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University and industry research relationships and interactions

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Iowa State University

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DEDICATION

This thesis is dedicated to my family, for their love and moral support during my college career. To Marion Lee Mitchell, my father; Mary Ann Mitchell, my mother; Marion Lee Mitchell Jr., my brother; Debra Ann Mitchell-Best, my sister; Patricia Ann Mitchell, my sister-in-law; Johnny Ray Best, my brother-in-law; and to my nieces and nephews, Micheal, Barron, Sonya, Thomas, Larry, Tammy, Johnathan, Tasha, and James. Thank you for all you have done in helping me to get where I am.
CHAPTER I. INTRODUCTION

The transfer of technology between university and industry has fascinated many, especially those who are directly involved in the transfer process. Technology advances rapidly and has a considerable impact upon manufacturers and society as a whole. As manufacturers seek technological innovation, expectations increase for new technology. Therefore, qualified and reliable sources must be available to transfer technology.

Students, professors, and scientists are viable sources for transferring technology day after day; thereby acquiring knowledge and skills necessary to implement innovations to other environments. Schreiber (1984) reports from a panelist's discussion on technology transfer:

> There was general agreement that the most successful method of transferring technology is to transfer people, to send selected individuals from industry to the research lab for a while (p. 71).

People transferred from university to industry and industry to university are more capable of implementing ideas of new technology because of first hand explanation and expertise. The exchange of people to each sector usually results from a collaborative relationship between university and industry.

A collaborative relationship includes common interests and needs in such areas as research and development, project activities, and research facilities. Consultants are normally the chief agents responsible for finding and pointing out interests and needs to both industry and
collegiate institutions. The primary relationship is usually dependent upon a consultant, as Melchiori (1984) states:

In a 1982 study of 340 relationships by the national science foundation, it was found that institutional linkages are frequently the result of consulting relationships. In 66% of these consulting relationships, the university was the initiator (p. 4).

Consulting is one of several linkages to university and industry relationships. Other important linkages based on a study from the Center for Science and Technology are:

1. general research support which includes gifts, equipment donations, and endowments.
2. cooperative support and knowledge transfer via both institutional and personal interactions.
3. formal technology transfer which includes industrial parks, extension teaching, and research institutes.

Melchiori (1984) wrote that these programs enhance the relationship by providing financial assistance, closer interactions to small businesses, and university and industry representatives taking a major role in how research is to be conducted.

The relationship between university and industry is no mystery. Melchiori (1984) stated that for many years they have encountered problems with patent rights, environmental impact, research and development funding, etc. From industry's perspective the relationship is affected by such barriers as proprietary rights, Federal government intervening, tax laws, faculty inability to communicate, etc. As a result of university and industry inability to establish a collaborative
relationship, industries are forming their own colleges. According to David Swanson, director of Iowa State University Center for Industrial Research and Service, industries are most likely to interact with experts on particular problems than with the university. This problem is most foreseeable in that university workers, research more on developing new technology as industry seeks solutions to implement existing technology.

Declercq (1979), based on comments from many commentators, concluded that universities show up as weak partners in more permanent, commercial agreements. He gives these reasons for this weakness:

1. Universities are non-commercial organizations; they do not enter into commercial relationships without great circumspection, not to say reluctance (p. 240).

2. Universities are complex organizations, lacking a unity of vision and a hierarchy of objectives, which are so prominent in the commercial enterprises (p. 240).

3. Universities are inherently bureaucracies, in the technical sense of the word, unable to reach decisions quickly, forced to grope their way for every unusual decision through a concatenation of committees (p. 240).

Universities and industries can make a greater impact on society if they increase their interaction and establish a trustful relationship.

Statement of the Problem

This study was conducted to investigate the technology transfer process and collaborative relationship, if any, between Iowa State
Purpose of the Study

The purpose of this study is threefold:

1. To identify method(s) used, if any, to transfer technology from Iowa State University to Iowa Industries.

2. To identify factors affecting interaction in collaborative relationships, if any, between Iowa State University and Iowa Industries.

3. To identify areas in which industries are interested in establishing a collaborative relationship with Iowa State University.

Need for the Study

Universities are looked upon as a source of technological innovations to industries to improve the economic situation. In order for universities to provide this information, they must keep abreast of the latest technology developed. However, Declercq acknowledged that universities have fallen short of fulfilling this role as he states:

It is widely accepted, in Europe as well as in the United States, Canada, and Australia that the transfer of inventions from campus to industry, or more generally, the integration of system at large, is slow, deficient, below expectations, and disappointing (p. 237).

Universities in some way must be able to increase their output of research and be effective. The more technology is updated the more society demands from universities. Declercq (1979) recognizes that "universities are now more than ever expected to deliver the goods, to
give value for value received, in the form of useful ideas for economic innovation and regeneration" (p. 239).

Swanson (1984) reported from a study conducted on Iowa manufacturers that:

Iowa manufacturers have a need for information on a variety of technical topics, but data on products new to the marketplace, processing equipment, and materials dominate the executive's mind—although information on existing products and markets also holds considerable interest (p. 2).

He states further in the report that:

Iowa manufacturers emphasized the need for cooperative industry/university research projects and encouraging company investment in its own research (p. 3).

Baer (1980) discussed the potential need for university/industry cooperation as industry feels the lack of support for their needs. He stated:

Inadequate coupling of university education in science and engineering to industrial needs has been a recurrent complaint of industrial research managers. Although university seek to offer students more than just training for industrial careers, closer university-industry interactions can both increase the relevance of academic education and lead to more realistic expectations within each sector.

Since much more industrial R & D is proprietary and not subject to outside review or criticism, quality control is a persistent problem. Closer links to universities give industrial scientists and research managers better opportunities for constructive peer review and research "yardstick" measures of performance. Interactions also enable firms to compete more effectively of top flight university graduates (pp. 9-10).

There is a need for collaboration between university and industry,
both to provide universities with additional research support and help industries to remain economically viable. This study will attempt to answer the following questions concerning universities and industries collaborative relationships and interactions.

**Questions of the Study**

1. What is the present relationship between Iowa State University and Iowa Industries?
2. Are Iowa Industries interested in establishing a collaborative relationship with Iowa State University?
3. Should industry or educational institutions make the initial contact to establish a collaborative relationship?
4. What problems or barriers exist which inhibit collaborative relationships?
5. What are some suggestions to improve the relationship between Iowa State University and Iowa Industries?
6. What disciplines or projects have been supported by industry at Iowa State University?
7. Does industrial support increase industries' collaborative relationship with Iowa State University?
8. What method(s) are best used to transfer technology from Iowa State University to Iowa Industries?
9. What current innovations are being transferred from Iowa State University to Iowa Industries?
Assumptions of the Study

The following assumptions were made in order to conduct this study:

1. High technology industries will provide information on the transfer process and their collaborative relationship between Iowa State University and Iowa Industries.

2. The information provided from the survey does enhance the collaborative relationship with Iowa State University and Iowa Industries.

3. The collaborative relationship between Iowa State University and Iowa Industries will increase the transfer of technology.

4. The transfer of technology from Iowa State University to Iowa Industries has a considerable impact on the demands of their communities.

Limitations of the Study

The following limitations were made in order to conduct the study:

1. The study represents universities in the state of Iowa.

2. The study was limited to Iowa State University and industries in the state of Iowa.

3. The questionnaire for the study was limited based on the respondent answers and adequacy of information requested.

An ERIC search was conducted for the research study and review of literature. Additional information was obtained from books, articles, and journals. Parameters, questions, and purposes of the study were developed and proposed to the program committee for approval.
Development of the instrument was designed by the researcher, pilot tested, and discussed with professors at Iowa State University for purposes of validation and modification. Chapter II of the study which includes the review of literature was prepared as the survey was administered. Preparation of Chapter III included the methodology of the study. It discussed the methods and procedures used to obtain data for the study. This section also included an analysis of the data. Chapter IV contained results of data analysis and findings for the study. The summary, conclusions, and recommendations were prepared in Chapter V.

**Definition of Terms**

1. **Extension Services (trade)** - Instruction designed to supplement or extend the trade knowledge of skill, or both of employed workers on industry.

2. **Industry** - Synonymously used with company, business, and organization.

3. **Patent Rights** - In general inventions, innovations, discoveries, and improvements made with the use of university facilities or services, or during the course of regular assigned duties are the property of the universities, and can be used and controlled as to secure an equitable benefit to the public, the inventor, and the university.

4. **Research Institutes** - The collection, analysis, and presentation of institutional data upon informed administrative and faculty decisions can be based. Its
primary concern is practical research for the solution of institutional problems through the accumulation and analysis of data.

5. **Technology** - The application of scientific knowledge to the solution of practical problems.

6. **Technology Transfer** - A dissemination strategy intergrating knowledge of the latest technological practices, procedures for their implementation, tactics for their integration into existing delivery systems and evaluation designs to measure the achievement of technological mastery.

7. **University** - An institution of higher education consisting of a liberal art college, offering a program of graduate study, and having usually two or more professional schools or facilities and empowered to confer degrees in various fields of study.
CHAPTER II. REVIEW OF LITERATURE

University/Industry Relationship

Government, universities, and industries relationships have been the primary sources of enhancing the economic development throughout the United States. The government and industry both have played significant roles in university and industry relationships. Government has provided research facilities, seed money to stimulate creation of cooperative research programs. On the other hand, industry has provided industrial grants for equipment purchase, gifts of advanced research instruments, and shared industrial facilities (Baer, 1980).

Support from government and industry have increased opportunities for universities and colleges to excel in high-technology areas such as robotics, computers, and biotechnology. The advancement in such disciplines have had a considerable impact on the economic development as well as university and industry relationships (Jaschik, 1986c).

The White House Advisory panel, which consists of 13 industry and academic leaders, recognizes that "Our university system remains unmatched in the world" (McDonald, 1986b, p. 1). However, this does not mean that the country should take its superiority for granted in the decades to come. The advisory panel contends that if the United States is to maintain its economic and military strength, there must be "significant increases" in federal support to enhance universities' research facilities, to update scientific equipment, and to recruit science and engineering faculty members (McDonald, 1986b).

Despite the strengths that universities provide to the country, the
deficit-reduction law enacted in December 1985, will decrease the 1986 federal budget by $11.7 billion. This will decrease student financial aid by $244 million. Other programs will also be cut by 4.3 percent that provide colleges with grants for scientific research (Palmer, 1986).

Education department officials feel that the decrease in such programs are of little importance to universities and colleges. Palmer (1986) reported education department officials stated that spending cuts would be "easily absorbed." Regan Administration officials commented that:

4.3 percent spending reductions would not matter much because the federal government provides less than 10 percent of the money for education in the United States (p. 14).

Charles B. Saunders, Jr., vice-president for government relations at the American Council on Education, replies:

...such remarks were "gross distortions" because they "evade the fact that the federal government has the prime responsibility for providing student financial aid and for basic research (p. 14).

He further states that:

...it was unfair to characterize the spending cuts as insignificant, the federal government is the source of about 75 percent of all financial aid provided to students and about 64 percent of the money spent by academic researchers (p. 14).

Furthermore, the White House Advisory Panel noted that during the 1970s many universities and colleges became idle of purchasing equipment,
updating facilities, and recruiting faculty members because of a reduction in federal research support. The panel stated that:

Our universities today simply cannot respond to society's expectations for them or discharge their national responsibilities in research and education without substantially increased support (p. 1).

Certainly, money alone will not provide for success in a collaborative relationship between university and industry; however, it can help alleviate some of the barriers which they encounter.

The state government has supported college and university programs that have enhanced the economic development within the state. Jaschik (1986d) elaborates that economic developments enhanced by colleges and universities are applied in many activities such as the following:

1. The improvement of existing programs related to economic development at colleges and universities. Over the past three years, Florida has contributed $400,000 to each of 34 endowed chair for "eminent scholars" after the state universities raised $600,000 for each chair from private sources.

2. Providing direct assistance to individual businesses. Arizona's largest community-college district— in Maricopa County—sends administrators on trips, sometimes along with other state representatives, to encourage business leaders to locate industries in the State.

3. The improvement of the overall relationships among the three sectors: government, higher education, and business. In Illinois, a governor's task force successfully pushed the
state to create a computer system that could provide companies with information on a wide range of professors' abilities that could make them useful to industries located in the state.

4. The creation of joint ventures among a state, its universities, and industry. In Pennsylvania, for example, the state government has helped finance research centers in specialized fields such as robotics, biotechnology, computer science, ... (p. 12).

The Ben Franklin Partnership is one of the more successful programs to link university, business, and government. Jaschik (1986b) reports that the state government has supported this program during the 1986 year with a total of $21 million. The program consists of four advanced-technology centers which had made dramatic changes in the Pennsylvania state's economy. Surveys of businesses that have worked with the centers have indicated the existence of many new jobs and jobs that were saved. Jaschik (1986b) reports further on the enrichment of the Ben Franklin Partnership program:

From March 1983 through August 1985, the four centers led to the creation of 1,082 jobs in new companies and 970 jobs due to expansion of existing companies. Another 1,518 jobs were "saved" for employees of companies whose managers said they would have left Pennsylvania without the program's retraining and research-assistance features (p. 17).

In addition to state funding, the government participates with other programs which stresses outside funding and affiliated with the Ben Franklin Partnership program. The government allocates $3-million
to engineering schools which have to match every state dollar with three dollars of outside funding in order to receive a portion of the $3-million. Plosila, deputy secretary for technology and policy development in Pennsylvania's Department of Commerce, commented that this program was designed to help the "sputnik-era equipment," but has had a significant impact in enhancing the links between the engineering schools and industry.

Jaschik (1986d) cited Enarson, president emeritus of Ohio State University as he stated he supported:

...greater interaction among universities, industries, and state governments. "Left to its own devices, higher education would be hopelessly introspective, and it wouldn't be confronting the obligations it has to society" (p. 12).

Whether it be finances, facilities, or gifts, universities need the support of government to keep abreast of this rapidly changing world of technology. Kennedy (1985) points out that a 1 percent drop in federal support to university science would mean that industry would have to increase their support by 20 percent to make up for the difference. He also noted that less than 5 percent of university research is supported by industry.

Industry Supported Research

The percentage of industry sponsored research at universities is considerably low as compared to that which federal agencies provide to universities. The vice-president of research at MIT, Kenneth A. Smith, points out that industry is likely to have different interests in
research than federal agencies. For example, high-energy physics and plasma fusion are unlikely to attract industrial sponsorship. He adds, there are limits to the ultimate growth of industrial funding. Nonetheless, industries have been significant in providing support to university research and development (R&D) through the '70s and early '80s. The National Science Foundation (1983) reported that industry has increased its support every year since 1970. From 1980 to 1981 industry showed a 11 percent increase in support of R&D.

Desruisseaux (1986a) cited Haire, president of the Council for Financial Aid to Education, that corporate support for education has increased for 14 consecutive years from 1970. Business is taking a larger role when the federal government limits its spending for student financial aid and research activities. Desruisseaux (1986b) states that:

In recent years, in the wake of government cuts in funds for social and other domestic programs, more and more companies have either helped create, or provided support for programs dealing with a range of domestic issues, from hunger and homelessness to unemployment and education. The improvement of public school education has been the aim of many of the programs (p. 20).

Peters et al. (1982) elaborates that general funds from industry is distributed to the university by several methods. There are monetary gifts, equipment donations, endowments, contracted agreements, grants to professors, graduate fellowship support, etc. Monetary gifts are valued highly by university scientist because they are flexible in providing seed money for new projects and start-up funds. Flexibility of monetary
gifts provide funds for travel to conferences, for temporary support of graduate students and for bridging research contracts. Although monetary gifts are flexible scientists contend that such gifts from industry are rare, difficult to obtain, and small amounts, in the $5,000 to $10,000 range. An exceptional case of unrestricted gifts beyond this range was allocated to a computer science department at a public university in the amount of $500,000.

The National Science Foundation (1983) reports that industry has provided a great deal of R&D support in the area of engineering. For example, the chemical engineering departments received 23 percent of extramural research funds during 1980 from industry. In 1981, aerospace companies contributed $28 million to universities for R&D. Engineering and applied science programs received over 80 percent of the monies.

Industry has donated equipment to universities consisting primarily of computers or computer related systems. Peters et al. (1982) reported that a committee of industrial representatives were formed at one engineering school to foster projects. Their primary goal was to use industrial funds (equipment gifts) to support projects in computers and machine control. In their achievement they provided the school with digital computer laboratory and several additional computers and machine control systems.

Contributions from industry have consisted of loan agreements. This allows industry to loan universities equipment and retain the title in order to depreciate the value of the equipment. An example of loan agreement occurred between the University of Washington and an aerospace
The problem was an outdated wind tunnel which would not meet future needs. The aerospace firm donated $1.5 million to the university to update the wind tunnel facility. As a result of interaction it was possible to have courses compatible to the project and students could have access to the company's equipment and software programs.

Industry supports universities by providing funds for constructions of research facilities and basic research. Peters et al. (1982) reports:

...a pharmaceutical firm is providing a private eastern university with several million dollars to build an institute of preclinical pharmacology (p. 82).

Peters et al. (1982) stated that the Procter and Gamble company enacted a program during 1980 to support university exploratory basic research. The company allocated $40,000 each to 3 of 88 proposals in support of this program. Additional funds were provided to two other proposals by a separate division that had a particular and immediate interest in these programs. The Dow Chemical Company also sponsored a grant program in support of university's basic research with $5 million.

Pake (1981) reports that the MIT-Industry Polymer Processing Program is supported by twelve industrial firms. The firms pay a membership ranging between $20,000 to $80,000 depending upon the level of the company's plastics output. Although established in 1975, Monsanto contributed $20 million over a duration of twelve years to Harvard Medical School for research.

Industry has supported university research through graduate
fellowships. Fellowships can be an important part of university and industry relationships. Peters et al. (1982) found that:

In a geology department, two or three graduate students were supported by oil companies. A portion of the money, a gift, went to the research assistants' salaries, and the rest of the money in the budget was itemized for supplies and travel (p. 75).

One company is giving a $4,000 Ph.D. fellowship supplement, and intends to give ten such fellowship supplements (p. 75).

In another case, a textile company will fund a graduate student in chemical engineering. The student will work at the company research laboratory in the summer, and in the fall he will attend classes and be paid $1,000 a month by the company (p. 75).

The National Science Foundation (1983) reports that:

According to a recent estimate, industry invested through all mechanisms a total of $500 million in R&D at universities and colleges in fiscal year 1981. This was about 1.5 percent of the R&D funding that industry spent internally. It is made up of a projected $288 million in grants and contracts, $9 million in gifts earmarked for research, and $116 million in consulting fees to faculty members (p. 107).

The Council for Financial Aid to Education reported that universities received $1.57 billion from corporate contributions in 1984-85 a 23.8 percent increase over previous years.

Industry expects results from sponsored research and working with universities. Peters et al. (1982) stated that:

Industry exists to provide the optimum return on
investment consistent with stable growth; it does so by producing a product, process, or rendering a useful service (p. 24).

Varrin and Kukich (1985) state that although industry's primary focus is making a profit and providing useful products and services, universities need the financial support and technical know how that industries can provide. On the other hand, industries look to universities for new talent, new ideas, and basic research facilities. Desruisseaux (1986a) cited Haire as he stated:

In a knowledge-based, highly competitive world, our business organizations have immense need for the educated people and new ideas that flow from our colleges and universities (p. 1).

Azároff (1982) contends that industry seeks specialists who are adaptable to narrowly drawn job descriptions. Industry usually seeks those specialists who have prior industrial experience through programs such as co-op and industry-sponsored research which prepare students with the necessary skills for respective companies' job descriptions.

Industry's expectations and demands in partnership with universities remain high as there are increases in technological changes, industry sponsored research, and patentable products. Peters et al. (1982) stated that:

Private industry is the sector of the U.S. economy in which the scientific and technological development of all sectors are employed in the production of economically important innovations. The health of industry's efforts at technological innovation depends on the training and skills of the scientists and engineers (SIEs) employed in industry (p. 109).
Therefore, universities must be able to provide viable resources for industry and society as well.

Universities' Obligations

Universities each have their own perceptions of functional roles in education, training, and public service. Research and development is of primary importance to universities' obligations of fulfilling these roles. Three general goals of R&D which have less conflict with each other are (1) to train students in research techniques, (2) to provide state-of-the-art information in fundamental and applied research, and (3) to conduct research as a source of financial support. The success of universities is directly related to the quality output of students and research productivity (Peters et al., 1982).

The National Science Foundation (1983) elaborates that universities and colleges are committed to determining the nature and quality of science and technology in the United States. They are required to be the home for independent inquiry and scientific research and as the primary training site for future scientists and engineers. The flow of scientists and engineers into a variety of settings and providing productive research laboratories are major roles of colleges and universities. Institutions must introduce students from a variety of disciplines to the theories and methods of science and technology. Not only should academic institutions limit introduction to science and technology but general education as well.

The National Academy of Sciences (1982) states that:
“General Education” is a movement that has its origins in the early part of the century. It attempts to reintroduce into the undergraduate curriculum the concept of a well-rounded, liberal education at a time when the undergraduate curriculum has become fragmented and narrowly focused (p. 126).

Arnow (1983) elaborates that universities are committed to three major roles in preparation for research arrangements. First, universities as an employer must employ faculty members competent in research. Scientists must be able to teach and provide research guidance and training to graduate students. Their working presence should establish a close relationship within his/her department. Second, as institutions receive grants for research they take the role of serving as host. The agency providing grants is given access to teaching and research environment. Institutions assume the responsibilities for managing grants, including any financial situations and research regulations such as safety, equal employment opportunities, and ethics. Third, universities serve as cosponsors for research and development. In this role, institutions are responsible for funding research that is not reimbursed by the federal sponsor. Universities absorb project-cost which are outside the regulations on "cost sharing" in federal research. In addition, universities are responsible for several types of indirect costs which are assigned to sponsored research but are not reimbursed.

Bowen (1982) emphasized the role of education as he stated:

Higher education is, of course, not alone in the shaping of our people or in the shaping of our
society. It shares these functions with the family, church, workplace, school, mass media, library, museum, peer group, social and political organization, casual conversation, and even private thought and mediation.

It now serves about a third to a half of every age cohort of young people and touches the lives of millions of others persons in less intensive encounters; it trains virtually the entire leadership of the society in the professions, government, business, and to a lesser extent, the arts; more specifically, it trains the teachers, clergy, journalists, physicians, and others whose main function is the shaping and guiding of personal development; it is the principal locus of basic research and scholarship; it is the main custodian of the cultural heritage; it supports a great pool of faculty talent available to consult on almost every conceivable practical question; and, as a highly visible presence in our society, it continually communicates its values and its concerns to the general public (pp. 9-10).

Clark (1982) reports that the Carnegie Council projected the future role of higher education and that the following contributions would be needed to fulfill its obligations:

1. Abilities to provide even more constructive evaluation for national self-renewal,
2. Capacities to provide more service to the surrounding community,
3. Capability to maintain a network of contact and communication (p. 200).

Although universities have major responsibilities to society and its students, it is important to examine the relationships they have with industries.
Strengthening University and Industry Relationships

Baer (1980) points out there is general agreement that university and industry relationships are desirable and in the public interest. He notes that the government has primary interest in the promotion of industrial innovation, however closer ties between universities and industries can provide support for regional economic development, improve R&D results for government programs, and enhance national research efforts.

The General Accounting Office (GAO) (1983) reported two significant factors in which research parks could enhance university and industry interactions. The first factor of importance stated that faculty and administrators must integrate into the university's mission, ways to interact with industry. Dr. Terman from Stanford University stated that:

If a university is to become an important factor in industrial development, a significant number of faculty members must develop and maintain personal acquaintance with key people in local industry and...[help] local industry become acquainted with the university. These faculty...must have a real perceptive interest in the problems of industries so that some degree of involvement with industry is a pleasure, not an assigned chore. It is also necessary to educate those segments of the local industry that are oriented toward an advancing technology, to the fact that the university can be a great value to them, and that it is to their advantage to make an effort to learn what the resources of the university are and how they can be used (p. 16).

Azároff (1982) stated that:
To make the relationship a real and lasting one, both partners will have to acknowledge that their preconceived attitudes must change. Industry needs to realize that it can't limit its involvement to approving a research proposal, but has to maintain an ongoing relationship. The faculty, in turn, must be willing to consult with and, better still collaborate actively with some industrial counterparts (p. 33).

A study conducted by the GAO reported that Stanford University was successful in implementing into its mission the integration with industry. Stanford used a long-term plan to ensure successful integration. Dr. Frederick Terman directed the plan as he was able to foresee the increase of Federal support during the 1950s and 1960s. Through this plan the university was to utilize the funds over a period of 20-years to build it into a nationally prominent research institution. The institution also initiated a plan to increase faculty interacting with industry. Furthermore, it provided strong incentives for faculty interacting with industry. Firms that were most likely to contribute to the university's academic objectives received high priority in being admitted to the research park. The primary function of this plan was to enhance university and industry cooperation by means of complementing the university's traditional commitments to academic excellence and public service.

The success of North Carolina's Research Triangle Park was primarily based on strong commitment to public service. More specific was North Carolina State University, with its quality engineering schools was more involved in interaction with park residents than Duke or the University of North Carolina. The university has led the
character of university and industry cooperation as it has much to offer to participating firms. Through its success it has been noted for academic excellence and application to existing problems outside the university.

The second approach to strengthening university and industry interactions by means of research parks is to match university strengths and industrial objectives. The General Accounting Office reported that many companies that they surveyed were not interested in specific research; however, they were in favor of moving closer to research areas which had strong academic backgrounds to supply the needs of their professional employees.

Companies were willing to relocate to benefit from quality departments in such areas as electrical engineering at Stanford University, the medical school at the University of North Carolina, and the bioengineering department at the University of Utah. In addition, the GAO also reported that some firms at Stanford were attracted because of the quality of the school and some firms were attracted to the Research Triangle Park because of the quality of life in the area.

Governor Branstad stated that to assist the growth of existing business and industry a number of programs were established. Programs consisted of small business development centers and small business incubators which are in operation on Iowa State campus. The programs utilize research that's going on at the regents universities to actually create jobs in the state of Iowa by establishing research parks.

Besides research parks, the GAO reports that cooperative research
centers are also viable in strengthening university and industry interactions. Cooperative research centers provide opportunities for many firms to join with a university in a long-term relationship of common interest to the participants.

Worthy (1985) reports from an article entitled "Purdue program enhances academe/industries ties." The Industrial Associates Program (IAP) of Purdue's chemistry department consists of companies which allocate $25,000 annually to the program. The IAP operates on the basis that the chemistry department receives at least $5,000 of the allocated funds. Many companies favor the option of allocating $12,000 to $15,000 to support a collaborative research project of mutual interest to the company and the departmental laboratory. The remainder of the $25,000 is to support other laboratory costs. R. Graham Cooks, the Purdue mass spectroscopist who chairs the department's industrial cooperation committee, points out that to keep the IAP fresh, formal collaboration is limited to two years; however, some relationships between industry and academia continues to be active.

Baitinger and Cooks in the article "Purdue program enhances academe/industries ties" state that:

Industry members gain inside knowledge of the people and the work going on at Purdue, as well as "the inside track" in recruiting promising graduate students. Industry scientists benefit from the stimulation of returning to the academic environment (p. 28).

The strength of the U.S. depends on the three economical sectors of our society, university, industry, and government. The outcome of intense
collaborative interaction among these sectors can be overwhelming as the nation's strength increases and the economic development enhances. However, conflict between sectors is most likely to prevent full potential of the nation's strength and economic development.

**Barriers to University/Industry Research Interactions**

Patents, proprietary information, different objectives and functions, and other barriers have caused conflict or prevented initiation of interaction among universities and industries. Patent rights have been one of the most recognized barriers to research interactions between university, industry, and government. Delay of publication also adds to the conflict of research interactions because if results cannot be published universities fail to fulfill part of its obligations to society (Varrin and Kukich, 1985).

Peters et al. (1982) stated that a patent law enacted July 1981, allows universities to retain ownership and patents arising from federal funding agreements. Universities obtain the freedom to negotiate licensing rights with companies which supported university research. Companies feel content operating under these terms especially negotiating for an exclusive license.

Industry sponsored research policies differ from federal regulations as Azároff (1982) reports that:

Industrial sponsors feel that, since they are paying for the research, any discoveries rightfully belong to them. If universities demur, industry willing shifts the sponsorship to contract research organization which, in some quarters, enjoy the reputations of greater efficiency (p. 32).
Varrin and Kukich (1985) regard that industrial sponsors do have the right to protect proprietary interest from being published even though it creates potential conflict with university needs to publish research results. The problem can be eliminated if research procedures are kept confidential and industry agrees to publications of new research findings.

McDonald (1986a) reports a study conducted by health-policy researchers at Harvard's John F. Kennedy School of Government found that biotechnology scientists are more likely than their colleagues to keep their research secret to protect their sponsor's proprietary interests. The study showed that the scientists generally published more, earn more money, are more likely to receive patents, and participate in more administrative and professional activities than do their colleagues who lack such support.

The study conducted at Harvard University further revealed that more than 40 percent of 106 companies surveyed indicated that they had derived at least one trade secret from university research and had made two to five times as many patent applications resulting from arrangements with university researchers as from other sources. This indicates that industry is capitalizing on expectations of sponsored research, protection of proprietary information, etc.

According to Sparks (1985), President of Whirlpool Corporation, in an article entitled "The Whirlpool Experience" stated that "there can be no doubt that industry benefits in working with universities" (p. 20). He notes the importance of partnerships between industry and university
as he reports: (1) partnerships provide access to developing technologies, (2) they help shorten the period associated with the learning process, as new-wave technologies are put to work, and (3) any one industry can gain from accomplishments in others.

Sparks adds that Whirlpool has been able to benefit from partnerships with university. He states the following as advantages:

We gain access to outstandingly creative people—both faculty and students. And we get to hire some of them, notable, top-quality students with experience in one or more areas of technology in which we already have interests. It puts us in a better position to move university-generated science and technology into the public arena, via industry-generated products and services.

It enables us to focus and maximize our educational efforts: our scholarships, fellowships, consortia, student design programs, co-op programs, and internships, as well as contract research and faculty grants (p. 20).

Peters et al. (1982) cited another barrier to university and industry research which is differing objectives and functions which can be seen through their organizational structures. Universities operate in a pluralistic view of organization structure such that faculty form the organizational structure. In opposition, industry is more goal-oriented and generally follows a hierarchical structure.

Summary

Government participation in university-industry linkages such as the "Ben Franklin Program" have been an important factor in enhancing the economic development as well as university-industry relationships.
Monetary support from government has made it possible for universities to continue programs in high technology areas such as computers, robotics, and biotechnology.

Industry has been a provider for programs in connection with universities as well as government. Gifts, donations, equipment, loan agreements, etc. have been provided by industry in the help of state economic development and university-industry ties.

Universities are grateful for the support provided by government and industry. Although universities have their own perceptions of functional roles in education, training, and public service, they should introduce students to general education as well as science and technology.

The review of the literature provided insight as to the current status and need of university-industry linkages. Furthermore, it has helped the investigator to construct an instrument for gathering relevant data.
CHAPTER III. METHODS AND PROCEDURES

This chapter describes the methods and procedures used to obtain and analyze data for the study. The study was conducted at Iowa State University in the department of industrial education and technology. The purpose of this study was to investigate the relationships, interactions, and technology transfer process between Iowa State University and Iowa Industries. The following activities are explained in this chapter:

1. Definition of population and identification of sample
2. Instrument development
3. Data collection procedure
4. Data analysis procedure

Definition of Population and Identification of Sample

The population of this study consisted of agribusiness and manufacturing companies. The population was limited to the State of Iowa.

The sample size consisted of 100 companies. A list of agribusiness and manufacturing companies were obtained from the PREPS (Funding Information and Editorial Services) data base system of Iowa State University. The list was used to select companies for the study. It was determined to select those companies with a listed representative. The companies were listed alphabetically.
Instrument Development

The instrument used for this study was designed to obtain information concerning industry and university interactions. The instrument underwent many changes in its preparation and consisted of 28 items. The first 15 items concerned the company's relationship with Iowa State University. If the companies had previous contact within the past 3 years they were asked to fully complete the questionnaire. Companies with previous contact but earlier than the past 3 years and companies with no previous contact were asked to complete only questions 16 through 28. These questions provided general information about the contacted company and Iowa State University.

The data gathering instrument was field tested to ensure content clarity and validity. Participants in the field test included faculty members of Iowa State University, with extensive knowledge about industry as well as academia. The participants were asked to test the questionnaire for poor wording, ambiguity, and appropriateness. Upon completion of the field test, participants comments were taken into account and the questionnaire was revised, reviewed by the major professor, and printed in its final form.

Data Collection Procedure

The questionnaire was mailed to a total of 100 Central executive officers. A self-addressed envelope was enclosed for returning the completed questionnaire and a cover letter, assuring confidentiality of all reported information, was signed by the investigator and the major professor. Both the cover letter and questionnaire were approved by the
Human Subjects Committee of Iowa State University (Appendixes A and B).

The 100 instruments were coded by number. The participants from industry who did not respond to the questionnaire within three weeks were sent a follow-up letter. Two weeks after the follow-up letters were mailed it was decided to cease data collection. Of the 100 questionnaires mailed, 5% were returned because of no forwarding address. Out of 95 questionnaires mailed, 44 or 46% were usable for data analysis.

Data Analysis Procedure

A computer program was written to analyze the collected data. The program utilized the Statistical Package for the Social Sciences program new edition (SPSSx) (Norusis, 1983). The data collected by the survey instrument were coded by the researcher and entered into the computer system with the assistance of personnel in keypunch office at Iowa State University.

The program utilized frequencies to produce a table of frequency counts and percentages for the values of individual variables. Means and standard deviations were also obtained to analyze the data.
CHAPTER IV. FINDINGS

This chapter contains results of the analysis of data collected for the study. The purpose of this study was to identify methods of technology transfer, factors affecting interaction in collaborative relationships among Iowa State University and Iowa companies, and areas in which Iowa companies are interested in establishing a collaborative relationship with Iowa State University. The findings are based primarily on the data collected by means of a questionnaire. A total of 44 (46%) of the questionnaires were returned and found useable for the analysis of data.

Responses and Findings of Companies' Relationship with Iowa State University

Table 1 illustrates the total number of companies responding to the questionnaire. More than 45% of the companies had previous collaboration with Iowa State University, while 24 (54.5%) had collaboration earlier than the past 3 years or no collaboration with Iowa State University. Table 2 represents a subsample of the 44 companies responding. Of the subsample 19 (95%) responded that it would be beneficial to maintain a collaborative relationship with Iowa State University.

Iowa State University has provided assistance in research areas to more than 88% of the companies responding, while only 11.1% reported no assistance was provided as indicated in Table 3.

Concerning the present relationship with Iowa State University, a
### Table 1. Previous collaborative project with Iowa State University

<table>
<thead>
<tr>
<th>Collaborative Project</th>
<th>Number Responding</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>20</td>
<td>45.5</td>
</tr>
<tr>
<td>No</td>
<td>24</td>
<td>54.5</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>100.0</td>
</tr>
</tbody>
</table>

### Table 2. Beneficial to maintain collaborative relationship with Iowa State University

<table>
<thead>
<tr>
<th>Collaborative Relationship</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>19</td>
<td>95.0</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>5.0</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Mean = 1.05  
Standard deviation = 0.224

*Subsample of 44 respondents.*

### Table 3. ISU to provide assistance in research, problem solving, etc.

<table>
<thead>
<tr>
<th>ISU Provided Assistance</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>16</td>
<td>88.9</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>11.1</td>
</tr>
<tr>
<td>No response</td>
<td>2</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*Subsample of 44 respondents.*
majority of the companies (80%) responded that they consider their companies to have a strong relationship with Iowa State University, 10% reported to have a weak relationship, and 5% reported to have moderately or very weak relationships as illustrated in Table 4.

Table 5 represents the methods used to initiate contact between Iowa State University and Iowa companies. Formal contact was the most frequently used method by 55% of the companies, 30% used informal contact, and 10% used consultants.

Table 6 displays the establishment of a collaborative relationship. It was observed that 35% of the companies reported that initial contact was made by Iowa State University to establish a collaborative relationship, 30% reported their industry were the initiator, and 35% reported their collaborative relationship with Iowa State University were mutually initiated.

Government assistance provided to collaborative relationships between Iowa State University and Iowa companies is shown in Table 7 which 100% of the companies reported no assistance was provided by government.

Table 8 represents continuing support for other projects at Iowa State University, 70% of companies indicated they would continue to support other projects, 10% indicated they would not support other projects, and 20% indicated they had no research project under way.

Departmental support is shown in Table 9 where engineering is supported by 45% of the companies, agriculture is supported by 30%, and veterinary medicine is supported by 10%. The mean was 2.10 and the
Table 4. Scale to determine company's present relationship with ISU

<table>
<thead>
<tr>
<th>Company Relationship/ISU</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very weak</td>
<td>1</td>
<td>5.0</td>
</tr>
<tr>
<td>Weak</td>
<td>2</td>
<td>10.0</td>
</tr>
<tr>
<td>Moderately</td>
<td>1</td>
<td>5.0</td>
</tr>
<tr>
<td>Strong</td>
<td>16</td>
<td>80.0</td>
</tr>
<tr>
<td>Very Strong</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Mean = 3.60  
Standard deviation = 0.883  

*Subsample of 44 respondents.*

Table 5. Method of contact used to initiate company's relationship with ISU

<table>
<thead>
<tr>
<th>Method of Contact</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal contact</td>
<td>11</td>
<td>55.0</td>
</tr>
<tr>
<td>Informal contact</td>
<td>6</td>
<td>30.0</td>
</tr>
<tr>
<td>Consultant</td>
<td>2</td>
<td>10.0</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>5.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Mean = 1.65  
Standard deviation = 0.875  

*Subsample of 44 respondents.*
Table 6. Which institution initiated contact to establish a collaborative relationship?

<table>
<thead>
<tr>
<th>Institution Initiated Contact</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iowa State University</td>
<td>7</td>
<td>35.0</td>
</tr>
<tr>
<td>Industry</td>
<td>6</td>
<td>30.0</td>
</tr>
<tr>
<td>Mutually initiated</td>
<td>7</td>
<td>35.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20^a</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Mean = 2.0  
Standard deviation = 0.858

^aSubsample of 44 respondents.

Table 7. Government provided assistance to ISU and companies collaborative relationship

<table>
<thead>
<tr>
<th>Government Assistance</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20^a</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

^aSubsample of 44 respondents.
### Table 8. Continuing support for other projects at ISU

<table>
<thead>
<tr>
<th>Continuing Support</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>14</td>
<td>70.0</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>10.0</td>
</tr>
<tr>
<td>No project underway</td>
<td>4</td>
<td>20.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Mean = 1.50  
Standard deviation = 0.827  

\(^a\) Subsample of 44 respondents.

### Table 9. Departments supported in research at ISU

<table>
<thead>
<tr>
<th>Departments Supported at ISU</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td>9</td>
<td>45.0</td>
</tr>
<tr>
<td>Agriculture</td>
<td>6</td>
<td>30.0</td>
</tr>
<tr>
<td>Veterinary</td>
<td>2</td>
<td>10.0</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>15.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Mean = 2.10  
Standard deviation = 1.41  

\(^a\) Subsample of 44 respondents.
standard deviation was 1.41.

Table 10 expresses companies view of giving donations to enhance research relationships. It is observed that 31.6% of the companies reported that donations do enhance their collaborative relationships with Iowa State University, 21.1% reported that donations did not enhance research relationships, and 47.4 reported that no equipment was donated.

The results of monetary support to enhance research interactions is shown in Table 11. Monetary support as indicated by 75% of the companies enhances research interactions, 5% indicated monetary support did not, and 20% indicated they gave no monetary support.

Concerning collaborative relationships companies were asked, have support of graduate students in research enhanced interactions among their company and Iowa State University? Table 12 contains the results, in which 55% of the companies responded that support of graduate students in research does enhance interactions, 5% responded support of graduate students in research had not enhanced interactions, and 40% responded that support of graduate students in research did not apply.

Table 13 contains is a breakdown of the most frequently used methods to transfer technology with the highest mean representing the highest ranked method. Among the three highly ranked methods are conferences and workshops with a mean of 5.95 on a scale of 1 to 10, faculty/industry exchange with a mean of 5.90, and consulting with a mean of 4.65. Other methods which received rank above a mean of 2.5 were computer access to data with a mean of 3.30, bulletins with a mean
Table 10. Research relationships enhanced by donations

<table>
<thead>
<tr>
<th>Donation to Enhance Relationship</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>6</td>
<td>31.6</td>
</tr>
<tr>
<td>No</td>
<td>4</td>
<td>21.1</td>
</tr>
<tr>
<td>N/A</td>
<td>9</td>
<td>47.4</td>
</tr>
<tr>
<td>No response</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Mean = 2.158  
Standard deviation = 0.898

*aSubsample of 44 respondents.

Table 11. Do monetary support enhance research interactions?

<table>
<thead>
<tr>
<th>Finances to Enhance Interaction</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>15</td>
<td>75.0</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>5.0</td>
</tr>
<tr>
<td>N/A</td>
<td>4</td>
<td>20.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Mean = 1.45  
Standard deviation = 0.826

*aSubsample of 44 respondents.*
Table 12. Support of graduate students in research and development to enhance interactions

<table>
<thead>
<tr>
<th>Graduate Support to Enhance Relation</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>11</td>
<td>55.0</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>5.0</td>
</tr>
<tr>
<td>N/A</td>
<td>8</td>
<td>40.0</td>
</tr>
<tr>
<td>Total</td>
<td>20&lt;sup&gt;a&lt;/sup&gt;</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Mean = 1.85  
Standard deviation = 0.988

<sup>a</sup>Subsample of 44 respondents.
Table 13. Frequency of technology transfer methods

<table>
<thead>
<tr>
<th>Method</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>X̄a</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Computer access to data</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3.05</td>
</tr>
<tr>
<td>2. Classes and seminars</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2.75</td>
</tr>
<tr>
<td>3. Conferences and workshops</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5.95</td>
</tr>
<tr>
<td>4. Conferences with companies</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3.30</td>
</tr>
<tr>
<td>5. Patent licensing</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td>1.40</td>
</tr>
<tr>
<td>6. Bulletins</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2.90</td>
</tr>
<tr>
<td>7. Films</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>8. Television</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td>.60</td>
</tr>
<tr>
<td>9. Consulting</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>4.65</td>
</tr>
<tr>
<td>10. Faculty/industry exchange</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>5.90</td>
</tr>
</tbody>
</table>

Highest mean = Highest rank

X̄a = mean; highest mean = highest rank.
of 2.9, and classes and seminars with a mean of 2.75.

Tables 14 and 15 represent companies which have manufactured any patent items of marketed any products from Iowa State University, respectively. Of the 20 companies responding 19 (95%) indicated they have not manufactured any patent items, 1 (5%) did not respond. Only 2 (10%) of the companies indicated that they have manufactured or marketed a product, while 18 (90%) indicated no manufactured or marketed product as revealed by the results in Table 15.

Responses and Findings of General Information about Iowa State University and Iowa Industries

Table 16 reveals the responses of 44 companies to the question asking has there been any interaction with Iowa State University that would influence your company to initiate contact for research purposes? Of the 44 companies, 39.5% stated that there has been interactions to influence them to initiate contact for research, 60.5% stated that previous interactions had no influence.

Table 17 is a breakdown of specific factors which would influence companies to initiate contact for research. The characteristics are ranked by the highest mean. The first and highest ranked characteristic was problem-solving with a mean of 3.11, basic research followed with a mean of 1.97, access to research facilities had a mean of 1.95, and manpower a mean of 1.84.

Examination of Tables 18 and 19 reveals information about barriers to research interactions. Table 18 displays the following results. Information dissemination restrictions were encountered most as a
Table 14. Companies which have manufactured any patent items from ISU

<table>
<thead>
<tr>
<th>Manufactured Patent Items</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>No</td>
<td>19</td>
<td>95.5</td>
</tr>
<tr>
<td>No response</td>
<td>1</td>
<td>5.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong>a</td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

*aSubsample of 44 respondents.

Table 15. Companies which manufactured or marketed any products from ISU

<table>
<thead>
<tr>
<th>Manufactured or Marketed Products</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>2</td>
<td>10.0</td>
</tr>
<tr>
<td>No</td>
<td>18</td>
<td>90.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong>a</td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

*aSubsample of 44 respondents.*
Table 16. Previous interactions to influence initial contact for research purposes

<table>
<thead>
<tr>
<th>Initial Contact</th>
<th>Number</th>
<th>Relative Percent</th>
<th>Adjusted Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>17</td>
<td>38.6</td>
<td>39.5</td>
</tr>
<tr>
<td>No</td>
<td>26</td>
<td>59.1</td>
<td>60.5</td>
</tr>
<tr>
<td>No response</td>
<td>1</td>
<td>2.3</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 17. Frequency of factors which would influence companies to initiate contact for research interactions with ISU

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>$\bar{X}^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Access to research facilities</td>
<td>4</td>
<td>12</td>
<td>13</td>
<td>8</td>
<td>7</td>
<td>1.95</td>
</tr>
<tr>
<td>2. Basic research</td>
<td>3</td>
<td>14</td>
<td>12</td>
<td>9</td>
<td>6</td>
<td>1.97</td>
</tr>
<tr>
<td>3. Man power</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>15</td>
<td>6</td>
<td>1.84</td>
</tr>
<tr>
<td>4. Solve problem</td>
<td>28</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3.11</td>
</tr>
</tbody>
</table>

$^a\bar{X} = \text{mean}; \text{highest mean} = \text{highest rank}.$
Table 18. Factors encountered most as barriers to companies research interactions

<table>
<thead>
<tr>
<th>Barriers to Research Interactions</th>
<th>Number</th>
<th>Relative Percent</th>
<th>Adjusted$^a$ Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information dissemination restrictions</td>
<td>11</td>
<td>25.0</td>
<td>31.4</td>
</tr>
<tr>
<td>Value conflict</td>
<td>10</td>
<td>22.7</td>
<td>28.6</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>18.2</td>
<td>22.9</td>
</tr>
<tr>
<td>Geographical area</td>
<td>5</td>
<td>11.4</td>
<td>14.3</td>
</tr>
<tr>
<td>Does not apply</td>
<td>1</td>
<td>2.3</td>
<td>2.9</td>
</tr>
<tr>
<td>No response</td>
<td>9</td>
<td>20.3</td>
<td>--</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>44</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Mean = 2.66
Standard deviation = 1.47

$^a$The percentages in the "ADJUSTED PCT" column have been calculated based on the number of respondents remaining after eliminating missing answers (including "No Response").
Table 19. Continuation of factors which are perceived most by companies as barriers to research interactions

<table>
<thead>
<tr>
<th>Items Most Barrier to Research</th>
<th>Frequency</th>
<th>Relative Percent</th>
<th>Adjusted Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differ objectives and goals</td>
<td>5</td>
<td>11.3</td>
<td>12.7</td>
</tr>
<tr>
<td>Differ administrative structure</td>
<td>4</td>
<td>9.1</td>
<td>10.3</td>
</tr>
<tr>
<td>Differ completion of project</td>
<td>4</td>
<td>9.1</td>
<td>10.3</td>
</tr>
<tr>
<td>Personal attitudes</td>
<td>4</td>
<td>9.1</td>
<td>10.3</td>
</tr>
<tr>
<td>Who supply research facilities and management</td>
<td>1</td>
<td>2.3</td>
<td>2.6</td>
</tr>
<tr>
<td>Does not apply</td>
<td>21</td>
<td>47.7</td>
<td>53.8</td>
</tr>
<tr>
<td>No response</td>
<td>5</td>
<td>11.4</td>
<td>--</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>44</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Mean = 4.410
Standard deviation = 1.943
barrier by 31.4% of the companies, value conflict encountered most as a barrier by 28.6% of the companies, geographical area encountered by 14.3%, and 22.9% encountered other barriers such as lack of knowledge on what is available and whom to contact. The mean was 2.66 with a standard deviation of 1.47.

Table 19 reveals additional variables perceived as barriers to research interactions. In these categories differing objectives and goals were perceived most frequently to be a barrier to research by 12.7% of the companies, differing administrative structures, differing completion schedules of projects, and personal attitudes were equally perceived by 30.9% of the companies to be a barrier to research. Who supplies research facilities and management was only perceived to be a barrier by 2.6%, and 53.8% of the companies reported that these variables did not apply. The calculated mean was 4.41 and the standard deviation was 1.94.

Table 20 illustrates negotiation of research requirements without university or industry lawyers. Companies were asked what percentage of settlement was achieved without the presence of a lawyer, 2.4% responded 25% of settlement without lawyer, 2.4% responded 50% of settlement without lawyer, 7.3% responded 75% of settlement without lawyer, 34.1% responded 100% of settlement without lawyer, and 51.2% responded that these categories did not apply. The calculated mean was 4.85 and standard deviation was 1.33.

Tables 21, 22, and 23 indicate the responses of companies' view of lawyers affect on prepublication review, patent and licensing, and
Table 20. Negotiation settled without university or industry lawyer involved in research requirements

<table>
<thead>
<tr>
<th>Settlement Without Lawyer</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>1</td>
<td>2.4</td>
</tr>
<tr>
<td>50%</td>
<td>1</td>
<td>2.4</td>
</tr>
<tr>
<td>75%</td>
<td>3</td>
<td>7.3</td>
</tr>
<tr>
<td>100%</td>
<td>14</td>
<td>34.1</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>2.4</td>
</tr>
<tr>
<td>Does not apply</td>
<td>21</td>
<td>51.2</td>
</tr>
<tr>
<td>No response</td>
<td>3</td>
<td>6.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>44</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Mean = 4.854  
Standard deviation = 1.333

Table 21. Company's perception of lawyers concerning prepublication review

<table>
<thead>
<tr>
<th>Prepublication Review</th>
<th>Number</th>
<th>Relative Percent</th>
<th>Adjusted&lt;sup&gt;a&lt;/sup&gt; Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>8</td>
<td>18.2</td>
<td>40.0</td>
</tr>
<tr>
<td>Negative</td>
<td>12</td>
<td>27.3</td>
<td>60.0</td>
</tr>
<tr>
<td>No response</td>
<td>24</td>
<td>54.5</td>
<td>--</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>44</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

<sup>a</sup>The percentages in the "ADJUSTED PCT" column have been calculated based on the number of respondents remaining after eliminating missing answers (including "No response").
Table 22. Lawyers affect on patent and licensing

<table>
<thead>
<tr>
<th>Patent and Licensing</th>
<th>Number</th>
<th>Relative Percent</th>
<th>Adjusted percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>10</td>
<td>22.7</td>
<td>52.6</td>
</tr>
<tr>
<td>Negative</td>
<td>9</td>
<td>20.5</td>
<td>47.4</td>
</tr>
<tr>
<td>No response</td>
<td>25</td>
<td>56.8</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The percentages in the "ADJUSTED PCT" column have been calculated based on the number of respondents remaining after eliminating missing answers (including "No response").

Table 23. Lawyers affect on proprietary information

<table>
<thead>
<tr>
<th>Proprietary Information</th>
<th>Number</th>
<th>Relative Percent</th>
<th>Adjusted percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>8</td>
<td>18.2</td>
<td>42.1</td>
</tr>
<tr>
<td>Negative</td>
<td>11</td>
<td>25.0</td>
<td>57.9</td>
</tr>
<tr>
<td>No response</td>
<td>25</td>
<td>56.8</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The percentages in the "ADJUSTED PCT" column have been calculated based on the number of respondents remaining after eliminating missing answers (including "No response").
proprietary information. Table 21 shows that 40% of the companies reported that lawyers have a positive affect on prepublication review and 60% reported lawyers have a negative affect on prepublication review. Table 22 reveals that 52.6% reported lawyers have a positive affect on patent and licensing, while 47.4% indicated lawyers had a negative affect. Table 23 displays that 42.1% of the companies responded that lawyers have a positive affect on proprietary information and 57.9% responded lawyers have a negative affect on proprietary information.

Table 24 indicates whether objectives and goals interfered with collaborative relationships between university and industry. Results show that 20.9% of the companies responded that objectives and goals did interfere with creating a collaborative relationship, 20.9% responded that objectives and goals did not interfere, and 58.1% responded that they did not know.

Tables 25 through 29 represent the results to improve research interactions. As indicated in Table 25, 78.6% of the companies reported that they provide additional personnel time to improve research interactions, while 19% would not, and 2.4% responded personnel time did not apply. In Table 26, 51.4% responded to put fewer constraints on conducting research to improve collaborative relationship, while 48.6% responded they would not. Table 27 indicates that 56.8% of the companies would be willing to support long term projects (more than one year) to enhance collaborative relationship, while 43.2% indicated they would not support research more than one year. Table 28 contains the
Table 24. Objectives and goals a factor of collaborative research

<table>
<thead>
<tr>
<th>Objectives and Goals</th>
<th>Number</th>
<th>Relative Percent</th>
<th>Adjusted(^a) Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>9</td>
<td>20.5</td>
<td>20.9</td>
</tr>
<tr>
<td>No</td>
<td>9</td>
<td>20.5</td>
<td>20.9</td>
</tr>
<tr>
<td>Don't know</td>
<td>25</td>
<td>56.8</td>
<td>58.1</td>
</tr>
<tr>
<td>No response</td>
<td>1</td>
<td>2.3</td>
<td>--</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>44</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Mean = 2.372  
Standard deviation = 0.817

\(^a\)The percentages in the "ADJUSTED PCT" column have been calculated based on the number of respondents remaining after eliminating missing answers (including "No response").

Table 25. Additional personnel time to improve research interactions

<table>
<thead>
<tr>
<th>Improve Res Personnel Time</th>
<th>Number</th>
<th>Relative Percent</th>
<th>Adjusted(^a) Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>33</td>
<td>75.0</td>
<td>78.6</td>
</tr>
<tr>
<td>No</td>
<td>8</td>
<td>18.2</td>
<td>19.0</td>
</tr>
<tr>
<td>Does not apply</td>
<td>1</td>
<td>2.3</td>
<td>2.4</td>
</tr>
<tr>
<td>No response</td>
<td>2</td>
<td>4.5</td>
<td>--</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>44</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

\(^a\)The percentages in the "ADJUSTED PCT" column have been calculated based on the number of respondents remaining after eliminating missing answers (including "No response").
### Table 26. Fewer constraints to improve research

<table>
<thead>
<tr>
<th>Less Constraints</th>
<th>Number</th>
<th>Relative Percent</th>
<th>Adjusted&lt;sup&gt;a&lt;/sup&gt; Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>18</td>
<td>40.9</td>
<td>51.4</td>
</tr>
<tr>
<td>No</td>
<td>17</td>
<td>38.6</td>
<td>48.6</td>
</tr>
<tr>
<td>No response</td>
<td>9</td>
<td>20.5</td>
<td>—</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>44</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

<sup>a</sup>The percentages in the "ADJUSTED PCT" column have been calculated based on the number of respondents remaining after eliminating missing answers (including "No response").

### Table 27. Companies to support long-term contracts to improve research interactions

<table>
<thead>
<tr>
<th>Long-term Support</th>
<th>Number</th>
<th>Relative Percent</th>
<th>Adjusted&lt;sup&gt;a&lt;/sup&gt; Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>21</td>
<td>47.7</td>
<td>56.8</td>
</tr>
<tr>
<td>No</td>
<td>16</td>
<td>36.4</td>
<td>43.2</td>
</tr>
<tr>
<td>No response</td>
<td>7</td>
<td>15.9</td>
<td>—</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>44</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

<sup>a</sup>The percentages in the "ADJUSTED PCT" column have been calculated based on the number of respondents remaining after eliminating missing answers (including "No response").
Table 28. Companies offering co-op and internships to graduate students to enhance research interactions

<table>
<thead>
<tr>
<th>Co-op and Intern to Grad</th>
<th>Number</th>
<th>Relative Percent</th>
<th>Adjusted Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>24</td>
<td>54.4</td>
<td>60.0</td>
</tr>
<tr>
<td>No</td>
<td>16</td>
<td>36.4</td>
<td>40.0</td>
</tr>
<tr>
<td>No response</td>
<td>7</td>
<td>9.1</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*bThe percentages in the "ADJUSTED PCT" column have been calculated based on the number of respondents remaining after eliminating missing answers (including "No response").

Table 29. Equipment donations to enhance research interactions of mutual value

<table>
<thead>
<tr>
<th>Mutual Value</th>
<th>Number</th>
<th>Relative Percent</th>
<th>Adjusted Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>28</td>
<td>63.6</td>
<td>70.0</td>
</tr>
<tr>
<td>No</td>
<td>12</td>
<td>27.3</td>
<td>30.0</td>
</tr>
<tr>
<td>No response</td>
<td>4</td>
<td>9.1</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*bThe percentages in the "ADJUSTED PCT" column have been calculated based on the number of respondents remaining after eliminating missing answers (including "No response").
results of 60% of companies that would provide co-op training for graduate students, to enhance research interactions and 40% would not provide co-op training to students. Table 29 conveys the results of 70% of companies that responded they would provide equipment to enhance research interactions, while 30% indicated they would not.

Table 30 represents companies' support of research based on evidence of previous research. Fifty percent of the companies indicated they would require evidence of previous research and fifty percent indicated they would not require previous evidence of research.

Table 30. Company's support of research depends on evidence of previous research

<table>
<thead>
<tr>
<th>Previous Research</th>
<th>Number</th>
<th>Relative Percent</th>
<th>Adjusted&lt;sup&gt;a&lt;/sup&gt; Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>21</td>
<td>47.7</td>
<td>50.0</td>
</tr>
<tr>
<td>No</td>
<td>21</td>
<td>47.7</td>
<td>50.0</td>
</tr>
<tr>
<td>No response</td>
<td>2</td>
<td>4.5</td>
<td>--</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>44</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

<sup>a</sup>The percentages in the "ADJUSTED PCT" column have been calculated based on the number of respondents remaining after eliminating missing answers (including "No response").
Research Questions

Question 1

What is the present relationship between Iowa State University and Iowa Industries?

Tables 1, 2, 3, and 4 provide information from the survey instrument in regards to research question number 1. The results reflect that companies have favorable relationships with Iowa State University. Previous collaboration within the past three years was identified among 45% of the companies. Further results revealed that 95% of the companies benefited from their collaborative relationship and 88% were provided with the assistance they needed. In addition 80% of the companies reported they had a strong collaborative relationship with Iowa State University.

Question 2

Are Iowa Industries interested in establishing a collaborative relationship with Iowa State University?

It was found as reported in Table 16 that more than 39% of the companies reported to have previous interactions with Iowa State University. Previous interactions with professors, students, referral services, CIRAS, and other contacts have directed companies interest in areas of engineering, agriculture, consulting, psychology, veterinary medicine, etc.
Question 3

Should industry or educational institutions make the initial contact to establish a collaborative relationship?

Table 6 depicts the results to research question 3. Results show a slight difference between companies and Iowa State University initiating contact to establish a collaborative relationship. Thirty-five percent stated that Iowa State University initiated contact to establish a collaborative relationship. Thirty percent reported their industry initiated contact.

Question 4

What problems or barriers exist which inhibit collaborative relationships?

Table 18 reveals results that information dissemination restrictions, value conflict, and geographical areas were most frequently encountered as barriers to research interactions. Other barriers listed in Table 19 also tended to inhibit collaborative relationships. Among these barriers were different objectives and goals, different administrative structures, different completion schedules of projects, personal attitudes, and who supplied research facilities and management.

Question 5

What are some suggestions to improve the relationship between Iowa State University and Iowa Industries?
Tables 25-30 provide results of suggestions to improve research relationships between Iowa State University and Iowa Industries. Among the suggestions to improve research relationships were to provide additional personnel time which 78.6% of the companies replied, 51.4% replied to put less constraints on research, 56.8% replied to support long-term contracts (more than one year), 60% replied to offer co-op and internships to graduate students, and 70% replied to donate equipment.

**Question 6**

What disciplines or projects have been supported by industry at Iowa State University?

The results in Table 9 show the most utilized departments of Iowa State University as indicated by companies. Forty-five percent of the companies indicated they supported the engineering department, 30% supported agriculture, and 10% supported veterinary medicine. Other departments supported by companies with a combined 15%, were forestry, statistics, and the center for industrial research and service.

**Question 7**

Does industrial support increase industries' collaborative relationship with Iowa State University?

Tables 10, 11, and 12 provide results to research question 7. Table 10 indicates that more than 31% of the companies responded that donations such as computers, shop machines, and robots enhances research relationships. Table 11 depicts that 75% of the companies replied that
monetary support enhances research relationships. Table 12 illustrates that 55% of the companies replied that graduate student support enhances research relationships.

**Question 8**

What method(s) are best used to transfer technology from Iowa State University to Iowa Industries?

Table 13 contains a breakdown of the most frequently used methods to transfer technology. The six most frequently used methods are conferences and workshops, faculty/industry exchange, consulting, computer access to data, bulletins, and classes and seminars.

**Question 9**

What current innovations are being transferred from Iowa State University?

Tables 14 and 15 represent the results of current innovations being transferred from Iowa State University to Iowa Industries. A high percentage of companies responded that they have not manufactured any patent items or marketed a product from Iowa State University.

**Summary of Findings**

The results from the analysis of data covered two basic areas. The first was the companies' present relationship with Iowa State University. Findings conveyed specific elements in which companies' expressed their views and ideas with respect to interactions with Iowa State University. These findings were based on a subsample (20) of 44
(46%) respondents. Ninety-eight percent of the subsample responded that it is beneficial to maintain a collaborative relationship with Iowa State University. Eighty-eight percent of the companies were assisted in research areas of their interest by Iowa State University. Eighty percent of the companies reported to have a strong research relationship with Iowa State University.

In reference to the relationship between Iowa State University and Iowa companies, both institutions initiated contact for collaborative relationships. Mutual contact was reported by 35% of the companies, therefore making an approximately even distribution among Iowa State University, Iowa companies, and both institutions mutually making initial contact to establish a collaborative relationship. A majority of the companies replied that monetary support and support of graduate students enhances research interactions. In addition, 70% of the companies will continue to support other projects at Iowa State University. The most effective means of transferring technology were conferences and workshops.

The second basic area dealt with general information about Iowa State University and Iowa Industries. Previous interactions with Iowa State University was an important factor that would influence companies to initiate contact for research as reported by 39.5% of the companies. Specific factors that would influence companies to initiate contact are access to research facilities, basic research, man power, and to solve specific problems.

Although companies encountered some barriers as would be expected
to research interaction, they were willing to improve research interactions in certain categories. The categories included additional personnel time, put fewer constraints on conducting research, support long term projects (more than one year), provide co-op training for students, and donate equipment if possible. Universities and industries are more likely to eliminate research barriers and accomplish their goals and objectives if they compromise on research restrictions.
CHAPTER V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The previous chapters of this research study dealt with the introduction, background, methodology, analysis, and findings of this research. The function and purpose of this chapter is to summarize the preceding chapters, draw conclusions based on the findings, and present recommendations for further research.

Summary and Conclusions

This section provides a summary and the conclusions of the study which are presented in relation to each research question. The nine research questions are restated followed by a brief discussion of the findings.

Restatement of the problem

The problem of this study was to investigate the technology transfer process and collaborative relationship, if any, between Iowa State University and Iowa Industries.

Restatement of the purpose

The purpose of this study is threefold:

1. To identify method(s) used, if any, to transfer technology from Iowa State University to Iowa Industries.

2. To identify factors affecting interaction in collaborative relationships, if any, between Iowa State University and Iowa Industries.

3. To identify areas in which industries are interested in
establishing a collaborative relationship with Iowa State University.

**Research Question 1**

What is the present relationship between Iowa State University and Iowa Industries?

**Discussion**

Based on the results in Tables 1-4, it is concluded that the present collaborative relationship is in good status and in the best interest to both Iowa State University and Iowa Industries.

**Research Question 2**

Are Iowa Industries interested in establishing a collaborative relationship with Iowa State University?

**Discussion**

The results found in Table 16 reveal industries' general interest in various disciplines. Therefore, it can be concluded that Iowa industries do have a need and interest in establishing a collaborative relationship with Iowa State University. There are some colleges that are more actively involved with industry than others.

**Research Question 3**

Should industry or educational institutions make the initial contact to establish a collaborative relationship?
Discussion

From the results reported in Table 6, it is evident that it does not matter which institution initiate contact. However, it is important to note specific characteristics that would influence an institution to initiate contact as shown in Table 17.

Research Question 4

What problems or barriers exist which inhibit collaborative relationships?

Discussion

Tables 18 and 19 illustrate the results of barriers to research interactions. It is concluded that the most frequently encountered barriers to research interactions are information dissemination restrictions, value conflict, geographical areas, different objectives and goals, different administrative structures, different completion schedules of projects, personal attitudes, and who supplies research facilities and management.

Research Question 5

What are some suggestions to improve the relationship between Iowa State University and Iowa Industries?

Discussion

The results show that more than 50% of the companies responded they would enact the proposed suggestions in Tables 25-30 to improve research relationships. Therefore, it can be concluded that the suggestions in
Tables 25-30 are viable and should be given great consideration to improving research relationships.

**Research Question 6**

What disciplines or projects have been supported by industry at Iowa State University?

**Discussion**

It is concluded based on the results found in Table 9 that Iowa Industries have a strong interest in engineering, agriculture, and veterinary medicine as opposed to other colleges.

**Research Question 7**

Does industrial support increase industries' collaborative relationship with Iowa State University?

**Discussion**

It is concluded that based on the findings in Tables 10, 11, and 12 that donations such as computers, shop machines, robots, monetary, and support of graduate students enhances research relationships.

**Research Question 8**

What method(s) are best used to transfer technology from Iowa State University to Iowa Industries?

**Discussion**

It is concluded from the findings and data reported in Table 13 that the best used methods to transfer technology from Iowa State
University to Iowa Industries are conferences and workshops, faculty/industry exchange, consulting, computer access to data, bulletins, and classes and seminars.

**Research Question 9**

What current innovations are being transferred from Iowa State University?

**Discussion**

Because of the limited results reported in Tables 14 and 15, no valid conclusions can be made in regard to innovations being transferred from Iowa State University although biological science and seed corn products were reported in the transfer process.

Based upon the findings of this study, there was evidence to indicate the following positive perceptions of relationships between Iowa Industries and Iowa State University:

1. Ninety-five percent of the companies viewed collaborative relationships to be beneficial.
2. Iowa State University provided assistance in research to more than 88% of the responding sample companies.
3. Eighty percent of the companies have a strong relationship with Iowa State University.
4. Seventy-five percent of the companies research relationship with Iowa State University was enhanced by monetary support.
5. Seventy percent of the companies would continue to support other projects at Iowa State University.
The reader is reminded that this survey was conducted during a depressed economic period in Iowa and that perhaps results will differ in a growth economic period.

Recommendations

This section of the study contains recommendations. Based on the findings of the study the following recommendations were made:

1. It is recommended that an instrument be developed to assess the institutional needs of university and industry collaborative relationships.

2. Further research should be conducted on collaborative relationships between Iowa Industries and Iowa Regents institutions to enhance economic development.

3. It is recommended that a further study be conducted to examine the technology transfer process. Those involved in the process should be enlisted to strengthen the instrument's reliability and validity that would create favorable collaborative linkages.

4. It is recommended that this study be duplicated with a larger sample of industries and size of employment along with Iowa Regents institutions during a more favorable economic period.

5. It is recommended that Iowa Industries be encouraged to work cooperatively in collaborative relationships.

6. It is recommended that further research be conducted to obtain the perceptions of Iowa State University personnel regarding collaborative relationships with Iowa Industries.
It is the author's opinion in this research that:

1. Companies in Iowa are interested in establishing collaborative relationships with Iowa State University but are not familiar with the services that Iowa universities can offer. Although companies encountered barriers in research interactions, they were willing to put fewer constraints on conducting research.

2. Iowa companies are reluctant to create extensive policies and procedures to become acquainted with university research projects that can provide solutions for their problems. As it is reported in the discussion on page 65, it is insignificant which institutions make initial contact as long as the spatial barrier is eliminated. Then companies can interact effectively with universities.

3. A research park to conduct research projects for Iowa universities and industries will enhance universities and industries research relationships and Iowa's economic development. Research parks have been proven to be successful (pages 24-25). They have strengthened university and industry research cooperation by combining academic excellence and industrial applications to existing problems outside the university.

I hope that this research and information will provide the basis for conducting further research on university and industry research relationships to enhance economic development nationwide.
REFERENCES


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APPENDIX A. COVER LETTER
Dear Chief Executive Officer:

I am a student at Iowa State University currently working towards a Master degree and conducting research to meet the requirements for a thesis. Enclosed is a questionnaire designed to identify present and future relationships between Iowa State University and Iowa industries. Realizing how busy you are, the questionnaire is intentionally brief and should only take about fifteen minutes for you to complete. The purpose of the questionnaire is to provide information which can be used to improve technology transfer between institutions and industries.

Your cooperation is greatly appreciated. Please complete the enclosed questionnaire and return it in the enclosed postage paid envelope. This information is being gathered for statistical purposes only and will be kept confidential.

If you have any questions regarding this research project, please feel free to call me at (515 294-5471). If you want a copy of the results they will be available for you upon request.

Please return the questionnaire as soon as possible to ensure the inclusion of your responses in the analysis and results.

Again, thanks for your assistance and cooperation.

Sincerely,

Scott D. Mitchell

Scott D. Mitchell

Dr. William D. Wolansky
International Education Program
College of Education
Iowa State University
(Professor in Charge of Study)
APPENDIX B. QUESTIONNAIRE
INSTRUCTIONS: Please answer the following questions by placing your response on the line to the left of the question. Specify answers where applicable. If your answer to question "1" is "No", then skip to question 16 (pg. 3) and complete the remaining questions 16 through 28.

1. During the past three years has your company had a collaborative project with Iowa State University?
   a. Yes
   b. No

2. Do you consider it helpful to your company to maintain a collaborative relationship with Iowa State University?
   a. Yes
   b. No

3. Has Iowa State University provided you with the assistance you need?
   a. Yes
   b. No

4. Place the letter in the blank space that best describes your company's relationship with Iowa State University, based on the scale ranging from weak to very strong.
   Weak b c d e Very Strong

5. Which method of contact was used to initiate a collaborative relationship between your company and Iowa State University?
   a. Formal contact
   b. Informal contact
   c. Consultant
   d. Other specify

6. Which institution initiated contact to establish a collaborative relationship?
   a. Iowa State University
   b. Your Industry
   c. Mutually Initiated
   d. Other specify
7. Has government (local, state, or federal) been an important assistance factor in creating a collaborative relationship with your company and Iowa State University?
   a. Yes  
   b. No

8. When the assistance has been completed for a project, is there continuing support for other projects?
   a. Yes  
   b. No  
   c. No project underway

9. Identify the disciplines or departments with Iowa State University that you have utilized in support of research and development activities?
   a. Engineering  
   b. Agriculture  
   c. Veterinary  
   d. Home Economics  
   e. Other specify  
   f. None

10. Have your donations such as computers, shop machines, robots, etc. enhanced the collaborative relationship between your company and Iowa State University?
    a. Yes  
    b. No  
    c. N/A

11. Does your support of financial funding enhance university and industry interactions (communication)?
    a. Yes  
    b. No  
    c. N/A

12. Have support of graduate students in research and development enhanced the collaborative relationship between your company and Iowa State University?
    a. Yes  
    b. No  
    c. N/A
13. Rank the following methods of technology transfer (1-10) that is applicable with your company. Start with the number "1" being first priority and the letters "N/A" not applicable.

- Computer access to data
- Classes and seminars
- Conferences and workshops
- Conferences with companies
- Patent Licensing
- Bulletins
- Films
- Television
- Consulting
- Faculty/Industry exchange

14. In the past three years, has your plant manufactured any patented items resulting from research at Iowa State University? If yes, what are they?
   a. Yes
   b. No

15. Have you ever manufactured or marketed a product from Iowa State University? If yes, what was it?
   a. Yes
   b. No

16. Has there been any interactions (e.g. Professors having worked in industry, Industrial contacts, etc.) with Iowa State University and your company that would influence you to make initial contact for research purposes? If yes what are they?
   a. Yes
   b. No

17. Rank the following items (1-4) in which your company would initiate contact for research interactions with Iowa State University, placing the number "1" in first priority.

- To obtain access to university research facilities
- To make use of basic research
- To gain access to manpower (Students and Professors)
- To solve a problem or get specific information.
18. Which of the following items has your plant encountered most as a barrier to research interactions?
   a. Value conflict
   b. Geographical area
   c. Information dissemination restrictions (e.g. proprietary rights, prepublication review)
   d. Other specify __________________________

19. Which of the following items is perceived most as a barrier to research interactions?
   a. Differing objectives and goals
   b. Differing administrative structures
   c. Differing time for completion of projects
   d. Personal attitudes
   e. Concern for who should supply research facilities and management
   f. Does not apply

20. What percentage of negotiating is settled without the presence of university and industry lawyers concerning research requirements?
   a. 25%
   b. 50%
   c. 75%
   d. 100%
   e. Other specify __________________________
   f. Does Not Apply

21. Do university/industry lawyers have a negative or positive affect on the following issues? (P=positive; N=negative)
   a. Prepublication review requirements
   b. Patents and licensing arrangements
   c. Proprietary information

22. Have dissimilar objectives and goals interfered with creating collaborative relationships between university and industry?
   a. Yes
   b. No
   c. Don't Know

23. In a collaborative relationship with Iowa State university to improve cooperative research would your company be willing to provide personnel time?
   a. Yes
   b. No
24. In a collaborative relationship with Iowa State University to strengthen research interactions would you be willing to put less constraints on conducting research?
   a. Yes
   b. No

25. In a collaborative relationship with Iowa State University to improve cooperative research would your company be willing to support research activities on a long term basis? (more than one year)
   a. Yes
   b. No

26. To strengthen university/industry interactions would your company offer Co-op and/or internships to graduate students from Iowa State University to work on challenging real world research problems (At company's expense)?
   a. Yes
   b. No

27. To strengthen university/industry interactions will your company be willing to provide needed equipment for research of mutual value to your company and the university?
   a. Yes
   b. No

28. To support research activities would evidence of previous research be required to enlist your support?
   a. Yes
   b. No