to review progress and make adjustments mid-stream. Informants report that partners who are flexible

and can easily adapt to changes and corrections are the most desirable ones with whom to work. Flexibility and patience are key attributes in making transactions happen and promote the ability to be creative enough to see the bigger, broader picture so that it perhaps it makes sense to engage with a commercial partner in a way that isn't immediately obvious. The partnership will benefit when there is an open and flexible attitude that allows partners to look beyond the immediate transaction and strategically recognize the bigger picture and future possibilities.

> *"You can develop better partnerships if you learn how to listen instead of always saying, 'this is how it is.' That give and take, that flexibility, that fluidity is critical, particularly for the long term relationship."* (Academia)

> *"Having people who are willing to do things maybe a little differently and work together is critical."* (Industry)

> *"It's important to offer up options and have some contingencies to work within to keep the agreement flexible. You must be nimble enough not have it stopped in its tracks because it gets caught up in some kind of contractual dispute. Flexible does not necessarily mean not specific. Sometimes it is specific but with different scenarios."* (Industry)

> *"It's never really one size because you have to be able to get to know the company and you have to really personalize that agreement for each of the companies based on their needs."* (Academia)

> *"What you did on the last deal isn't necessarily what's going to work on the next deal. You have to be flexible enough to look for solutions that might work."* (Academia)

> *"It's so important to remain flexible. There is always something that blows up. I want to work with people who are flexible and who can go to Plan B when Plan A blows up in their face and not people who just lose their minds. There are people who are really good when things are all going well but when things go off the tracks they seem to lose their mind."* (Industry)

Characteristic #10 – A manager who keeps the project on track

> "I think a key part of the success is having a relationship manager who is essentially the single point of contact and knows how to gain access within the partner organization." – Ronald McDermott, Ph.D., Vice President, Kellogg Company

The role of a translator as a person who understands the language of both academic and industry partners was seen as an important component of success by informants. Having a manager who is directly involved in the relationship and can see the broader view of where the two very different cultures overlap can help move beyond project disruptions and disagreements. Frequent contact by the designated manager can keep small issues from becoming larger problems that can sidetrack the project agenda.

> *"It's having a contact person at both the university and the company who both have some decision-making capacity that is so important. These individuals can stay in touch with one another and if things are not going the way they should be, those two are empowered to find out why."* (Industry)

> *"It's critical to have someone whose total job is just to make sure that those partnerships are achieving what everybody thought they were going to achieve, and keeping them from getting off-track, before you get to the point where something happens that's a real problem."* (Academia)

> *"You really do need to have someone like a concierge whose role is to help walk the partners through the process, let them understand who to talk to, what the university's concerns are, and what strengths and weaknesses are, so that we can come up with something that meets everybody's needs."* (Industry)

> *"Having a strong leader or a coordinator is really important – someone who is a project manager who understands the different participants, how they work, what they do, and is able to direct the research as well as make decisions."* (Industry)

> *"The most effective partnerships have someone who is a liaison between the actual scientist and the people in the department who are being funded and the donor or the company. "* (Academia)

> *"Sometimes you may have hundreds of accounts you are working closely with in industry. So it's important to have a single account manager who the company knows they can go to, to help them find their way around to make things easier. We are really large and complex organizations and we are trying to make it easy for people to interact by having a single point of contact in making those connections."* (Academia)

> *"You are going to have conflicts. You just have to manage them. So it is not to try to avoid the conflicts of interests; it is to manage the conflicts of interest."* (Industry)

> *"Having a project manager, a coordinator, who can monitor the progress toward milestones and shepherd the progress is critical."* (Industry)

> *"The professors don't have the ability to do this; even the administrators don't have it. You have to have someone who can shepherd the cause and manage it. Her job is to*

keep the list. She pings everybody all the time. She puts meetings together. She is the driver and I appreciate that kind of stuff." (Academia)

"The project manager is not always a scientist, but he's a relentless facilitator. He can even be to the point where he can be a little bit on the naggy side, but we tell him that and over the years he has become very good at not tipping over onto the nagging side and can apply just the right amount of pressure almost all the time." (Academia)

"The scientists can say all the sophisticated stuff but we need someone who can manage the relationship. XXX follows up with all the thank-yous, the emails and the follow-up information. She's the one who writes the to-do lists and doesn't leave anything left undone. And most importantly she has a way of making herself an innocent party. So if she asks something inappropriate or pushes too hard it's not the scientists or the administrators who have to feel the heat. It keeps all of us a little cleaner." (Academia)

Characteristic #11 – Well-trained tech transfer staff

"The relationship with the university can set the tone for everything you do from that point on. That, of course, has everything to do with your tech transfer office. Everything starts from a company point of view of how good or how flexible or how accommodating your tech transfer office is." - John Cavanagh, Ph.D., N.C. State University

The most successful partnerships are facilitated by technology transfer offices that approach the deal structure as partners, not negotiators. Informants report that when tech transfer officers are skilled in the technology aspect of commercialization and are able to think creatively about how to structure a transaction or partnership that is specific to a partner as opposed to a boilerplate agreement, then the relationship begins as a true partnership effort. Having the tech transfer office work in conjunction with and as part of a team with the legal counsel, departmental faculty, scientific staff and development officers can help to facilitate and expedite the sometimes long and cumbersome process of reaching a written agreement. Industry informants speak positively about those tech transfer offices that are able to offer a seamless process for reaching an agreement. They applaud a process that is expeditious and is characterized by open communication and elasticity. They describe the best tech transfer offices as "progressive," "nimble," and "quick."

"The one thing I would add to that is you don't want to mess up the direct faculty-to-researcher relationship by any policies at the university. But if you are really going to grow partnerships, you have to think about them more broadly and more strategically. We try to be careful not to make it difficult for our faculty to have the $5,000 testing agreement with XYZ Company while we try to elevate our relationship with XYZ to a higher level. We are careful not to screw that up." (Academia)

"Teaching the tech transfer staff was one of my biggest challenges. I had to emphasize to them that they needed to be good listeners, so that they would hear what the person on the other side of the phone was saying to them about how they had to structure the deal." (Academia)

"People in research administration come from all walks of life. I've had employees who were historians and anthropologists. If they don't have some sort of financial background to help understand the money part of the perspective, they don't always know that the company could be under water." (Academia)

"As tech transfer offices get more start-up activity under their belts they get a better idea when to be firm and when to be flexible. As companies understand how universities work, they come to appreciate what universities can do." (Industry)

"One of the problems universities have in tech transfer is that they hire people who don't really understand what the commercialization process is all about, so they continually encumber the development of technology into a product." (Industry)

"We set up a task force in my office with the research foundation, tech transfer, counsel and sponsored programs to look at what the company wants and, if we can, accept it and negotiate it quickly to minimize delays." (Academia)

"There's never really a one size fits all because you have to get to know the company and personalize the agreement for each of the companies based on their needs. The tech transfer office has evolved to a place where we try to make it easy for companies with master agreements, finding ways to do project proposals and develop budgets, and then go forward with it without having to negotiate each time and making sure the agreement represents the different concerns of each of the payers involved. The concerns of an electric utility are very different from those of a bank, which is going to be different from dealing from a manufacturing company. It takes a while to really understand what a company's real needs are and where there are sore points. After that, it smoothes the road tremendously because we've got a common set of ground roles that everybody understands and makes it a lot easier for the new projects to flow more easily." (Academia)

Characteristic #12 – The presence of an internal champion

"The most successful partnerships are the ones where there is a strong advocate on both sides." – Mary Ann Lila, Ph.D., Director, North Carolina State University Plants for Human Health Institute

Partnerships seem to benefit greatly from the existence of a champion who takes a personal and passionate interest in the success of the partnership. Even more beneficial is the existence of a champion on both sides of the table, both of whom have a strong interest in seeing that the partnership avoids getting caught up in minor misunderstandings or lapses in communication. The champion also is able to see beyond the individual competitive interests and view the common good that can be achieved through the successful partnership.

> *"Occasionally we are fortunate enough to have that one person who is excited about the project or knows about it and it just fits with him. It's a kind of serendipity. The challenge is building or developing a champion within the industry partner who is excited about the project; who can champion the cause of the university technology at the company so that we can avoid some of the 'not invented here' hurdles or who can get industry scientists excited and engaged even though they have their own projects they are working on."* (Industry)

> *"The most successful project has a single champion working the project. It is better if you have a couple of champions, but if you don't have a couple of champions then one champion is usually sufficient."* (Industry)

> *"You need to be able to point to that one person at XXX and one person at the university as say 'that guy is 100% behind making sure this project is going to work'."* (Academia)

> *"I really think the key was finding the right partners who were leaders in their respective fields and were willing to go the extra mile to make sure the project stayed on track."* (Academia)

> *"The most successful partnerships are the ones that have a champion who is a strong advocate on both sides."* (Industry)

> *"If you have that champion for your project then when things get difficult he can step in and sweep away the problems and just issue the approval."* (Academia)

Characteristic #13 – Support from the top

> "The leadership at the top of the university and the relationship between the president, the provost and the industry leadership is absolutely critical. If there is a good relationship there and people are making great effort, then the stars are aligned and you can do great things." – Steven A. Lommel, Ph.D., Vice Chancellor for Research, North Carolina State University

Informants report that it is extremely important to the success of the relationship that the senior leadership of both the university and the company see the inherent value of the partnership and are willing to invest both the time and financial resources to assure that the partnership has the opportunity to grow and flourish. When difficulties arise, often the leadership at the top can step in and make sure the differences get resolved quickly and the focus on achieving the goals of the partnership remains strong.

> *"Sometimes these discussions or negotiations seem to go on forever. It may be necessary for the CEO of the company and the Chancellor to have an off-line conversation and say 'do we want this to happen?'. If the two of them decide they want to continue, that can be very important to making things happen. Sometimes when you reach an impasse you just have to have another level of commitment, another level of oversight to say 'should we move forward or should we just pack it up and go home'. Ultimately the CEOs and the Chancellors are the ones who make that decision."* (Academia)

> *"It's great to have the buy-in of senior management. This gives the project instant credibility."* (Industry)

> *"Who is at the table is extremely important during the negotiation. It has got to be people from each organization who actually shape the focus of the organization, who have the power to make decisions and the recognition that what they say can actually happen."* (Industry)

> *"If you have a major initiative, you must have top management on board from the very beginning, or it's not going to work. When the project has a large budget they will say 'why should we invest here as opposed to University X?' You have to get the senior management to see the value in what your university can do that sets it apart from others."* (Industry)

> *"The leadership at the top of the university and the relationship between the president, the provost and the company personnel is absolutely critical."* (Academia)

> *"The project was successful because it got the support all the way up to the President."* (Academia)

Characteristic #14 – Interdisciplinarity

> "The universities that have an attitude of interdisciplinarity where people from one department talk to people in other departments generate something that is wildly different from other universities and can produce some pretty exciting break-throughs." – Carl P.B. Mahler II, J.D., Executive Director, Office of Technology Transfer, UNC Charlotte

Industry informants report that there is great interest from academic partners who can cross disciplinary boundaries among departments within the university and develop partnerships which can approach problems harnessing the intellectual capital of scientists from disparate backgrounds within the university system. The university who can put together such interdisciplinary teams is a valuable asset to the industrial partner who is looking to access as many innovative and novel ideas as possible as a result of the partnership. "Like a tsunami, an emphasis on interdisciplinarity is the wave of the future; universities that have the foresight to now become prepared will have placed themselves in a position to make a difference in the years to come" (Hirsch and Weber, 2002, 88).

> *"You are not going to benefit from the industry partnership unless you understand what their needs are and then try to see if that aligns with yours. Often this takes a multidisciplinary approach where you pull in resources from different departments within the university."* (Academia)

> *"Academic boundaries are a mystery to the nonacademic world. We protect them and we believe departments know how to manage their affairs. But if you go out and talk to business and government, particularly business which is always reinventing itself due to the competition, they don't quite see how you can justify saying 'this is how we've always done it'. They want to see academic scientists working together across disciplines to look at things from different perspectives and bringing different skill sets to the table."* (Academia)

> *"We have to be a truly interdisciplinary university now where you've got the mechanical engineers working with the computer scientists and sometimes even with the biologists - all working on common projects that they all have got the same sort of buy-in for."* (Academia)

> *"The fact that they had that same sort of interdisciplinary attitude where the folks from one department would be talking to people about something wildly different from their own department, it really made for some pretty exciting breakthroughs here."* (Industry)

Characteristic #15 – Physical proximity

> "We could have just sat in our offices in California and rounded up partners to work with but that is never as good as being so close that you can actually sit and talk in the corridors and have them write on white boards with you and stop by their offices. It makes things happen much quicker and much faster and is much more useful to us to be close." - Nicholas D. Gillitt, Ph.D., Director, Dole Nutrition Institute

While not imperative, informants report that being able to be in close physical proximity with the partner facilitates an effective partnership. The personal connection that is made by casual and frequent contact facilitates the ease of developing effective communication channels and a strong working relationship. Partners want to know that they can easily interact with each other in a convenient and timely manner.

> *"We wanted that recognition of the person sitting on the other side of the table. Sitting together face to face and working through issues was important to us."* (Industry)

> *"Proximity is not a deal killer, but the fact is, a lot of our deals have been based on proximity. This has to do with the personal relationship. I can drive and see the people I am working with, invite them to football games, have a quick dinner. It's all about relationships."* (Academia)

> *"We can sit in front of our computers and we can do all of our meetings virtually. We can save cross country and international travel, but that can only happen after that period of trust has been built up, and that almost always involves personal interaction, in the same room interactions."* (Industry)

> *"Location, location, location. They loving being on the campus, physically accessible to not just the state-of-the-art facilities that we had that they could use, but also students, faculty, corporate, executives, and workers interacting in that environment. That was really a special situation."* (Academia)

> *"There's something magical about the mix of the people and the different walks, different roles that those people are playing at points in time, whether they are current students or students who did internships and who then got hired and became employees. Putting all of these people in contact with each other on a daily basis where they could interact and work together in the same place was a wonderful thing."* (Academia)

> *"I could give you dozens of examples where things would have never happened if we hadn't had breakfast or lunch in the hospital cafeteria. I don't think it would have happened that we discussed working together; we sort of just stumbled across it. This was where things started to happen."* (Industry)

> *"Proximity certainly helped us make our decisions. Companies need to know that there is an established presence and the ability to access the academic partner easily and frequently." (Industry)*

Table 24 summarizes the fifteen characteristics of successful partnerships as described by the key informants.

Table 24: Characteristics of successful partnerships

1. Long-term partnership relationships are more successful than short-term projects.
2. A strong element of trust exists between the partners.
3. Clear alignment of goals and overlapping missions.
4. Partnerships provide a win-win situation.
5. Effective communication skills.
6. Interpersonal relationship or prior experience with the partner.
7. Reputation and expertise of the partner.
8. The ability to iron out problems at the beginning of the partnership.
9. Flexibility.
10. A manager who keeps the project on track.
11. Well-trained tech transfer staff.
12. The presence of an internal champion.
13. Support from the top.
14. Interdisciplinarity.
15. Physical proximity.

9.0 DISCUSSION

> "We are just at the beginning of an era of essential partnerships, alliances and coalitions. We are learning to build community beyond the walls of the organization, with the same kind of initiative and energy we have used in building the organization within the walls." – Frances Hesselbein, in Working Across Boundaries (Linden, 2010, 3).

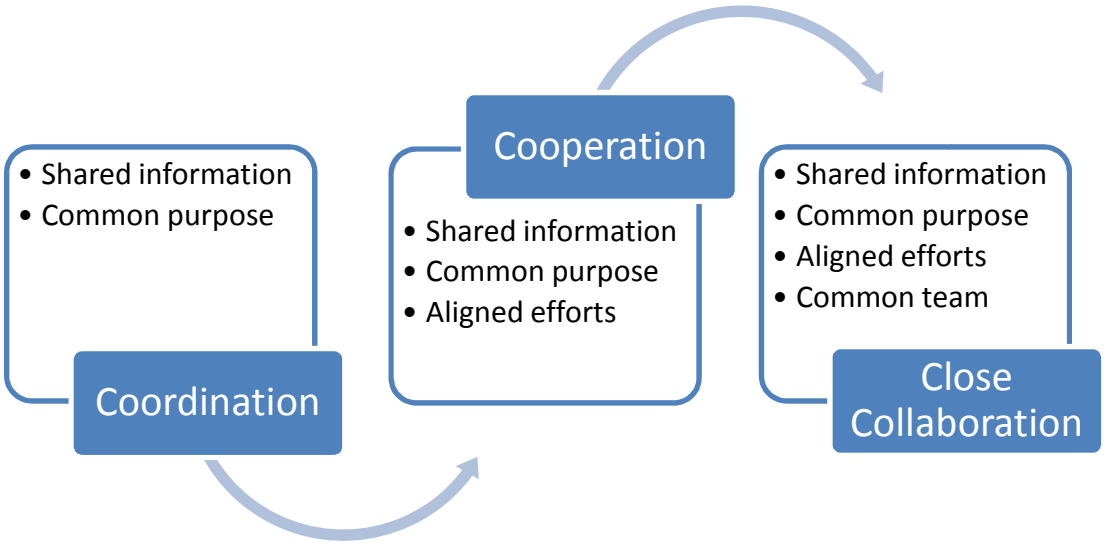
The purpose of this section is to examine the findings and seeks to reflect upon the larger meaning these results offer in order to develop and implement a Plan for change.

Throughout the four aspects of this study – the literature review, key informant interviews, case perspective analysis and document review – information was gathered in order to answer the research questions. The literature review sought to understand current knowledge and evidence as to successful academic-industry partnerships and what the literature might perceive as barriers to success. The process of conducting key informant interviews and the subsequent case perspective analysis sought to get point in time information from experts in the field and to analyze their interpretations and experiences based on real-life practice. The document review attempted to look for trends and commonalities in how institutions address these obstacles and challenges.

As a result of this search, the subject of building collaboration and coalitions became a major focus of this discussion, specifically, the characteristics and attributes which were observed in the data collection process that would be contributory to building collaboration and therefore, successful partnerships. In *The Future of Public Health in the 21st Century,*

the Institute of Medicine defines collaboration as "a purposive relationship between partners committed to pursuing both an individual and a collective benefit" (Institute of Medicine, 2003, 389). Rosenberg et al. (2010) wrote that true partnerships exist along a spectrum from coordination, to cooperation, to close collaboration. Table 25 illustrates this continuum:

Table 25: The partnership continuum



(Rosenberg et al., 2010, 5)

Academic partners and their industry partners may initially have common purposes and may even share certain information with each other. As they move into the cooperation stage, the sharing of information and commonality of purpose allows for the formation of partnerships where efforts begin to align and partners begin working cooperatively toward the formation of an integrated team. In a true partnership, members from both sides of the partnership develop a level of comfort in which they begin to function as a common and integrated team working toward a unified goal. According to Rosenberg, true collaboration can be defined as "those rare times when people from different organizations come together with passion and purpose and accomplish dramatically more than any agency or person could

do alone" (Rosenberg et al., 2010, 9). He concludes by citing Rob Lehman from the Fetzer Institute: "Collaboration, on the surface, is about bringing together resources, both financial and intellectual, to work toward a common purpose. But true collaboration has an 'inside,' a deeper more radical meaning. The inner life of collaboration is about states of mind and spirit that are open – open to self-examination, open to growth, open to trust, and open to mutual action. The practices of true collaboration are those practices of awareness, listening, and speaking that ring us into openness and receptivity" (Rosenberg et al., 2010, 7).

An understanding of the forces that surround academic-industry partnerships must first acknowledge the levels of influence that affect these partnerships: individual, relationship, community, organizational and societal (Linden 2010, 37). Utilizing that framework, the barriers which were identified in the literature review and the key informant interviews can be characterized as follows, although many of these barriers can actually be attributed to more than one category, as indicated in Table 26:

Table 26: Mapping of the key findings on barriers to partnerships[6]

[6] Adapted from Linden (2010,37)

Rosenberg et al. (2010, 13) assert that "the seeds to success or failure are sown in the early stages of a partnership - that awkward period when disparate organizations come together to start a common effort." Many university industry partnerships, by nature of the requirements of their independent organizations, must begin with the lengthy legal process of defining the goals and objectives and addressing the various outcomes which may exist. Although critical, this focus on the contractual may cause the partnership to miss important work that must be done before the partnership begins to take shape, including identifying the right partners, developing a goal that is actually important to both partners and agreeing on approach, organization and role of the partners.

Rosenberg et al. state "the forces that pull people apart are very strong, some of them are wired into the very DNA of organizations, and it takes far more than good intentions to make collaborations work" (2010, 59). They conclude that potential collaborators must work diligently to avoid the "highly mitigated culture" that may cause an unwillingness to confront these difficult issues that may not be openly expressed (2010, 54). This culture may contribute to an atmosphere in which partners, unwilling or unable to exert the energy necessary to work through differences in goals and objectives, deem the partnership unworkable because it does not develop in accordance with their original views of what the partnership would offer. As a result of this, issues may remain unresolved and the impact of the partnership is lessened.

Individual partners will always arrive at the beginning of a partnership with their unique and personal agendas, as well as an organizational agenda that is to be addressed. It is important to find a mechanism to bring these agendas into alignment in order to fulfill the maximum potential of the partnership. Rosenberg defines this process as one in which

members are intrinsically challenged to set aside individual egos and concerns and to acknowledge the motivations which influence each member, including personal and organizational objectives (2010, 90).

Although the mission at the beginning of this research project was to develop a list of characteristics that would secure the success of an academic-industry partnership, it became clear during the evolution of the research that there simply is no "magic bullet" that can make these partnerships succeed. The list of characteristics for successful partnerships that was developed as a result of the interviews with key informants is certainly indicative of the qualities which describe some of the partnerships that have met with a measure of success. But underlying these qualities and characteristics is the basic tenet that there are critical, almost fundamental, qualities possessed by the individual partners that must be integral to the partnership. Although the list of characteristics which were summarized from the key informant interviews are ones that most certainly would describe any successful partnership, several of them are critically important for successful academic-industry partnerships. Upon a review of the data collected from informants, these qualities rose to the top in terms of frequency and intensity of the discussions:

1. Trust
2. The ability to form interpersonal relationship
3. The ability to align goals and objectives
4. The presence of strong communication skills
5. The ability to look at the relationship as a true partnership

These qualities can be defined as the presence of a heightened level of social capital. This social capital must be developed between the partners in order to create the intense level of trust necessary for the formation of high level collaborations indicative of successful

partnerships. Absent the presence of complete trust that the partners share the same sense of vision and direction, that there is no desire to manipulate the partnership in a way that benefits one side of the partnership at the expense of the other, and unless the goals of the partnership have been aligned in such a way that evokes a clear understanding of the mission and objectives, then the partnership will not succeed.

The establishment of trust and a shared vision lays the groundwork for a more collaborative method of problem-solving to address many of the contentious issues that were identified as potential barriers to collaboration. Rosabeth Moss Kanter from the Harvard Business School (Linden, 2010, 94) states: "Alliances cannot be controlled by formal systems. Rather, they require a dense web of interpersonal connections. Successful partnerships manage the relationship, not just the deal." Keeping the focus on the vision and the relationship and not letting structural or operational difficulties wear down the partnership will increase the likelihood for success dramatically. Being able to communicate this vision is "the lifeline for any type of collaboration. Communication is vital to the building of the personal relationships from which trust emanates" (Rosenberg et al., 2010, 122). Partners must also accept that the development of the shared vision is "an interactive, circular process and not a simple, linear progression from vision to strategy to action" (Yukl, 2006, 300). Linden concurs with the importance of developing trust as the basis for collaboration. "Trust and confidence form the soil from which collaboration grows. The essence of collaboration is joint effort toward a common goal, which means we are reliant on each other. If we don't trust the other to follow through, if we don't have the confidence in the other's abilities, it will not work. It's as simple and important as that. Detailed memos of understanding won't replace mutual trust and confidence" (Linden, 2010, 42).

10.0 PLAN FOR CHANGE

> "Academic and business research should therefore be seen as overlapping and interacting systems, with the former augmenting the capacity of the latter to solve an increasing range of complex problems." (Brusoni et al., 2001, 796).

10.1 Yukl's discussion of resistance to change

In order to surpass the fundamental barriers to collaboration, one needs to understand the underlying potential areas that cause partners to resist change. Yukl, in *Leadership in Organizations* (2006), writes that there are several areas of resistance:

1. Partners may not have trust in the people who propose the change. There must be a belief in the potential partner and a feeling of trust that there is proposed mutual benefit for both sides of the partnership. This kind of trust can only be developed when academic and industry partners have laid the groundwork for the kind of meaningful relationships that characterize successful partnerships.
2. The belief that change may be unnecessary. Partners may believe that the same research agenda can be achieved within the organization and view the partnership as unnecessary. The process of establishing silos, or keeping information separate or isolated, among universities and organizational bureaucracy among industry may contribute to the feeling

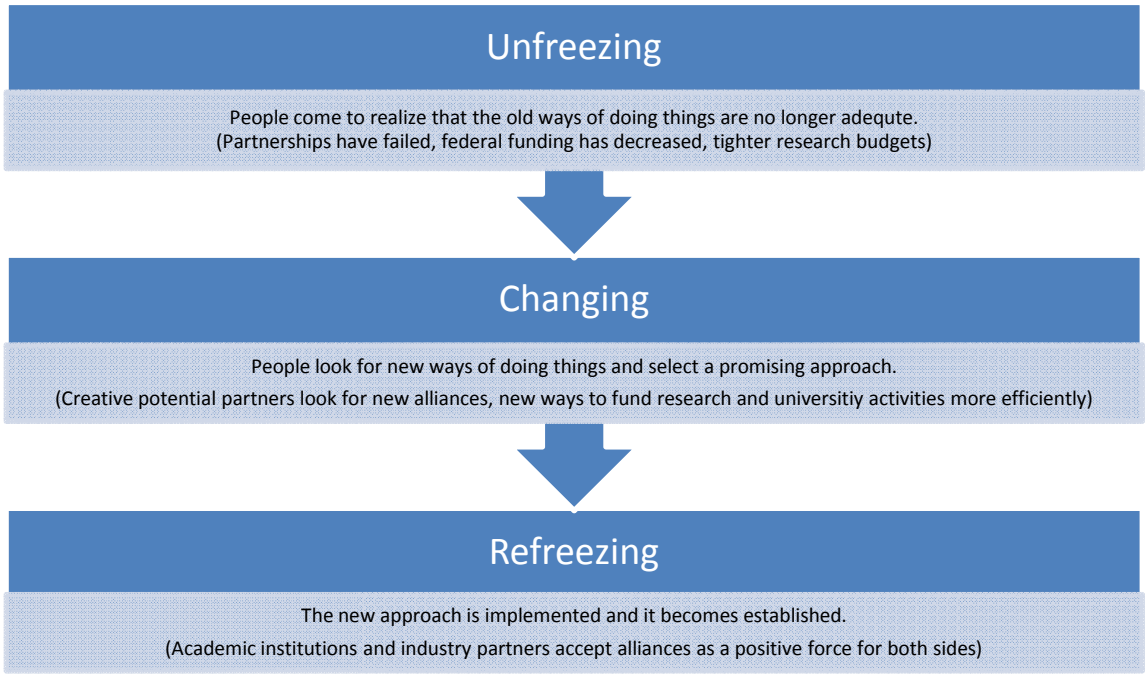
that external partnerships are unnecessary and have nothing to add to the current research agenda.

3. The belief may exist that the change is not feasible or that the research agenda is unlikely to succeed. A lack of understanding of the professional capabilities, scientific prowess and past accomplishments of the potential partners may contribute to pessimism that the partnership could yield positive results.
4. The potential of higher costs may cause partners to weigh the potential inconvenience of doing things in a new and different way, and may believe that the change will result in higher personnel or facility costs as a result of additional responsibilities or duties the partnership might entail.
5. Fear of personal failure. Some potential partners might fear the loss of their own personal freedom and expertise by bringing in the expertise and specialty of outside partners.
6. The threat to values and ideals. If the organizational culture of the company or the academic institution encourages siloed thinking and proprietary values, then the concept of partnering with someone and sharing confidential data with an outsider may cause resistance.
7. Partners may resent interference. Partners who are unaccustomed to working in partnership situations may resist change because they perceive the possibility of being controlled by others as an attempt to manipulate or force change, causing resentment and hostility.

Yukl adds that "unless people acknowledge the need for change and perceive that they have a choice in determining how to change, they will resist it" (2006, 286). Lewin

describes a "force field model" which is necessary in order to evoke change in an organization. This model, depicted in Table 27, incorporates three steps toward evoking change:

Table 27: Lewin's force field model for change



(Yukl, 2006, 286)

In order to fully convince partners of the need for change, stakeholders must understand that the vision for a more productive future outweighs the short-term inconvenience or discomfort incurred by those changes. The vision that is communicated should appeal to the ideals and aspirations of the organization as well as the individuals whose cooperation is required. According to Yukl, this vision should be challenging but realistic and should emphasize distant ideological objectives rather than immediate tangible benefit. The vision should also be focused enough to steer decisions and planning but general

enough to allow for the initiative and creativity of the stakeholders to contribute to the development of strategies for attaining it (Yukl, 2006, 295).

10.2 Further thoughts on change from Kotter

Change can stall because of "inwardly focused cultures, paralyzing bureaucracy, parochial politics, a low level of trust, arrogant attitudes, lack of teamwork and the general human fear of the unknown" (Kotter, 1996, 20). The influence for change can occur only through a clear understanding of each of the stakeholders which are to be targeted, the culture of these stakeholders' organizations, the shared beliefs and assumptions which exist and the underlying needs and values of the stakeholder organizations. To succeed, the plan for change must incorporate the convergence of diverse visions from people throughout the stakeholder organizations, including academia, industry and institutional partners. "The combination of trust and a common goal shared by people with the right characteristics can make for a powerful team. It will have the potential to do the hard work involved in creating the necessary vision, communicating the vision widely, empowering a broad base of people to take action, ensuring credibility, building short-term wins, leading and managing dozens of different change projects and anchoring the new approaches in the organization's culture" (Kotter, 1996, 66).

Kotter's leadership theory suggests that change will not occur if these three situations exist:

1. The urgency of the vision is not understood or has not been properly communicated.

2. Leadership has not been successful in establishing systems or structures that will allow people to affect change. Even if all the proper stakeholders have been put in place, change will not occur if the resources have not been allocated.
3. Change agents assert that change has occurred too early in the process, before stakeholders have internalized the new behaviors, and before the change has had an opportunity to solidify itself (Kotter, 1996, 21).

Clearly, the ability to establish successful partnerships and collaborations will only occur if change agents are able to communicate the vision, establish strong relationships and sustain these behavioral changes over a sustained period of time. Kotter further elucidates effective and successful organizational change in his eight steps of change: 1) creating a sense of urgency, 2) creating a guiding coalition, 3) developing a strong vision and strategic plan, 4) communicating the change vision, 5) empowering employees for broad-based vision and plan of action, 6) generating short-term wins, 7) consolidating wins and producing further change and 8) anchoring new approaches into the organization's culture (Kotter, 1996, 20-24).

10.3 Reported barriers and solutions

The 57 key informant interviews identified barriers that must be addressed as part of the development of a plan for change. Twelve barriers to successful partnerships were identified and summarized in Table 28:

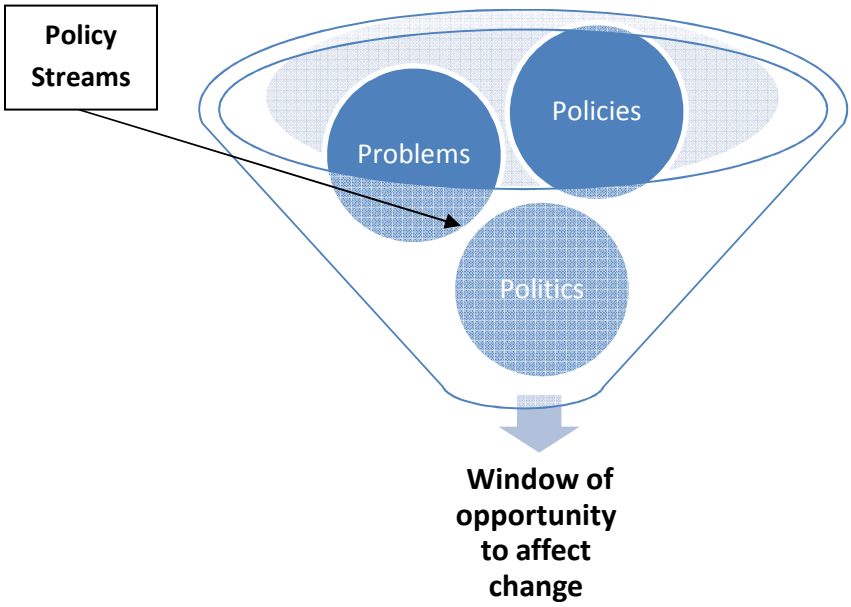
Table 28: Reported barriers and solutions

Reported barrier	Potential solution
1. Intellectual property rights and ownership	Open communication and discourse, trust in the partnership effort, convergent vision
2. Accountability issues relating to timetables and schedules	Open and frequent conversation and reporting structure, established measurables and end goals, clearly defined objectives
3. Cultural differences	Building interpersonal relationships, shared beliefs and missions, skilled communication
4. Poorly staffed tech transfer offices resulting in lengthy documentation process	Ability to see strategic partnership opportunities, working through contract issues at onset of partnership
5. Unrealistic expectations and lack of clear goals and objectives	Ability to articulate the vision and work through the plan of action, effective and clear communication channels
6. Overhead rates and lack of transparency	Trust, effective communication
7. Publication rights	Willingness to understand the academic mission of education, trust, confidentiality
8. Changes in personnel	Strategic relationships and interpersonal connections that override individual preferences and "pet projects"
9. Changing priorities	Strategic goals that supersede individuals' goals and speak to the mission of the partner organizations
10. Internal issues and intra-organizational struggles	Belief in the common overarching mission of the partnership
11. Confidentiality	Clear understanding of what is acceptable to each of the partners
12. Academic freedom	Indisputable acceptance of the academic mission

10.4 Kingdon's theory of agendas, alternatives and public policies

The development of new and energized policies on the part of both academia and industry is greatly needed. Kingdon suggests through his theory that policy alternatives occur across three independent streams: problems, policies and politics depicted in the diagram in Table 29 below:

Table 29: Kingdon's policy window model



While different stakeholders play roles in each of these streams, the streams are interrelated in order to advance any sort of effective change effort. An issue "is most likely to achieve public agenda status when public problems, policy alternatives and political opportunities intersect" (Kingdon, 2003, ix). The participants in these independent streams, or "policy entrepreneurs," are continually looking for the connections between current politics and potential policy change and are looking for these "windows of opportunity" which emerge. When the convergence of problems, policies and politics is properly

capitalized upon by policy entrepreneurs, issues can then be placed upon the political agenda and can become issues of corporate, social and institutional development.

These windows, or problems and policy unrest, exist within universities and academia today. Kingdon likens the conveying of ideas for change to a "primeval soup" in which individual ideas and thoughts are combined, resulting in the formulation of new policies and agendas. "Ideals float around in such communities. Specialists have their conceptions, their vague notions of future directions and their more specific proposals. They try out their ideas on others by going to lunch, circulating papers, publishing articles, holding hearings, presenting testimony and drafting and pushing legislative proposals. The process often does take years...and may be endless. The 'soup' changes not only through the appearance of wholly new elements, but even more by the recombination of previously existing elements. Some ideas survive and prosper; some proposals are taken more seriously than others" (Kingdon, 2003, 116-117). Certainly, from the perspective of academic institutions, policy changes are being driven by political agendas including decreased funding, absence of research and grant funding and other budgetary restrictions. Corporations are also considering alternate mechanisms for funding downstream research in more cost effective ways by partnering with academic experts and eliminating costly internal research and development functions. "Many universities are coming to realize that with recurrent expenditures mounting, student demographics changing, and salaries demanded by able teachers and researchers on the rise, a pure teaching function might prove to be unsustainable. Closer relations with the business sector may be unavoidable. Thus, university policies are in transition and seeking a compass that will reconcile past experience with current aspirations. This activity is raising their profile and perhaps paving the way for a

substantially larger role in what is shaping up as a global innovation system. If innovation is likely to be the principal driver of growth, universities could emerge as the most dynamic transnational entities and a commercial force in their own right" (Yusuf & Naeshima, 2007, 18-21). This process of developing the "primeval soup" relies on experts who possess "knowledge, time, relationships and good reputation" in order to provide multiple solutions to these complex issues and agendas. These experts are shrewd and perceptive enough to recognize the relationships that exist among the problems and the policies and to connect the streams in a way that "meets the test of political feasibility" (Kingdon, 2003, 147).

The following three sections identify the plan for change within the three independent streams of policy alternatives developed by Kingdon: problem streams, policy streams, and political streams. These streams are summarized in Table 30:

Table 30: Summary of the plan for change within the Kingdon model for policy alternatives

Change within the problem stream	1. Oral Presentation of dissertation research findings
	2. Dissemination of written research findings through white paper
	3. Industry conferences and symposiums
	4. Submission of findings in scientific journals or scholarly publications
Change within the policy stream	5. Establishment of monthly scheduled meetings to discuss partnership progress
	6. Mentoring opportunities for young faculty and industry employees on the NCRC
	7. Poster presentation at fall symposium at NCRC
	8. Establishment of Chemistry 101

Changes within the political stream	9. Sharing of research findings with policy makers and leaders
	10. Consensus building and policy development among NCRC faculty and industry officials

10.4.1 Kingdon's "problem stream"

This study focused in part upon the problems which exist as barriers to successful academic partnerships. Kingdon states that "problems are matters of interpretation and social definition" and will only be perceived as legitimate issues when there is adequate pressure to take action. In both the worlds of industry and academia, there is awareness that leveraging the collective assets can provide competitive advantage to both partners. Table 31 describes that the first step in the plan for change must be to increase awareness of the problem stream.

Table 31: Plan for change within the Kingdon problem stream

Action item	Target audience
1. Oral Presentation of the research findings	Faculty of the NC Research Campus
2. Dissemination of written research through white paper	Research faculty at the home institutions of the UNC system, other interested stakeholders, study participants
3. Industry conferences and symposiums	Broader audience of stakeholders and professionals involved in research and partnership opportunities
4. Submission of findings in scientific journals or scholarly publications	Selected journals and publications

10.4.2 Overview of the "problem stream" plan for change

1. *Oral presentation of research findings* - A presentation to participants in academic-industry partnerships who are active on the North Carolina Research Campus (NCRC). There are approximately 350 faculty and staff working on the NCRC who are actively involved in academic-industry relationships. It is anticipated that these results will facilitate existing partnership relationships as well as provide beneficial information to initiate new partnership opportunities. Discussing these results will create awareness to existing barriers between successful academic-industry relationships as well as successful partnerships at the NCRC and within the university institutes. This presentation will occur at a symposium to be held at the David H. Murdock Core Laboratory Building on the NCRC in summer, 2014. Targeted participants include faculty and research team members from the university institutes, industry partners, and institutional partners.
2. *Dissemination of research in white paper* - A white paper containing the research findings will subsequently be made available to those academic scientists within the sixteen campuses of the UNC system who might benefit from the experience of the key informant interviews. An electronic copy of the results of this research will be made available to the Vice Chancellor of Research at each of the UNC campuses for distribution to faculty members involved in research initiatives.

The mode of delivery and sharing of information will be an important component of this action item. Technology and electronic media, including Facebook, Twitter, blogs and interactive media, such as audio and video podcasts, should be included and are effective ways to communicate with the ever increasing tech-savvy

society. An executive summary of the research results will be posted on the NCRC Facebook page as well as our weekly digital newsletter, *The Collaborator*, which is widely distributed among more than 2,000 campus partners, legislators and other members of the scientific and academic community with a link to access the report in its entirety.

Many of the key informants and others who contributed to the body of this research have expressed interest in reading the results of the research and a copy of the white paper and a link to the entire dissertation report will be sent to them electronically for their information. Many of these individuals occupy positions within their respective institutions and companies that would allow them to begin a useful dialogue regarding ways of developing more successful partnership relationships. Education and credible information are essential prerequisites to informed decision making. Being able to convey this information and communicate the messages is a critical component of effecting change.

3. *Industry conferences and symposiums* - Because of the researcher's work in developing partnerships and alliances on the North Carolina Research Campus, she has become recognized as a subject matter expert, having presented on numerous occasions at conferences, meetings and seminars. The results of the research will be shared with participants of the University-Industry Demonstration Project at their general meeting in fall 2014, where the researcher has been asked to present on a panel regarding successful partnerships. The research will be submitted for potential inclusion in the UIDP Webinar Series for maximum exposure to all of the public and private institutions, corporations, national laboratories and government agencies who

are members and participants in this organization. The material will be submitted for presentation at the fall 2014 convening of other technology transfer meetings or meetings which emphasize collaborative academic and industry research initiatives, including BIO, the Business Higher Education Forum, the National Council of University Research Administrators and the Association of University Technology Managers. The researcher will also endeavor to meet individually with the chief research officer at each of the eight universities which are located on the NCRC in order to better ascertain whether a dialogue can be initiated to further understand barriers and opportunities for partnerships.

4. *Submission of findings in scientific journals or scholarly publications -* A synthesis of the findings of this research will be submitted for publication in various academic and scientific journals, including *The Journal of Technology Transfer, The Journal of Higher Education, Research Management, the Journal of the Society of Research Administrators, Management Science, Research Policy, Technology Analysis and Strategic Management, R&D Management, Industry and Higher Education, Industry and Higher Education and the Journal of Policy Analysis and Management*.

10.4.3 Kingdon's "policy stream"

Kingdon describes the policy stream as one in which "many ideas float around, bumping into one another, encountering new ideas, and forming combinations and recombinations. The origins of policy…. are obscure, hard to predict, and hard to understand or to structure. Order is developed from chaos, pattern from randomness." Additionally, in many ways, recombination, or the coupling of already familiar concepts, is more important than mutation, or the appearance of entirely new ideas (Kingdon, 2003, 200). Because this

recombination of notions, cultures, thoughts and ideas is more important than invention, there may be "no new thing under the sun" although there may be the opportunity for dramatic and transformational change and innovation. In order to facilitate this opportunity, there must be a high level of communication, interaction and social capital shared among the stakeholders (Kingdon, 2003, 201), as described in Table 32:

Table 32: Plan for change within the Kingdon policy stream

Action item	Target audience
1. Establishment of monthly scheduled meetings to discuss partnership progress	Senior Faculty of the NC Research Campus
2. Mentoring opportunities for young faculty and industry employees on the NCRC	Junior level faculty, post docs, mid level scientific industry staff
3. Poster presentation at fall 2014 symposium at NCRC	All faculty and industry partners at NCRC and interested community leaders
4. Establishment of Chemistry 101	All faculty and industry partners and potential partners at NCRC

10.4.4 Overview of the "policy stream" plan for change

1. *Establishment of monthly scheduled meetings to discuss partnership progress* - The results of this research are static and cross-sectional, but new participants and players in the academic-industry partnership arena will be constantly unfolding and developing, causing the plan for change to be a dynamic one. New players can offer unique perspectives on potential problems, issues and solutions. Therefore, a working group of scientists located at the NCRC has been organized to continue discussing

issues and proposed solutions to developing new and enhanced partnership relationships. This group will convene on a monthly basis and the results of these meetings will shared via a listserv email with campus partners and participants. Not only will this group focus on actual partnership opportunities, it will focus its efforts on many of the elements of transformational leadership that have been discussed in this report. Effective communication skills, methods of overcoming cultural differences, the development of social capital and understanding strategic relationships will be important issues to discuss at these monthly meetings. Only through the development of long term relationships and strategic partnerships can meaningful success of this change item occur. Kingdon writes that "when interested stakeholders submit their perspectives, preferences and proposals for consideration…. these ideas confront, compete and combine with each other," leading to the ability to successfully affect policy change (Kingdon, 2003, 116).

2. *Mentoring opportunities for young faculty and industry employees on the NCRC* - Peer group influence and social networking are vitally important communicators for the exchange of information in the academic community, as well as with younger members of the workforce. Peer educators and mentoring should be advocated for increasing education about forming alliances and creating networks among the scientific and business community. The peer education aspect is a critical piece of the plan for change as peers can share a common identity with the target audience and often speak a common language. As a result of their familiarity with the audience's cultural and experiential background, they are able to convey useful and real-life information, contributing to potential success.

3. *Poster presentation at symposium at NCRC* - A poster competition will be held in fall 2014 at a symposium in which post doctoral faculty and interns can present posters regarding successful partnership ventures in which they have been involved. Awards will be presented for those posters which best exhibit a collaborative effort toward a successful partnership. Posters will then be displayed for two weeks in the common area of the David H. Murdock Core Laboratory Building and will be featured on the NCRC webpage, the DHMRI webpage and in an article in the weekly *Collaborator.* This will give visibility to the issue of improving and strengthening academic-industry partnerships and will hopefully encourage others to solidify potential relationships.
4. *Chemistry 101 -* Although the pairing of potential partners in the workplace setting is critical in terms of aligning expertise, scientific objectives, and research interests, establishing personal relationships and the development of social capital is at the heart of successful collaborations. To that end, a weekly social venue held on the balcony of the David H. Murdock Core Laboratory Building has been established to facilitate interpersonal interaction and relational opportunities. It is anticipated that as stakeholders develop meaningful personal connections with others, partnerships will evolve as trust and rapport take root. Informal social settings provide non-threatening opportunities for potential partners to become familiar with each other, both in terms of background and scientific expertise, but on a personal and social basis.

10.4.5 Kingdon's "political stream"

In order to affect change, Kingdon describes the existence of social moods that influence a broader pattern of thought and policy, including "organized political forces,

patterns of support for or opposition to the prominence of certain agenda items, within interest groups or other structures" (Kingdon, 2003,146). He continues: "As officials and those close to them encounter ideas and proposals, they evaluate them, argue with one another, marshal evidence and argument in support or opposition, persuade one another, solve intellectual puzzles and become entrapped in intellectual dilemmas" (Kingdon, 2003, 125). In order to affect this political stream, groups must be able to achieve consensus among the stakeholders. This consensus among stakeholders is the force that can have significant impact on policy agendas and outcomes. Kingdon writes that every social movement needs organization and leadership to have a policy impact. The elucidation of the issues surrounding academic-industry partnerships will hopefully initiate discussions among policy makers, those in leadership roles and industry decision-makers. The results of the expert informants who were interviewed as part of the research process provide feedback and "credible information on social conditions, available policy options and likely impacts, recurrent interactions with policy makers, a large and geographically dispersed membership, group cohesion and unified positions on priority issues, and organizational resources" (Kingdon, 2003,149). Further, advocates for policy change can "find a receptive audience" and an "opportunity to push their ideas" (Kingdon, 2003, 149).

The plan for change within the political stream is described in Table 33:

Table 33: Plan for change within the Kingdon political stream

Action item	Target audience
1. Sharing of research findings with policy makers and leaders	Academic, industry, institutional leaders
2. Consensus building and policy development among NCRC faculty and industry officials	University senior leadership and officials, industry executives, legislators and thought leaders

10.4.6 Overview of the "political stream" plan for change

1. *Sharing of research findings with policy makers and leaders* - Meaningful policy change and strategic focus will occur primarily when presented in consensus by a variety of stakeholders. Therefore, an increased awareness of the issue of improving strategic partnerships will be an important step in finding solutions to barriers and improving the potential for partnerships. By listening to the voices of industry and academic experts as they pertain to the need for strengthening strategic partnerships, an opportunity will present itself to encourage increased advocacy from senior university leadership as well as senior industry executives with the power to invoke policy changes and support for these partnerships.
2. *Consensus building and policy development among NCRC faculty and industry officials* - Policy advocacy and the ability to bring a unified voice to policy makers as well as among the constituent stakeholders is an important element of the policy stream. By acknowledging barriers and comparing successful strategies for the development of partnership relationships, the stakeholders are able to learn from each other and will share useful information that is critical to the collaborative process.

The success of this plan for change will be realized over an extended period of time. It is anticipated that there will be a high degree of interest in this subject among faculty and corporate partners, improving the likelihood of success of academic-industry partnerships. Therefore, this much discussed issue will increasingly be one that is vetted among interested parties at meetings, seminars, academic and industry settings. It is hopeful that this discussion will facilitate more open communication between the potential partners, which is the very essence of successful partnership relationships. As successful communication

occurs, this topic will be one that is centric to corporate research planning and the academic mission and agenda. As this takes root, we will be able to define success in the partnerships that will develop across a broad spectrum of opportunities for collaboration and alliances.

10.5 Evaluation of the plan for change

Outcome measures to evaluate the success of the plan for change will be utilized on a qualitative basis, as we learn about the challenges and successes on the personal, sociological, and professional levels. Interviews with participants in the plan for change action items can provide rich information concerning the implementation of successful partnerships and barriers for success. This information can then be used to further refine working groups, dissemination of information and policy recommendations. An annual review of the partnerships on the NCRC with participants and stakeholders will be held in order to ascertain what aspects are working well and what barriers or issues have arisen during the implementation and development of the partnership. Kingdon states that "feedback often brings problems to (our) attention, programs that are not working as planned, implementation that does not square with the interpretation of the legislative mandate, new problems that have arisen as a result of a program's enactment or unanticipated consequences that must be remedied" (Kingdon, 2003,100). Feedback from stakeholders involved in the plan for change will come both from systematic monitoring and evaluation which will take place in the form of interviews with stakeholders on a quarterly basis and also from an informal monitoring of the social interactions that occur at the meetings, symposiums, social opportunities on the campus and daily professional interactions. The exchange may only be achieved through joint cultivation of leadership skills essential for a successful collaborative process.

One of the most important contributions to the political agenda, according to Kingdon, is the awareness of the problems that comes from our own experiences in administering a program. Therefore, this researcher's daily work responsibilities will enable her to closely monitor the action items that have been proposed and implemented in the plan for change.

10.6 Broader implications of the plan for change

The plan for change incorporates explicit goals and timetables within the problem, policy, and political stream recognized by Kingdon's theory of policy alternatives. While the plan for change outlines specific actionable items, it is the goal of this researcher that the dissemination of these research findings will generate a broader discussion among both academic and industry leaders toward the development of a more seamless and informed approach on the part of both sides of the partnership toward the development of these relationships.

Academic partners should work toward a more transparent and strategic approach to partnerships, one which offers greater ease to the industry partner in identifying potential partners across disciplines. University leadership must work to develop a single point of contact for potential partners; one who could coordinate technology transfer officers, legal representation, department heads and research faculty. The single point of contact could navigate the labyrinth of conflicting interests and work to provide timely proposals to potential industry partner, eliminating one of the most frequent barriers to partnerships as reported by industry informants.

Greater efforts should be made to educate and inform those members of the academic community as to the relationships that the university has made with industry partners in order for these individuals to see the broader strategic implications that these partnerships can offer. When an effort has been made to educate faculty and staff about the potential benefits and past contributions of industry relationships, then the discussions can move beyond singular transactions and toward the long term focus that this research found to be the most effective type of relationship.

University partners must find ways to offer transparency and accountability in order to allow their industry partners to meet their corporate objectives in funding research projects. Scientists working at the bench must receive some training in how to interface with business in meeting the corporate objectives of productivity, return on investment and accountability. By understanding the culture of business, these academic scientists will not only be able to perform high quality science, they will be able to understand the unique perspective of corporate thinking in terms of evaluating future investment in the research arena.

Finally, the discussions regarding the future of academic-industry relationships must originate at the highest levels of both academic institutions and corporate leadership. When university administrators mandate that the interface of academic research and industry participation be streamlined in a way that calls for all levels of participation within the university to work together in achieving a broader strategic focus, the quest for a single research transaction will move aside for the development of longer term goals and objectives. Likewise, industry participation will increase when senior executives look beyond individual,

short-term results and find partners with whom they hope to partner in long term relationships to achieve broader, strategic initiatives.

11.0 CLOSING COMMENTS

The intellectual exchange between academia and industry is complex, calling for an integrated set of policies in education, development, research and development, recruitment, subsequent employment and job creation. These policies need to strike a balance between entrepreneurship and the autonomy of research and innovation that can stimulate the rise of novel discovery and the commercialization of new industry. This exchange will only be achievable if both academic and industry partners cultivate the leadership skills that are essential for a successful collaborative process. These skills "are not the traditional leadership skills. Collaboration requires leadership through persuasion and relationship building because the real coalition skills are interpersonal. These types of leaders must excel at surfacing ideas, facilitating thoughtful discussions, listening to different perspectives, handling conflict and voicing consensus as it develops" (Rosenberg et al., 2010, xiii).

While the research has elucidated many of the challenges that potential partners face in the development of long term relationships, further research is needed to clarify the actual mechanisms necessary for a more comprehensive, intersectoral policy-development approach, an effective communication plan and the necessary components of a feasible educational program that incorporates an institutional and organizational approach to the development of long-term partnerships. One certainty remains: in order to build consensus and bridge existing deficiencies, meaningful dialogue within and between academic and industry settings must occur in order to broaden the current paradigm of academic-industry partnerships.

APPENDIX A - INTERVIEW RECRUITMENT LETTER

Dear (insert participant's name),

I am currently a student in the DrPH program at the Gillings School of Global Public Health at the University of North Carolina at Chapel Hill. My dissertation project centers on the relationship between industry and universities as they partner for research and innovation. I would like to ask for your participation in this research. Participation will involve a personal interview at a place and time that is convenient for you and will last no more than one hour. The purpose of the interview is to solicit your opinions about how your organization partners with (insert universities/industry) for research, innovation and new product development. Specifically, I am interested in understanding the characteristics and qualities that make these relationships successful as well as what you perceive to be the major barriers to the establishment of effective, successful partnerships.

Thank you for considering participation in this research initiative. Please contact me at (704) 938-5410 or at lsafrit@castlecooke.com if you have questions regarding this study or if you would like to participate.

Sincerely yours,

Lynne Scott Safrit

Disclosure:

I am currently affiliated with the North Carolina Research Campus and I am responsible for developing partnerships between industry and universities. The data that will be assimilated for my doctoral dissertation is not related to any ongoing negotiation or partnership relationship.

I will be the sole recipient of the information that is obtained from your responses. All participants will be asked for permission before any reference to their identity is made in my thesis or in any subsequent publications. Additionally, any records of the interview will be maintained electronically in password protected files and any hard copy information that is linked to a specific individual will be stored in a locked file.

APPENDIX B - INTERVIEW CONSENT FORM

Title of Study: The Intersection of Academia and Industry: Avoiding Pitfalls and Navigating Successful Partnerships

Purpose of the Study: The purpose of the study is to obtain a better understanding of the relationship between universities and industry in developing research partnerships and to utilize that knowledge to recommend a change in strategic focus for either industry or academia in how partnerships are developed and structured.

Potential Benefits and Harms: There is no direct or indirect harm that could result in your participation in this study. However, your participation in this study could result in personal benefits by elucidating certain factors that cause problematic issues in developing industry-university partnerships, or by highlighting certain characteristics that may cause these partnerships to develop in a more positive way.

Anonymity: Your anonymity will be maintained at all times throughout the course of this study. No information that is obtained as a result of your participation will be disclosed or attributed directly to you without your prior written consent, and final reports will provide aggregated data or data that are not attributable to a single source. All data files will be stored will be stored on a password-protected laptop and maintained in a secure location. All files will be destroyed once the final analysis is completed.

Consent

I, _____, understand that I am being asked to participate in a study to answer questions relating to partnerships between universities and industry, and to identify barriers to these partnerships as well as facilitating factors to the development of these partnerships.

I understand that I am voluntarily participating in this study, and I can refuse to answer any question during the course of the interview. I can withdraw from the study at any time.

If I so request, I will receive a copy of the summary of the results of this study upon its completion. I understand the nature of the study in which I am participating, and I have been provided with a copy of this executed consent form and a copy of the approval of this study by the UNC Chapel Hill Institutional Review Board.

_____ _____ _____

Signature of Participant Name (please print) Date

If you have any questions or concerns, prior to or following your participation, please do not hesitate to contact the following:

Lynne Scott Safrit
lsafrit@castlecooke.com
(704) 938-5410

APPENDIX C - GUIDELINE FOR INTERVIEW QUESTIONS

Purpose of the Interview:

The purpose of this interview session is to gain a better understanding of academic-industry partnerships, what makes them successful and what barriers exist to their success. Approximately 25 individuals from both the university and industry settings will be interviewed. The interview process will take approximately 45 minutes. However, it may be necessary for me to contact you either through email or telephone if there are follow-up questions. The interviews will be confidential in nature, and your comments will not be directly attributed to you in a way that would disclose your identity. The themes and ideas that emerge as a result of this study will be used to advise and inform parties that are involved in the negotiation of or the development of academic-industry partnerships in an effort to improve strategies, impact organizational planning and achieve positive and long-term results.

Do I have your permission to record this interview session?

Do you have any questions about the study or this interview?

Briefly describe your role within your organization in the context of academic-industry partnerships.

Is there an example you could offer of a partnership that has been successful for you? What was it about that project/partnership that made it work well?

What were the goals or objectives for that project? How were the goals determined? Were they clearly defined or documented for both parties? Was there a written document that outlined all of the terms for the research initiative?

Was there a written agreement that outlined faculty time, industry staff time, funding, etc.?

What was the method of communication between the partners? Was there a plan in place prior to the partnership that outlined how, when and to whom information would be communicated? Was there a regularly scheduled method of communication? Was it written or verbal? Were there regularly scheduled updates? How were communication problems handled if they arose?

Was the timeline for the partnership discussed upfront? How was this timeline determined? If issues arose, how did you handle them?

Can you tell me some of the things that have worked well for you in your experience with academic-industry partnerships?

What would you consider are some of the characteristics of successful academic-industry partnerships?

Can you think of an example of a partnership that didn't work? What were some of the reasons that it failed?

What are some of the barriers that you perceive that cause these partnerships to fail (PROBE: intellectual property, timing/publication rights, culture, alignment of goals, agreed upon objectives, assignment of duties, speed of negotiation, type of project, communication plan, confidentiality)? Do you have an example of a partnership that has failed? What was the reason for its failure?

Which type of partnership do you consider the most successful (PROBE: long term, special purpose, research orientation, fee for service, focused time frame)?

How did you measure whether or not a particular partnership was successful? Was there a predetermined measure of success contemplated at the beginning of the partnership?

What do you see as the primary benefits of academic-industry partnerships to your organization?

What was done, if anything, to manage any difficulties that arose during the relationship?

On a scale of 1 to 5, with 5 being the most important and 1 being the least important, could you rank the following aspects of a university-industry partnership in terms of their importance to the success of the relationship?

1. The development of specific goals and objectives.
2. Prior relationship with the research partner/past experience.
3. Buy-in by senior leadership/management.
4. Assignment of duties.
5. Trust between the two partners.
6. Establishment of a plan for communication.
7. Development of a long term partnership instead of a one-time/short term project.

Are there any other thoughts or opinions about academic-industry partnerships that you would like to share with me?

Are there others at your organization that you would recommend that I speak with about this topic?

May I contact you again with follow up questions or for clarification?

Thank you again for your time to discuss this topic. I greatly value your insight and your knowledge about this subject matter. May I use your name and title in the final report or would you prefer that I keep all or part of that information anonymous? If you are interested, I would be happy to share the results of this study with you when the final report has been approved and accepted by UNC.

APPENDIX D - INTERVIEW KEY

1	Armentrout	09/07/12	2:30pm	47 min.	A-008	09/16/12
2	Bath	09/23/12	2:00pm	32 min.	I-013	12/12/12
3	Billingsley	09/11/12	2:00pm	38 min.	I-005	10/19/12
4	Brigonnet	10/16/12	2:00pm	55 min.	B-004	02/11/13
5	Broad	11/01/12	11:00am	41 min.	A-033	01/22/13
6	Brock	09/20/12	9:00am	33 min.	A-022	09/25/12
7	Brown	09/18/12	3:30pm	42 min.	A-017	12/02/12
8	Burhman	09/19/12	9:00am	38 min.	A-018	10/14/12
9	Califf	09/12/12	4:00pm	51 min.	A-015	12/10/12
10	Casey	09/04/12	8:00pm	38 min.	A-002	10/19/12
11	Cavanaugh	09/10/12	9:30am	39 min.	A-011	12/02/12
12	Christian	09/11/12	3:00pm	42 min.	A-013	10/19/12
13	Colman	01/29/14	9:20 am	42 min	B-005	01/31/14
14	Crosbie	09/17/12	10:15am	39 min.	I-007	11/03/12
15	Cutcher	09/20/12	3:30pm	38 min.	A-021	11/25/12
16	Faridi	09/18/12	10:00am	39 min.	I-008	12/06/12
17	Gillitt	09/07/12	10:00am	47 min.	I-002	09/14/12
18	Heylman	09/10/12	3:30pm	40 min.	I-003	12/19/12
19	Johnson, L.	09/25/12	9:00am	58 min.	I-015	01/21/13
20	Johnston, D.	09/21/12	2:00pm	52 min.	I-011	12/20/12
21	Kresovich	09/05/12	11:00am	70 min.	A-005	12/21/12
22	Leath	09/27/12	11:00am	39 min.	A-025	10/03/12
23	Liao	10/03/12	11:00am	38 min.	A-028	10/12/12
24	Lila	09/07/12	11:00am	41 min.	A-007	09/23/12
25	Lomax	09/25/12	10:30am	39 min.	A-024	12/03/12
26	Lommel	09/04/12	2:30pm	50 min.	A-001	01/30/13
27	Luce	10/04/12	10:00am	45 min.	I-019	10/12/12
28	Luther	09/24/12	10:00am	57 min.	I-014	11/03/12
29	Mahler	09/20/12	1:00pm	50 min.	I-019	11/26/12
30	Maxwell	09/07/12	3:30pm	46 min.	A-009	12/18/12
31	McDevitt	09/11/12	9:30am	43 min.	B-002	12/12/12
32	McDermottt	10/04/12	9:00am	51 min.	I-018	11/16/12
33	McIsaac	09/06/12	3:00pm	36 min.	I-001	11/27/12
34	Mercier	09/21/12	10:15am	32 min.	A-023	09/29/12
35	Mittleman	09/13/12	3:00pm	36 min	B-003	10/07/12
36	Murphy	09/20/12	2:00pm	37 min.	A-020	11/29/12
37	Nieman	09/05/12	2:00pm	71 min.	A-003	11/16/12
38	Oblinger	09/11/12	11:00am	43 min.	A-012	11/09/12
39	Pilkington	09/04/12	1:15pm	40 min.	B-001	09/09/12
40	Piller	09/20/12	10:00am	79 min.	I-010	11/29/12
41	Roses	10/11/12	9:00am	56 min.	A-030	11/12/12

42	**Ryals**	**09/17/12**	**11:00am**	**42 min.**	**I-006**	**11/14/12**
43	**Sanhai**	**09/21/12**	**11:00am**	**40 min.**	**I-012**	**11/29/12**
44	**Smith**	**10/24/12**	**4:30pm**	**34 min.**	**A-032**	**12/10/12**
45	**Sonnefield**	**09/12/12**	**9:00am**	**38 min.**	**A-016**	**11/16/12**
46	**Steffens**	**09/19/12**	**2:00pm**	**33 min.**	**I-009**	**10/07/12**
47	**Steltzer**	**10/04/12**	**2:00pm**	**34 min.**	**A-029**	**10/18/12**
48	**Swick**	**09/11/12**	**1:00pm**	**37 min.**	**I-004**	**09/30/12**
49	**Thorp**	**10/11/12**	**2:00pm**	**40 min.**	**A-031**	**11/16/12**
50	**Torphy**	**09/25/12**	**2:00pm**	**44 min.**	**I-016**	**12/12/12**
51	**Wagner**	**09/28/12**	**4:00pm**	**34 min.**	**I-017**	**10/18/12**
52	**Waldrop**	**09/11/12**	**4:15pm**	**37 min.**	**A-014**	**09/28/12**
53	**Wilhelm**	**10/02/12**	**4:00pm**	**51 min.**	**A-027**	**11/07/12**
54	**Williams**	**09/06/12**	**9:00am**	**34 min.**	**A-006**	**09/28/12**
55	**Woodson**	**09/07/12**	**8:30am**	**35 min.**	**A-010**	**10/01/12**
56	**Young**	**09/28/12**	**2:30pm**	**47 min.**	**A-026**	**10/03/12**
57	**Zeisel**	**09/05/12**	**4:00pm**	**40 min.**	**A-004**	**09/25/12**

APPENDIX E - KEY INFORMANT THEMES & NUMBER OF STATEMENTS CODED PER THEME

Themes	# of Statements
Reasons Partnerships Form	30
Benefits of Partnerships – General	97
Benefits of Partnerships – Opportunities for Students	24
Benefits of Partnerships – Economic Development	18
Measures of Success	12
Recent Trends	4
Best Practices – Universities learning to perform like businesses	14
Characteristics of Success – Multidisciplinary	29
Characteristics of Success – Builds on the strength of each partner	22
Characteristics of Success -Long-term partnerships	127
Characteristics of Success – Physical proximity	16
Characteristics of Success – Interdisciplinary	7
Characteristics of Success – Internal Champion	19
Characteristics of Success – Overlapping Missions	25
Characteristics of Success – Ironed out problems at the beginning	44

Characteristics of Success – Flexibility	42
Characteristics of Success – Clear alignment of goals	82
Characteristics of Success – Support from the top	16
Characteristics of Success – Manager who keeps things on track	38
Characteristics of Success – Reputation and Expertise	78
Characteristics of Success - Win-Win situation	98
Characteristics of Success – Well-trained tech transfer staff	35
Characteristics of Success - Clear objectives	52
Characteristics of Success – Personal relationship with partner	99
Characteristics of Success - Transparency	32
Characteristics of Success - Open communication	97
Characteristics of Success - Trust	84
Barriers - Accountability/Timing/Deadlines	96
Barriers - Bureaucracy	20
Barriers – Conflicts of Interest	18
Barriers - Confidentiality	12
Barriers - Tech Transfer Office	20
Barriers - Internal Issues within university/industry	21

Barriers - Change/turnover in personnel	33
Barriers - Lack of flexibility	18
Barriers - Unmet expectations	64
Barriers - Changing priorities	25
Barriers - Documentation process is complicated/cumbersome/lengthy	73
Barriers - Overhead rates	47
Barriers - Cultural differences	86
Barriers - Publication Rights	41
Barriers – Intellectual property	148

APPENDIX F - SAMPLE EXCERPTS FROM KEY INFORMANT INTERVIEWS

Goals are aligned

"…to the degree that we can successfully march back in line with each other we are going to do a better job for our patients and ultimately our shareholders."

"Getting the business obviously had to do with cost, IP, and their willingness to be flexible and work with us, did they have a physical location where we could place a laboratory. The technical side was how well they would align with us strategically in terms of our technology interest and capabilities and where those arrows point."

"I think it's a problem is when you try to move ahead without knowing whether you have the shared goals. There has to be some time to make sure that you have built the allegiance."

"You are not going to get something from the industry side unless you understand what their needs are and then try to see if that aligns with ours. Our institution, we think, has a reputation and a tradition of interdisciplinary work, partly from the land grant and partly from the kind of faculty we have attracted here. That helps in these areas and certainly helped to win the some big projects."

"We begin with the assumption that each stake holder has both common and competing so there will opportunity to enlarge the pot and in effect times to divide the pot, but beginning with that assumption most initiatives work best where there is a shared vision of success and

that doesn't mean that everyone has to have the same meaning of what success represents for them, because again when you assume common and competing interest, there has to be enough areas of overlap so that the part of the word shared is not just success or vision, so there is in effect something in it for each of the parties."

"Initiatives that work the best deliver on what I call both ends. They have to deliver both on the separate interests of each of the parties as well as the shared interest. If you are just asking people to contribute to the collective good then it is a form of charity and it is limited on the impact and the scope people agree on."

Communication

"To have industry be happy, you have to communicate carefully what the boundaries are. You have to listen to what is important to them and deliver it. You can't take the money and not deliver. Often with governmental grants, you don't have to deliver what you promise you just have to deliver science. With industry it is more a kin to a contract and you must deliver what you promise. Most investigators are not used to that culture."

"Well, I think that is one of the things that you have to be really good at - letting people know that you hear what they say and listening to the other side. It seems that a really important component in developing successful relationships is to be able to communicate that to people and have them know that you are not just in it for what you want, but you are trying to look at what would be a win/win for both partners."

"It bites you big time and it tarnishes your relationship. What I said before, when you are trying to build a legacy, you cannot afford that. I would rather be upfront and tell you what we can and cannot do. If we deliver, fine. If we don't, fine. At least I was honest with you."

Personal Relationships

"I think it is better if you have a long term relationship. Now the trouble with working with industry is that people move around a lot, much more than in academia. So often you do all that cultivating and they move to a new position. The nice part is they almost never leave the related industry and end up as a director of research of another company and you can resume the relationship. Usually it is worthwhile to cultivate that relationship."

"Relationships … that is really key for industry. If you know somebody who actually knows what they are doing, you are going to try to partner with them. I worked with somebody in the past that I totally respect that person. They deliver and they know what they are talking about. That's what motivates me for a partnership."

"It's all about networking. The network I have is the most valuable thing I have. After 35 years in the industry, I can call somebody and they'll connect me to somebody that can solve my problem if they can. I think the relationship in a network and the credibility through the network is the most important thing in a partnership because I would never partner with somebody I didn't know."

Change in Personnel

“Major reason that that happens is that people leave. Some partner who had something important to contribute ends up leaving his company or leaving his position then the availability of that resource changes and the new person doesn't have the appetite for it.”

“Often it's difficult because you start working with a researcher within a company, and because companies like to move people around, all of a sudden you find yourself working with somebody new and they either don’t have the same passion for that particular research objective or search initiative, or it just sort of falls through the cracks and they are left floundering. That is a legitimate complaint that happens a lot.”

“You get so far along in a project and then there is a change in management within the company and all of a sudden that person doesn't have the same interest or the same focus and it dies on the vine because the focus changes, but that isn't anything you can control.”

Timing/Schedules

“There is an urgency in terms of deliverables and that is often an issue where the companies are frustrated when we ask a third time extension on the project. Faculty members don't rise to that level of concern for them.”

“ Basically it comes down to them just learning to communicate with the other party to try to understand the objectives, the timetable, the needs and making sure the language is the same in terms of the end result. Then staying in contact. It doesn't do anybody any good to call if you call a month after the report is supposed to be there and it's not there and you are angry

about it. You should know to keep in touch with the investigator, keep the calls regular so you know the reports will be on time."

"You know time is money and I think the universities don't appreciate that at all. If I want this thing, I want to get it concluded this month or it's going to have much less value to me. If you spend 6 months trying to negotiate a tougher deal, you've probably just taken a lot of value out of what you are looking at because it has taken a while to get there."

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