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Exploring the university-industry-government high technology research triad: public policy ramifications of biotechnology

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Exploring the university-industry-government high technology research triad: Public policy ramifications of biotechnology

Reichel, Brian Josef, Ph.D.
Iowa State University, 1990
Exploring the university-industry-government high technology research triad: Public policy ramifications of biotechnology

by

Brian Josef Reichel

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of the Requirements for the Degree of DOCTOR OF PHILOSOPHY

Department: Sociology and Anthropology
Major: Sociology

Approved:
Signature was redacted for privacy.

In Charge of Major Work
Signature was redacted for privacy.

For the Major Department
Signature was redacted for privacy.

For the Graduate College

Iowa State University
Ames, Iowa
1990
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GENERAL INTRODUCTION

C. Wright Mills (1959, p. 201) once wrote, "As you re-arrange a filing system, you often find that you are, as it were, loosening your imagination." His observations epitomize sociological scholarship. Throughout the course of my graduate career I have often found myself "re-arranging my files" to capture the essence of the multiple, and seemingly unending, issues that surround biotechnology. The growth of the biotechnology enterprise has inevitably resulted in a corresponding increase in topics ripe for sociological investigation. The sharp rise in external research support earmarked for biotechnology research, for instance, presents a plethora of research opportunities for organizational sociologists. Moreover, the wealth of consumer products promised by biotechnology creates an abundance of potential research topics for sociologists interested in areas such as social impact assessment, consumer behavior, and adoption-diffusion. For those sociologists willing to loosen their imaginations, biotechnology offers seemingly endless research opportunities.

Because the potential sociological issues that involve biotechnology are so numerous, however, narrowing one's research topic necessarily entails grasping, at least in a general sense, the nature of those issues. In my opinion, four categories of issues are common to biotechnology:
primarily ethical issues; (2) issues involving human health and safety; (3) environmental issues; and (4) socioeconomic issues.

Although the issue categories are distinct, they are not always mutually exclusive. Often, multiple categories of issues become interwoven. The recent controversy over the patentability of transgenic animals, for example, involved several issue categories. Opponents of transgenic animal patenting cited animal welfare concerns (ethical), unknown and unregulated ecological consequences (environmental), and the probable detrimental effect on the family farm (socioeconomic) as justifications for a transgenic animal patent moratorium (Adler, 1988). Frequently issue categories merge with one another, which leads to unfocussed inquiry as debates range across, rather than within, issue categories. As a case in point, opponents of bGH (e.g., Comstock, 1988) make a point of creating ethical issues out of what many classify as purely socioeconomic issues (e.g., Browne and Hamm, 1988; DuPuis and Geisler, 1988). Successful and pointed sociological inquiry demands an ability to recognize, sort through, and isolate the various issue categories, much as one would treat Mills' filing system.

Those issues that are primarily ethical relate to concepts such as morality and fundamental rights. These include issues involving animal genetic screening, human gene therapy, and biological weapons (Suzuki and Knudston, 1989).
Other examples of purely ethical issues include animal rights (Wise, 1986), the ownership of human tissue (Office of Technology Assessment, 1987a), and the morality of manipulating the fundamental codes of life (Office of Technology Assessment, 1989). These issues are ripe for sociological investigation into interest group mobilization, societal response to ethical concerns, and the impact of moral and ethical issues in framing social problems. Human health and safety issues, on the other hand, tend to be based on more pragmatic concerns, such as food safety and nutritional quality. Consequently, this issue category often has as its focus concerns about the ability of current regulatory mechanisms, like the Federal Food, Drug, and Cosmetic Act, to deal with any human health risks biotechnologically derived food products may pose (Brace, 1984; Gibbs and Kahan, 1986; McNamara, 1987). Consumer safety and human health concerns also include issues such as products liability (Earley, 1990), public perception of genetic manipulation (Office of Technology Assessment, 1987b), and laboratory safety.

Probably the most immediate health and safety issues that could involve sociologists are those focusing on consumer perceptions of food safety.

Probably the most hotly debated issues are those involving the environment (Sagoff, 1988). Biotechnology caught the environmental regulators off guard (Harlow, 1986), and resulted in a comprehensive plan (the "Coordinated
Framework") under which federal agencies are to cooperate to ensure that biotechnology is encompassed by existing environmental statutes (Hoffman, 1988-89), such as the Toxic Substances Control Act (Sorell, 1985) and the National Environmental Policy Act (Pizzulli, 1984). In particular, the deliberate release of genetically modified organisms into the environment raises many issues related to ecological risk and federal regulation (e.g., Krimsky, Bergman, Connell, Shulman and Wilker, 1988; Marchant, 1988; Mellon, 1988; Office of Technology Assessment, 1988a; Pasternak and Glick, 1987, Tangley, 1985; Tiedje, Colwell, Grossman, Hodson, Lenski, Mack and Regal, 1989; Vandenbergh, 1986). Another major prong of the environmental issue category concerns biotechnology’s promise of providing means of reducing pesticide and herbicide applications in agriculture, thereby creating a more sustainable agricultural production system (MacDonald, 1989). Sociologists have been involved in this area in assessing adoption and diffusions of new technologies in terms of potential environmental impacts. Future investigations could also focus on the organizational coordination of environmental regulation and the most efficient methods to attain environmentally sensitive farming, for example.

A close second to environmental issues, in terms of the intensity of controversy, are those issues involving socioeconomic impacts of biotechnology. Many of these issues involve biotechnology investment patterns (Office of
Technology Assessment, 1988b), especially as they affect Third World countries (Silva, 1988) and the evolution of the biotechnology industry (Teitelman, 1989). Other issues are oriented toward the impact biotechnology has on social institutions, such as small farms (DuPuis and Geisler, 1988), agribusiness (Buttel, Cowan, Kenney and Kloppenburg, 1984), and research organizations (Fogleman, 1987), particularly universities (Kenney, 1986). At the university level, particular issues arise over the influence of proprietary rights on research agendas (Eisenberg, 1987; Kleinman and Kloppenburg, 1988; Korn, 1987) and academic freedom (Eisenberg, 1988). More to the point, the technological advances promised by biotechnology have led to technology transfer policies based on university research laboratories. As universities and government agencies strain to meet the technology transfer goals set by policy makers, numerous issues emerge. In their attempt to capture the literature on the organizational structure of biotechnology research, Woodman, Shelley and Reichel (1989) suggest the range and scope of the technology transfer issues. This dissertation builds on their knowledge base.

Explanation of Thesis/Dissertation Format

This dissertation represents the culmination of almost four years of continuous involvement with the bioethics
program at Iowa State University. The first section was derived from a paper originally written for an interdisciplinary bioethics course, which was taught by various members of the Iowa State University Bioethics Committee in the spring semester of 1988. The section was published as "Biotechnology and the Cooptation of the University" by the Iowa State University Research Foundation as part of a continuing series sponsored by the technology and social change program. This paper demonstrates the applicability of cooptation theory to explain increased university-industry biotechnology research ties and the corresponding strains placed on the traditional university structure from such relationships. Public policies driving university cooptation are analyzed and particular cases of organizational strain are specified.

The second section represents the first investigation I undertook as a graduate fellow of the National Agricultural Biotechnology Council. It was co-authored by Drs. Paul Lasley, William F. Woodman, and Mack C. Shelley, II, and was published in volume five of the journal Agriculture and Human Values as "Economic Development and Biotechnology: Public Policy Response to the Farm Crisis in Iowa." This essay combines special interest group theory and the organizational resource-dependence model to explain Iowa's public policy of stimulating biotechnology research.

Specifically, in periods of social crisis, policy makers
become particularly vulnerable to interest groups mobilizing to compete for scarce funds. At this point legislators are no longer able to address the specific needs of their primary constituency directly, but rather are forced to do so in pretext only. New, unfamiliar technologies provide ample ammunition for astute interest groups to take advantage of times of economic turmoil and maneuver for policy support through dramatic campaigns of "salesmanship". By publicizing a crisis situation, dramatizing it effectively, and advertising an innovation as the solution to the crisis, legislators may be effectively persuaded to give priority to interest group pressures above and beyond those of the local constituency. Iowa's attempts to address the farm crisis through economic development strategies relying on biotechnology are examined in this paper. The results of extensive surveys of Iowa's legislators and farmers are examined and the consequences for Iowa's policy process of using biotechnology under the auspices of economic development are discussed.

Section three presents data collected as part of a research project undertaken by Drs. Woodman and Shelley and funded by the Iowa State University Bioethics Committee, for which I was their research assistant. The paper was co-authored by Drs. Shelley and Woodman, and was originally presented at the 1989 Midwest Sociology Society Conference in St. Louis, Missouri as "Reducing Coordination Barriers Between
Universities and Industry: An Empirical Study of IORs in Biotechnology." The original manuscript is under review with the journal *Policy Studies Review*. This paper represents exploratory research undertaken to demonstrate the applicability of the interorganizational relations approach to explaining university-industry coordination in biotechnology research. From the interorganizational relations viewpoint, it was hypothesized that the inherent differences in history and goals between industrial and educational entities results in inevitable barriers to coordination in research and development. Furthermore, this model posits that the perception that university, industry and state government representatives hold of coordination barriers are determinative of the measures employed to deal with them. Multivariate statistical analyses were conducted to evaluate survey data designed to test the interorganizational model in the context of biotechnology research.

Finally, section four represents a legalistic analysis of conflict of interest issues associated with technology transfer initiatives. This section was derived from my summer with the Office of Technology Transfer at the National Institutes of Health, where I worked as a program analyst to assess the applicability of, and necessity for, conflict of interest guidelines for federal scientists who were actively engaged in technology transfer activities. Section four will be published in volume forty of the *Drake Law Review* as
"Regulating Conflicts of Interest in the Technology Transfer Age: Promoting Public Trust or Defeating Public Interest."
This paper analyzes the federal government's role in technology transfer and the conflict of interest problems peculiar to federal scientists. The underlying theme of the paper is that traditional policies of avoiding the appearance of conflicts of interest among federal employees conflict with technology transfer policies. Methods of reconciling the two seemingly competing policies are suggested in this section.
SECTION I. BIOTECHNOLOGY AND THE COOPTATION OF THE UNIVERSITY
INTRODUCTION

In 1980, the London Economist announced that, "Biotechnology is one of the biggest industrial opportunities of the late twentieth century." Several startling discoveries have occurred in biotechnology. Among the most critical for the advancement of science are: the analysis of the structure of DNA (1953); the identification of the enzymes that permit gene splicing (1973); and the development of hybridomas and monoclonal antibodies (1975). This last discovery, which enabled scientists to obtain a pure culture of antibodies, sparked the commercial interest in the technology. With stunning swiftness, recombinant DNA techniques have moved from university laboratories into the marketplace. Corporate investors have become so enamored of recombinant DNA that the market value of stocks for many small enterprises that specialize in gene splicing have more than doubled since their initial price offerings. Most leading chemical manufacturers are now actively involved in genetic engineering and other companies have been actively recruiting genetic engineers. In fact, many of the current industrial biotechnologies evolved from older technologies, such as fermentation, and were incorporated with new methods from molecular biology (Glick, 1982).

Biotechnology holds the potential for broad impacts for many traditional industries. Between 1976-1981, forty to
fifty new companies were founded in the United States to do business specifically in the area of applied molecular genetics. The total number of employees in these companies was in excess of 1,000, the majority of whom held advanced degrees in the fields of microbiology, genetics, or biochemical engineering (Jackson, 1981). The expectations are that biotechnology will ultimately make it possible to enhance crop yields, reduce costs of raw materials, and produce new cures in the medical arena, to name but a few possible outcomes.

The current biotechnology activity by industry actually represents a second stage in the biotechnology industry's evolution. The first wave of biotechnology companies aimed mainly at the medical and pharmaceutical market. During the 1970s, a number of seed companies were purchased by chemical, oil, and pharmaceutical companies. Ciba-Geigy, for example, acquired Funk, Sandoz took over Northrup King, and Occidental Oil purchased Ring Around Products, while Pfizer, Stauffer, Shell, Upjohn, and Atlantic-Richfield all absorbed seed companies. Industries are now moving to apply genetic engineering techniques to boost profits in agriculture. The major initiatives have come from chemical, oil, and pharmaceutical companies that have either expanded their own research capabilities or invested in the proliferating "agrigenetics" companies (Walsh, 1981). Companies with existing major agricultural research programs, such as DuPont
(Business Week, 1980), are placing an increased emphasis on biotechnology.

In addition, a number of new companies concentrating solely on applications of bioengineering to agriculture have added a new dimension to this type of research, e.g., Agrigenetics, International Plant Research Institute, and Advanced Genetic Science Ltd. Simultaneously, first-wave biotechnology companies like Biogen, Cetus, Genentech, and Genex, which have worked primarily on medical applications in the past, are expected to be increasingly interested in agriculture. For instance, the Cetus Corporation's first genetically engineered product introduced in the United States was a piglet vaccine (Dwyer, 1984). Cetus simultaneously established a research laboratory in Madison, Wisconsin, which focusses mainly on bioengineering in agriculture. The increased emphasis on agrigenetics should not, however, be construed to indicate that pharmaceuticals are no longer an important part of the biotechnology industry. On the contrary, an analysis of recent Federal Drug Administration drug approvals revealed that there has been a groundswell of new products from biotechnology in this area. Biotechnology has also played a major role in the pharmaceutical industry's increased research and development expenditures.
CORPORATE SUPPORT OF UNIVERSITY RESEARCH

Funding Trends

As early as 1981 the rush of industry funds into university research on genetics was quite apparent. Early that year DuPont gave a $6 million, five-year grant to Harvard University Medical School for fundamental research in molecular genetics. This followed by just over one month a $50 million, 10-year grant by West Germany’s Hoechst to Harvard-affiliated Massachusetts General Hospital for basic research in molecular biology (Bouton, 1983; Culliton, 1982c). The contract between Hoechst and Massachusetts General Hospital is widely considered a model for agreements between academe and industry. Since then, the size of grants awarded by industries to universities to accelerate genetics research has increased (Chemical Week, 1981). These grants indicate that chemical companies are having problems building in-house biotechnology expertise and are having to compete with universities for commercially viable products. Some companies expect to attract researchers by delving into more basic research, or by conducting seminars and conferences. However, since 1965 corporate financial support of academic research has doubled (Chemical and Engineering News, 1983). This represents some $400-$500 million alone in 1980-1981.

The size of the grants focuses attention on the magnitude
of the drive by the chemical industry to move into biotechnology on the ground floor, and it is an acknowledgment that American universities are the leaders in the field. Thus, research agreements between chemical companies and universities are commonplace. Dow Chemical, for example, has "more than 50" of them, ranging, it says, from "very specific pieces of work to quite open-ended and nonspecific" projects (Chemical Week, 1981, p. 23). But industry-supported research has usually been connected in some way to areas that are already paying off commercially, e.g., drugs and agricultural chemicals. Now, many chemical companies have invested heavily in biotechnology research at universities with anticipated long-term commercial results.

In essence, the biotechnology industry has mushroomed, and the ivory tower image of biology has been irrevocably altered. Biology has now joined engineering, computer science, agricultural research, and chemistry as a field with strong commercial ties. While the development of biotechnology promises vastly improved agricultural and energy products, better health care, more efficient pollution control, and a host of other benefits which scientists have only begun to envision, the commercialization of biotechnology could not have come at a more opportune time for American universities. Declining student enrollment, inflation, cuts in student aid, and decreased federal funding all combined to create dangerous financial pressures for universities.
throughout the country in the late 1970s.

Government funds for research and development in a broad range of scientific areas other than defense had been reduced. At the same time, American industry began pouring more money into innovation and product development, an upswing that also began in the late 1970s. Industry now accounts for approximately half of the total national research and development budget ($63.8 billion), compared to one-third in the 1960s when the federal government was the major contributor. The 1987 pattern continued an eight-year trend in which industry research and development spending increased at an average rate of 5.3%, while federal research and development support rose at an average annual rate of 3.3% (Spalding, 1987). In fact, federal research and development and basic research support has steadily declined in real dollars, and other nations are beginning to surpass the United States in the share of the gross national product devoted to these purposes (Bok, 1976). University support in some states, especially in states experiencing downward trends in agriculturally-dependent economies, has also declined because of a general belt-tightening of state funding. Thus, the nation's research and development system has been slow to apply the powerful new genetic engineering techniques developed during the past decade.

The depth and intensity of corporate interest in university research, however, has recently increased. In
particular the new stress placed on the potential value to industry of basic rather than applied research has opened avenues to replace lost federal and state funding, and may potentially enhance the rate of commercial application of university research, especially in high-technology fields such as biotechnology. As a result, biotechnology companies are funding university research to an unprecedented degree. Blumenthal, Gluck, Louis, and Wise (1986) found that 46% of companies having interests in biotechnology were funding university research. The total expenditure, $120.7 million in 1984, represented 16 to 24% of all funding for biotechnology research in universities, a striking departure from the 3 to 4 percent of all research funds normally allocated to universities by all industries.

The university community, particularly in light of federal cutbacks in research dollars, has shown a special interest in locating sources of industrial support. While the appropriate role of the federal government in university research has traditionally been to support fundamental research at universities, industry’s role was defined as supportive of applied research and technology transfer. Biotechnology, however, has led universities to seek closer ties with industry partly because of their concern over declining levels of federal funding for basic research, but also because of federal policies which make university-industry cooperation advantageous for industry and the
national economy as well. But the federal government is not expected to cease being the major funding source for universities. Even if industry drastically increases its university funding, it still will be supplying only a relatively small amount. In fact, a Battelle study reported that for every one percent reduction in federal research and development funds, there needs to be a corresponding twenty percent increase from industry for industry to reach the level of funding of university research that the federal government currently assumes (Perpich, 1983).

Government is now, and seems likely to remain, the principal source of support for university research in biotechnology. However, congressional changes, if they are made, will likely reduce, rather than increase, any research and development budget request (Chemical and Engineering News, 1982a). Thus, industry support of university research, especially in the area of biotechnology, will likely continue to rise (Blumenthal et al., 1986). While it appears that the private sector is being expected to carry more responsibility than it did in the past for the financing of university research, industrial sponsors are not, and should not be, primarily charitable organizations. Industry expects something in return for its investment in university research, and universities seem to be willing to respond to such industry demands, leaving open the possibility for universities to forfeit traditional academic freedoms
The Policy Environment

The Reagan administration's policy of deregulation spilled over into its research and development and science policies, providing venture capital and biotechnology firms with ample opportunities to carry more responsibility than industry had done in the past for launching new initiatives, for expanding facilities, and for developing research opportunities via linkages with universities. Blumenthal et al. (1986) reported that university research accounts for 23% of all biotechnology patent applications made and that patent applications from university laboratories were dramatically cheaper than those from the supporting companies' laboratories per each research dollar invested. Although the "biotechnology industry" may be setting a trend in terms of support for university research, the Blumenthal et al. (1986) study acknowledged that the need for federal support remains undiminished. The rich flow of venture capital into biotechnology does, however, mean that government need no longer support that element of biomedical research so heavily.

In short, faced with the prospect of continued cuts in government-funded research at a time of rising operating costs, university administrators are courting corporate research and development contracts aggressively. At the same
time, industries have begun to realize that, in order to keep up with developments in the rapidly expanding international high-technology arena, they must form linkages with university laboratories. Such linkages give industries access to basic scientific research being done in high-technology fields and provide an edge on commercializing innovations. The university community, particularly in light of federal cutbacks in research dollars, has shown a special interest in locating sources of industrial support. While appropriate role of the federal government in university research has traditionally been to support fundamental research at universities, industry's role was defined as supportive of applied research and technology transfer. It seems, then, that biotechnology has led universities, especially land-grant institutions, to seek closer ties with industry partly because of institutional concerns over declining levels of federal funding for basic research, but also because federal policies have made university-industry cooperation advantageous for industry and the larger national economy as well.

In addition, all state governments are now operating some program aimed at promoting university-industry-(government) interaction to spur economic growth (Jaschik, 1986). Often this has meant planning high-technology projects, such as biotechnology, as opposed to looking for ways to help existing industries. Political leaders believe that such efforts will attract new industries and create new jobs. Industries, in
turn, benefit from concentrated research programs which many corporations cannot afford to sponsor on their own, while universities receive money from both state government and business to bolster their research capacities and gain considerable attention from state policy makers and industrialists. Thus, high-technology industries have become the targets of economic development for many state and local governments, as well as of the efforts of universities. A survey by the Office of Technology Assessment (1983) identified over 200 state and local level economic development initiatives with at least some features directed at high-technology development. Moreover, as has been noted, several federal policies have emerged which encourage the growth of university-industry linkages in an effort to stimulate high-technology industries.

Over the past twenty years several regions of the United States have developed strong local economies based on fast-growing, technology-based industries. Encouraged by the success of high-technology industries in California's "Silicon Valley," Massachusetts' "Route 128," and North Carolina's "Research Triangle," many other states have launched government initiatives to promote similar high-technology industrial development of their own. More and more, states are turning to high technology as the key to economic revival. In fact, the new faith in high technology has resulted in a virtual "high tech fever" as states vie to attract high-
technology industries. The emergence of a "biotechnology industry" has added a new dimension to the high-technology fervor of the past two decades. Firms with biotechnology concerns are viewed as a potential source of new jobs and economic growth, as well as an important factor in U.S. international competitiveness and the balance of trade. They are also viewed as a key source of innovations that are essential to increased productivity in more mature industries.

States whose high-technology strategies emphasize basic and applied research in emerging technologies such as biotechnology tend to focus on the resources and facilities of their university systems and on the importance of cooperation between university and industry activities. Currently, in fields such as biotechnology, at least a dozen states have established centers specifically geared toward stimulating university-industry cooperation and coordination, with all of the centers claiming to be one of the best in the country. Furthermore, several states are working to improve or expand the university faculty, curriculum, and research in technologically relevant disciplines. To encourage these efforts states often provide research and development tax credits, offer matching funds for industry-sponsored university research, seek out federal contracts, and even support the creation of independent centers of research and development.

A review of federal policy shows that widespread
political support exists for increased university-industry collaboration. In addition, the biotechnology industry's financial support of university research has continued to grow since the Blumenthal et al. (1986) study (Reichel, Woodman, and Shelley, 1987), providing encouraging support for economic prospects in some states as a result of university linkages with biotechnology companies. Although the amount of money expended by biotechnology companies on university research is by no means overwhelming, an analysis of federal policy suggests that university-biotechnology company linkages will be encouraged to the point that such linkages can be maintained for years to come. Furthermore, federal policy, while encouraging university-industry linkages, will continue to support research programs geared toward high technology at an ever-increasing pace. Hence, the economic benefits hoped for in many states as a result of high-technology/biotechnology spinoffs will undoubtedly take place.

Political support for funding of industry spinoff attempts is undoubtedly high in many states. Thus, at the agency level, the land-grant university has become a primary implementor of public policy innovation. Facing times of resource scarcity, the public university has been more than willing to step forward as the agency to provide the desired response to needed public policy innovations. Lagging technological innovation, reduced federal support of research, scarcity of highly trained scientists and engineers, the
deteriorating state of university research equipment, and potential economic benefits to universities through collaboration with industries have created a virtual pathology among the land-grant universities toward creating university-industry linkages. Clearly, the public university is desperately seeking to design policy and strategies to collect resources to meet its own needs, under the guise of meeting the needs of the state and nation in the process.

Problem Areas

As universities have been scrambling for deals with neighboring companies, not only in biotechnology fields but in computer research, agriculture and engineering as well, such maneuvers have not been without their critics. Culliton (1981) commented on the "explosion of technology transfer," saying:

Biomedical research itself has entered the marketplace; molecular biology has become big business. Concern increases that this development will result in fundamental changes in the way in which research is conducted, that new ties between academy and industry will strain the fabric of the university, and that the public perception of science will be altered. (p. 1195)

At a June 1981 meeting of a National Institutes of Health advisory committee, serious potential problems with the influx
of industrial money into the area of medical and biomedical research, including patent rights, the free flow of information, and the transformation of universities into industrial training institutes, were noted (Sun, 1981). By 1982 some faculty and students at universities throughout the country argued that the "fabric of the university" was, indeed, quite strained. For example, Jack Doyle (1985), in discussing the University of California, Davis-Calgene partnership, pointed out that "the possibility that graduate education could be influenced by faculty associations with genetic engineering companies, corporate sponsors, or both is very real" (p. 342). In addition, the Graduate Student Association of Stanford University issued a statement in April 1982 which charged that commercialization of biology research on that campus had already resulted in a number of cases of strained relations between faculty and students (Garrett, 1985). In particular, the Association charged that students were forced to abandon projects upon discovering that faculty advisors had turned the research concept over to a company in which the faculty held proprietary interests, and that faculty members were either assigning graduate students to work directly in company laboratories in which faculty had interests, or encouraging them to avoid university laboratories altogether.

Similar complaints were voiced by students and faculty at other campuses. By the spring of 1982, Stanford University
President Donald Kennedy was sufficiently concerned with the seriousness and scope of the problem that he convened an unusual meeting. Representatives of nine top biotechnology firms, major universities (Stanford University, California Institute of Technology, Massachusetts Institute of Technology, Harvard University, and the University of California), and key law firms gathered at Pajaro Dunes, California to create guidelines for university-industry relations. After three days of discussion the group agreed on only vague statements of intent. University and corporate leaders agreed only on the principle of preserving academic values and managed to set an agenda for future debate on the commercialization of biology (Culliton, 1982a; Journal of College and University Law, 1982-83). Thus, while the Pajaro Dunes conference did reach a consensus that traditions of academic openness should not be impeached by trade secrecy, that universities must satisfy their members and the general public, and that the primary functions of the university should remain teaching and research, the particulars of any guidelines to insure that such principles were maintained were left to each campus, with the result that every university has followed a different course.

More so than in other academic areas, the field of biotechnology engenders concern and soul-searching. When the presidents of Yale, Princeton, Johns Hopkins, and Cornell arranged to meet with their industrial counterparts in
Philadelphia in December 1982, it became clear that lofty issues were at stake. While the tone of the meeting was the need for convergence of corporate and academic goals, some in attendance were less abstract, as a Genentech official said, "Let's talk about money. Make no mistake, that's why we're here" (Roberts, 1983, p. 159). In 1983, a House of Representatives subcommittee, chaired by Representative Albert Gore, Jr. (D-TN) was reported to recommend that faculty should not hold equity positions in companies whose ventures overlapped with their academic research, and that a national conference should be held to write guidelines for academic-industrial relations (Culliton, 1983).

Clearly, the proliferation of significant contractual arrangements between universities and private corporations has broadened both the scope and the importance of industry-funded university research, as well as increased the presence of industry at institutions of higher learning. With the continuing decline in federal funding for much academic research, universities are increasingly developing ties with industries that may take up some of the financial slack. The most important difference between traditional university-industry research relationships and the new academic-industrial ties are the scale of investment and the speed with which industry is trying to acquire scientific knowledge, especially in biotechnology (Culliton, 1982b). University heads are currently trying to devise ways to gain corporate
funding while maintaining academic values, a struggle that will continue into the near future.

While it is widely acknowledged that the United States is entering a new era in the funding of research and development activities, the assumption that universities are organizationally prepared to deal with the excessive demands and expectations of biotechnology being placed on university-industry linkages is rarely challenged. In light of vigorous responses by the academic community to procure vitally needed funds from industry, the essential values and integrity of the scientific research process and the dominance of excellence must be preserved. However, the power and value equilibrium ideally hoped for between industries and universities in the university-industry research relationship cannot be maintained as long as it is being tipped in favor of the biotechnology industry. The biotechnology industry clearly understands what it expects to gain, how to overcome problem barriers, and what outcomes to anticipate from the university-industry partnership (Reichel, 1988).

Perhaps more importantly, the nature of biotechnology, both with regard to the technology itself and the various policies surrounding it, has led industry to become dependent on the university for many of its productive inputs. In 1981, Congress passed the Patent and Trademark Amendments, which established a uniform patent policy for federally sponsored research on university campuses. Prior to the legislation,
each federal agency had its own guidelines, and in some cases the agency retained ownership of patents derived from university research sponsored with federal funds. The Patent and Trademark Amendments gave universities the first right of refusal to the ownership of any inventions created with federal monies, thereby providing incentives for universities to develop their research to a stage at which it would be commercially viable and, therefore, of some benefit to industry. Thus, the amendments established a strong incentive for universities to work closely with industries to market their research.

A major avenue to attract private venture capital into research is preferential treatment of gains on the sales of patent rights. A patent holder may receive a capital gains tax advantage upon the transfer of all substantial rights to a patent. While such "substantial rights" have been the subject of both regulations and litigation, the results are not entirely consistent. A similar capital gains tax advantage is available to the inventor who has sold the patent after holding it for more than one year. In this connection, added impetus has been given to the private sector to finance agricultural research by the case of Diamond v. Chakrabarty. Here, in 1980, the patentability of living organisms was first confirmed by the United States Supreme Court. This case enlarged the accepted understanding of patentable subject matter, with the Court concluding that a new bacterium created
by genetic engineering was patentable and that all life forms might be patentable if the novel organisms resulted from human ingenuity.

In addition, a more recent ruling allowing for the patenting of genetically altered animals could spur the development of an animal biotechnology industry comparable to the present biotechnology industry. The ruling stemmed from the Supreme Court's 1980 Diamond v. Chakrabarty decision. In 1985, the U.S. Patent Office's Appeal Board ruled that genetically altered plants could be patented, and, in 1987, it ruled that it would allow patent applications for genetically altered animals. Rulings such as these leave the door wide open for university biotechnologists to patent laboratory discoveries. Given that universities have in place the facilities for conducting the basic research demanded by the relatively new field of biotechnology, biotechnology companies and venture capital firms have been busily forming cooperative agreements with universities.

With the spreading understanding that industries can protect their investment through the Plant Variety Protection Act and the Supreme Court decision on patentability of new life forms, there has developed in the private sector an acute interest in supporting related research and development in academic institutions and in developing industrial in-house laboratories capable of conducting fundamental research. Various kinds of industrial entities with limited existing
expertise have emerged with the purpose of contracting in academia for research, the results of which would become the property of the grantor. Thus, no longer are universities simply providing technical expertise to industry in the form of human capital; they are now being called upon to provide the very productive inputs needed for the proliferation of the biotechnology industry. Changes in patent laws have made it possible for universities to patent not only manipulated organisms, but the very processes of biotechnology as well, and subsequently license them to industries. As has been demonstrated, it is this "patent on knowledge," i.e., the ability to market basic biotechnology research, that has made university research so attractive to the biotechnology industry.
Biotechnology research is widely recognized as still being conducted primarily by experts in academia, and industry thus has an incentive to utilize these experts whenever possible. Cooptation is a process whereby representatives of key elements of one organization are absorbed into the leadership or policymaking structure of another organization in order to avert threats to the latter organization's stability or existence (Hasenfeld, 1983). By inviting participation of university scientists into its research structure, the biotechnology industry hopes that, in return, these scientists will be won over and lend support to the industry's legitimacy. This strategy is likely to be used when the resources needed by an industry are concentrated, and it lacks strategic resources of its own, or when it encounters threats it cannot easily neutralize by resources it already controls (Hasenfeld, 1983). Thus, in being coopted by the biotechnology industry, universities are exchanging, in effect, a significant amount of autonomy for support from external elements (industry). This is most effectively done by identifying the leading biotechnology expert in academia and hiring them as consultants or advisors, or giving them research grants and the like (Orr, 1980). This activity requires a modicum of finesse; it must not be too blatant, for the experts themselves must not recognize that they have lost
their objectivity and freedom of action.

Therefore, until university administrators realize that they cannot micromanage academic research in biotechnology without the threat of becoming coopted by the biotechnology enterprise, arrangements between academia and industry in the biotechnology arena will continue to threaten the freedom of academic opinion and expression. Moreover, there is a further moral dimension to the case of cooptation in biotechnology research that has not yet been considered: the very definition of the role of the university, especially the land-grant university, must be reconsidered as a consequence of biotechnology.

Ties between industry and universities are, of course, nothing new. Many started with the agricultural industry, which has always enjoyed a close and special relationship with state universities. The Morrill Act of 1862 was the first federal policy to support such linkages; federal funds were distributed to states explicitly to support the efforts of colleges in sustaining local agricultural industries. The key word here is local. Buttel (1990) has argued that the very nature of biotechnology assures that its impacts will be anything but regional-specific. One strand of DNA is the same DNA no matter what part of the state, nation, or world it may appear in.

Furthermore, it is not the small, local industries that are supporting the majority of agricultural biotechnology
research. Rather, the large chemical corporations, such as DuPont and Monsanto, are the firms most actively supporting university research in this area. Thus, if the mandate of the land-grant university was indeed to support and improve local agriculture, one is left to wonder whether the land-grant university is instead acting *ultra vires*, or beyond its conferred authority, in conducting certain sponsored biotechnology research. Likewise, the public policy principles upon which the land-grant university was founded—to maintain and further the collective interests of the agricultural community—can only be supported if one assumes that the "corporate good" adequately reflects the "common good," a supposition that this author is both unwilling and unable to defend.

Perhaps the words of David Noble (1980) best summarize the nature of the concerns addressed in this essay:

Universities are shifting their allegiance back to the private sector—and to the dominant power in that sector, the petrochemical industry—under the goad of grave financial problems and in an effort to escape from governmental red tape and scrutiny. The universities' new role will be to provide research and training in new industrial sectors—particularly biotechnology—and bestow ideological sanction and scientific legitimacy upon Big Business's campaign against governmental "interference" in the economy . . . . (p. 246)
REFERENCES


SECTION II. ECONOMIC DEVELOPMENT AND BIOTECHNOLOGY IN IOWA
For the founding fathers of this country, mechanisms of accountability would prevent governmental representatives from acquiring interests distinct from those of their constituents (e.g., Federalist No. 10). Ideally, the separation of powers would ensure that if representatives became too self-interested, or if a particular group acquired too much power over one set of representatives, there would be safeguards to prevent either representatives or private groups from obtaining authority over government in general. However, what the proponents of representative democracy failed to foresee was the dramatic impact that private and public interest group politics would have on influencing public policy. In times of severe economic crisis and capital scarcity, the ideal of representative government often gives way to the pressure of political interest groups. Often this means that legislative responses to an economic crisis may not adequately reflect the desires of immediate political constituents.

New, unfamiliar technologies are introduced into our society at a rapid pace, leading to seemingly quick and easy answers to tough policy decisions. Illustrations of this phenomenon are readily reflected in the New Deal legislation of the 1930s. On its face this legislation sought to provide solutions to a generally recognized economic crisis. However, much of the New Deal plan was widely supported by interest
groups, such as broadcasters, doctors, and other professionals, who had a great deal to gain from legislation that effectively legitimized and protected their professional and organizational interests (Knott and Miller, 1987).

This century has been characterized by ever-expanding relations between government and the scientific community, leading many scholars to refer to the past fifty years as the "Age of Big Science." Rogers (1983) has spoken of the pro-innovation bias which characterizes the contemporary Western mentality. Policy makers often assume that adoption of a given innovation will produce only beneficial results for its adopters, and that their job is to ensure that the innovation is adopted as quickly as possible. This casts legislators in the role of advocate as opposed to representative. Differing expectations and differing levels of knowledge about the capabilities of innovations between representatives and constituents force legislators to impose and define the crisis to which a given innovation is seemingly responding. This leaves ample room for interest groups to use technology and innovation as pretexts in which vested interest can be advanced. Where no single or clear avenue of response exists to deal with a given crisis, policy makers defer to the expertise that innovation is presumed to represent.

Fundamentally, the policy process refers to the various stages of issue identification, research, intervention, evaluation, and feedback which typically reflect the public
policy arena. The formal stages of the policy process are: problem formation, policy formulation, policy adoption, policy implementation, and policy evaluation (Portney, 1986). Problem formation refers to the process whereby some problem (often a perceived crisis or near-crisis situation) emerges and becomes recognized. Policy formulation reflects the process in which various political actors (e.g., interest groups, legislative leaders, executive branch officials, the electorate, the courts) interact to develop a specific proposal or series of alternative proposals in response to the emerging social problem. Policy adoption refers to the process in which legislators, courts, executive officials, and others enact a specific policy response, usually in the form of legislation, executive orders, administrative regulations, or court decisions. Policy implementation focuses on the events that occur when some policy adoption is turned over to an administrative unit to be put into effect. Policy evaluation refers to the process whereby governments review what has occurred previously, often attempting to determine whether programs or policies have worked and should be continued. Lindblom (1980) has added a feedback dimension to this process.

Obviously, no one phase of the policy process operates in isolation from the environment and independent of other stages of the process. Both program evaluation and implementation provide a dynamic feedback mechanism affecting the various
stages of the public policy making process. Thus, policy formulation is ongoing, taking place even when some aspects of the policy are being implemented. The implication is that development of public policy in any given area is a never-ending circular process.

Couched in terms of the policy process, the effects of interest group politics can be readily examined. Generally, interest groups act as "crisis identifiers," directing the policy maker's attention toward a particular situation which has not yet been characterized as a priority problem by a clear majority. In effect, the bulk of the lobbyist's work is geared toward the problem formation stage of the policy process. The rationale of interest group politicking is that until a particular situation is generally recognized as a priority problem by policy makers, no steps will be taken to address it. The job of the interest group lobbyist becomes that of convincing policy makers that the lobbyist's situation should be treated as a priority problem, thereby giving the interest group an access point into the policy process.

However, in times of crisis particular situations are readily identifiable as priority problems, and the work of the interest group regarding problem formation becomes redundant. Thus, interest groups shift their attention toward policy formulation. Interest group efforts are geared toward pressuring policy makers to adopt particular means toward addressing the problem presented by the crisis. Hence, policy
formulated in times of social crisis often becomes a cloak beneath which one or more hidden agendas are advanced. More importantly, once policy has been adopted to address crisis situations, interest groups may be given the responsibility of implementing, and even evaluating, the policy which they themselves helped formulate (Knott and Miller, 1987). An example of this process is seen annually in the administrative budgetary appropriations process (Wildavsky, 1984).

The Case of Iowa

Iowa is no exception to the nation-wide trend toward "Big Science." Desperately seeking to pull itself out of a faltering, agriculturally-dependent farm economy, Iowa has been making major advances toward attracting high-technology industry, most notably biotechnology firms. In July 1986 the Iowa State Legislature allocated $17 million from state lottery proceeds to go toward biotechnology research at Iowa State University over a five-year period.

In January 1987, Iowa Governor Terry Branstad announced a proposed $35 million molecular biology building for Iowa State University. An initial investment of $35 million by the state legislature was reported to mean possibly an additional $120 million in research funds for Iowa State University (Neff, 1987). Legislators showed a "highly-favorable" reaction to the governor's recommendation, according to Dick Vohs, the
governor's press secretary. Vohs stated that Iowa State University officials were confident the center would attract $120 million in federal grants in the next decade should the building be approved, creating 437 construction jobs over a two-year period, and providing space for 60 research scientists and approximately 180 support staff. An additional 2,100 spin-off jobs were projected, especially if corporate links were established with the molecular biology center. Vohs said establishing such links would help to "accelerate technology transfer from the research lab to commercial development" (Anderson, 1987a, p. 9). In addition, Iowa State University and the City of Ames joined forces to develop a research park with the intention of creating 6,000 jobs and millions of dollars of investments in the state of Iowa. The research park was intended to be a site developed to enable companies to locate close to the university, according to Len Goldman, ISU Vice President for planning and development, and director of the proposed park (Almquist, 1987). The Ames City Council applied for a $1.6 million loan from the Iowa Department of Transportation and $1 million in federal money through the Iowa Department of Economic Development. The remaining cost of the $4.6 million project was pledged by the Iowa State University Achievement Foundation. In February the Iowa State Board of Regents approved Iowa State University's research park. The park would be the first linked with a university in Iowa, and university officials were reported as
referring to it as the "Silicon Valley of the Midwest" (Lantor, 1987).

In May 1987, Iowa State University backed up its hope that biotechnology could pay big benefits to the state's agriculture and to the Iowa economy by awarding scholarships of $1,400-per-year to ten undergraduate students with interests in biotechnology studies (Muhm, 1987). That same month, Iowa lawmakers approved a $37.5 million package for Iowa State University that included funding for the molecular biology "Center of Excellence" and improvements at the proposed research park (Fogarty, 1987). When Iowa State University announced its hiring of six new molecular biologists and awarding them $150,000 each in lab set-up funds to bring their expertise to Iowa (Daily Tribune, 1987), the groundwork was finally complete for soliciting industry support. In September, Iowa State University polished some of its top research projects and put out the welcome mat to greet representatives from biotechnology industries at the first Iowa Biotechnology Showcase (Anderson, 1987b). More recently, Iowa State University hired a "Biotechnology Industrial Liaison," whose role has been defined as helping Iowa State University faculty members who are interested in finding opportunities to collaborate with industries (Price, 1988).

To appreciate the nature and size of the biotechnology policy direction being assumed by Iowa State University, one must understand the reasoning behind such massive new
appropriations of state monies. The chairman of the oversight committee of the Iowa State University biotechnology program provides a taste of the rationale behind the concentration on biotechnology at Iowa State University:

With regard to the vision for biotechnology at Iowa State University, our ultimate goal is to use the new techniques of molecular biology to enhance the economic welfare of the state. We believe that this will occur through research in three primary areas: (1) the development of new products from our traditional commodities through bioprocessing; (2) improving the efficiency and profitability of crop and livestock production; and (3) development of new products and processes through the genetic modification of plants, animals, and microorganisms. The vision of Iowa State University’s biotechnology program is strongly influenced by the desire to fully utilize the agricultural resources of the state for the welfare of its constituents. (Fehr, 1987)

Biotechnology has been advanced as a key to economic development for Iowa by representatives of Iowa State University, a land-grant institution and the recipient of the biotechnology funding appropriated by the 1986 state legislature. In fact, an Iowa State University publication succinctly stated in December 1986 that, "Iowa State University reasserted its pledge to assist in developing a new
economic future for Iowa. Three projects were proposed to advance this goal including a research park in the Ames area" (Grad News and Notes, 1986, p. 1). Thus, while Iowa's policy makers have clearly formulated their notion of an economic development strategy as consisting of increased interactions between universities and industry, they have delegated the actual policy implementation to a public agency--Iowa State University. Additionally, it is quite evident that the university has much to gain from assuming a biotechnology emphasis. As an organization responding to an environment currently characterized by a great deal of financial uncertainty, Iowa State University has much to gain in the form of prestige and financial reward by offering its services as a means to overcome a perceived state economic crisis.

Wildavsky (1984) has characterized this agency approach to procuring program funding as "the crisis strategy." According to Wildavsky (1984) there comes a time when it is necessary for an agency to admit that a new program is in the offing or that substantial increases in existing ones are desired. This situation calls for a special campaign in which three techniques are used: "the crisis," "salesmanship," and "advertising." Each strategy's purpose is to generate extraordinary support for securing sizable new appropriations. Events do not have meaning in themselves, but are given meaning by observers. From time to time situations arise, such as the farm crisis, which virtually everyone recognizes
as a crisis. The agency in a perceived position to meet a crisis can greatly increase its appropriations. By publicizing a situation, dramatizing it effectively, and perhaps asking for the necessary emergency appropriations, an agency may maneuver itself into a position of responsibility for large new programs.

In organizational theory, the resource-dependence model is an ideal way to conceptualize the political strategy of crisis adaptation. This model has strong ties to what is called the political-economy model of organizations (Wamsley and Zald, 1973; Benson, 1975) and the dependence-exchange approach (Hasenfeld, 1972; Jacobs, 1974). The basic premise of the resource-dependence model is that decisions are made within the internal political context of the organization and deal with environmental conditions faced by the organization. Furthermore, this model assumes that organizations attempt to deal actively with the environment; organizations will try to manipulate the environment to their own advantage. Rather than being passive recipients of environmental forces, organizations will make strategic decisions about adapting to the environment. Clearly, no organization can generate all of the various resources it needs. Similarly, not every possible activity can be performed within an organization to make it self-sustaining. Both of these conditions mean that organizations must depend on the environment for their resources. The resources that are needed can be in the form
of finances, personnel, or services that the organization cannot provide for itself. Often environmental resources are available through other organizations. The fact that resources are obtained from other organizations means that the resource-dependence model can be thought of as an interorganizational model.

Since the resource-dependence model portrays the organization as an active participant in the relationship with the environment, it also contains the idea that the administrators of organizations "manage their environments as well as their organizations, and the former activity may be as important, or even more important, than the latter" (Aldrich and Pfeffer, 1976, p. 83). This is what Parsons (1960) called the institutional level of operations, where the organization is linked to social structure by its top executives.

The complexity of an organization's relations with its environment can be demonstrated by examining the transactions involved in what Parsons (1956) called "goal achievement relations." There are many different real outcomes or consequences of organizational activities. Some outcomes are useful to others, become recognized and evaluated, and thereby become manifest functions or purposes of the organization. Other outcomes may have disutility for some, and, when recognized, become negative purposes or negatively valued manifest functions. It is in terms of these purposes that the consumers, clients, or other users directly or indirectly
influence managerial activities in organizations either by buying or not buying, using or not using, the outcomes, as well as by pressures upon governmental or other agencies that control the flow of resources.

Seen in this light, the activities of Iowa State University in maneuvering for and gaining appropriations of funding must be viewed as a response to its environment. The implementation scheme for the new program involves establishing university linkages with biotechnology companies, in hopes of attracting high-technology firms to the state. The proposed research park, concentrating on scaled-up manufacturing and applied research, brings with it the hopes that the park will serve as the core infrastructure around which large-scale manufacturing will grow. The university will provide the basic biotechnology research necessary to make the infrastructure possible. In this light, Lasley and Bultena (1987), in a statewide survey of Iowa farmers, found farmers' faith in science and their commitment for economic development to be the best predictors of constituency support for Iowa State University-industry linkages. Similarly, Bultena and Lasley (1990) found that most farmers enthusiastically endorse the changes expected in production efficiencies as a result of biotechnological advances in agriculture. Thus, while Iowa State University has actively pursued biotechnology research and closer linkages with industry, a primary constituency group of Iowa State
University, Iowa farmers, is expecting some benefit from these actions.

In implementing a new biotechnology research direction at Iowa State University, university leaders have argued that such a direction will contribute significantly to the recovery of Iowa's agriculturally-dependent economy. However, more than any other action, the hiring of an industrial liaison by Iowa State University makes evident that Iowa State University expects biotechnology research to provide large amounts of scarce research grants for the university. Thus, economic development has become the pretext under which to pursue an agenda consisting of using biotechnology research as a means to procure resources for Iowa State University in a funding environment characterized by a great deal of uncertainty. In order to fulfill the explicit policy goal of strengthening the financial base of Iowa State University, university leaders have attempted to reshape the environment in which the institution operates and define new institutional directions through biotechnology research. In other words, in order to fulfill specific policy goals at the institutional level, Iowa State University's leaders must first show the relevance of biotechnology funding to its constituencies. Since Iowa State University lacked strategic resources of its own, it had to rely on winning over Iowa's policy makers and farmers. The extent to which resources could be procured and a biotechnology research direction legitimized was dependent on
making biotechnology appear relevant to the environmental conditions of the time.

Enter Biotechnology

Biotechnology provides a unique framework in which to examine the social networking involved in the policy process. The emergence of this powerful set of tools magnifies the choices that must be made in agricultural research. The expectations that biotechnology will ultimately make it possible to enhance crop yields, enable more diversification of farm activity, reduce costs of raw materials, and reduce dependence on chemical inputs have led state policy makers, especially in rural regions of the country, to support university research efforts in this area heavily.

More and more, state governments are pinning hopes for economic development on the development of high technologies. All state governments are now operating some program aimed at promoting university-industry-(government) interaction to spur economic growth (Jaschik, 1986). Often this has meant planning high-technology projects, such as biotechnology, as opposed to looking for ways to help existing industries. Political leaders believe that such efforts will attract new industries and create new jobs. Industries, in turn, benefit from concentrated research programs which many corporations cannot afford to sponsor on their own—universities benefit by
receiving money from both state government and business to bolster their research capacities and gain attention from state policy makers and industrialists. Thus, high-technology industries are becoming the targets of economic development for many state and local governments, as well as of the efforts of universities.

A survey by the Office of Technology Assessment identified over 200 state and local level economic development initiatives with at least some features directed at high-technology development (Office of Technology Assessment, 1983).

Over the past twenty years, several areas of the United States have developed strong local economies based on fast-growing, technology-based industries. Encouraged by the success of high-technology industries in California's "Silicon Valley," Massachusetts' "Route 128," and North Carolina's "Research Triangle," many other states have launched government initiatives to promote similar high-technology industrial development of their own. More and more, states are turning to high technology as the key to economic revival. In fact, the new faith in high technology has resulted in a virtual "high-tech fever" as states vie to attract high-technology industries.

The emergence of the "biotechnology industry" has added a new dimension to the high-technology fervor of the past two decades. Firms with biotechnology concerns are viewed as a
potential source of new jobs and economic growth, as well as an important factor in U.S. international competitiveness and the balance of trade. They are also viewed as a key impetus of innovation which is essential to increased productivity in more mature industries.

States with high-technology strategies emphasizing basic and applied research in emerging technologies (e.g., biotechnology) tend to focus on the resources and facilities of their university systems and on the importance of cooperation between university and industry activities. Currently, in fields such as biotechnology, at least a dozen states have established centers specifically geared toward stimulating university-industry cooperation and coordination. Not surprisingly, all of the centers claim to be one of the best in the country. In addition, several states are working to improve or expand the university faculty, curriculum, and research in technologically relevant disciplines. To encourage these efforts states often provide research and development tax credits, offer matching funds for industry-sponsored university research, seek federal R&D contracts, and even support the creation of independent centers of research and development.

Abelson (1986) notes that federal policy has increased the pressure for expanded university-industry interactions. While many states are promoting programs aimed at stimulating university-industry interaction, no two states are fostering
identical programs. However, some common features of such programs have emerged: research parks located close to universities; incubator facilities on or close to campuses; financial support for start-up companies; encouragement of faculty to initiate commercial enterprises; cofunding with industry of academic-industrial research centers; and extension services to companies in the state.

The Reagan administration’s policy of deregulation has spilled over into its R&D and science policies, providing venture capital to biotechnology firms with ample opportunities to carry more responsibility than industry has done in the past for launching new initiatives, for expanding facilities, and for developing research opportunities via linkages with universities. Blumenthal, Gluck, Louis, and Wise (1986) reported that university research accounts for 23 percent of all biotechnology patent applications made. They also reported that patent applications from university laboratories were dramatically cheaper than those from the supporting companies’ laboratories per each research dollar invested. Although the "biotechnology industry" may be setting a trend in terms of support for university research, the Blumenthal et al. (1986) study acknowledged that the need for federal support remains undiminished.

A review of federal policy shows that widespread political support exists for increased university-industry collaboration. The "biotechnology industry’s" support of
university research has continued to grow since the Blumental et al. (1986) study (Reichel, Woodman and Shelley, 1987), providing encouraging support for economic prospects in some states as a result of university linkages with biotechnology companies. Although the amount of money expended by biotechnology companies on university research is by no means overwhelming, an analysis of federal policy suggests that university-biotechnology company linkages will be encouraged to the point that such linkages can be maintained for years to come. Next, the effects of biotechnology funding on the policy process in Iowa is examined through the expectations and perceptions of Iowa’s policy makers and farmers. The question posed here is whether biotechnology is in fact generally perceived as an economic development vehicle.
In Spring 1988 a survey instrument was sent to all members of the Iowa State legislature. In addition, results from a large panel survey sample of Iowa farm operators (conducted by the Iowa Farm and Rural Life Poll) were compared to those obtained from the legislature survey. As may be seen from Table 1, the samples were designed to produce a diversity of views on issues related to university research in biotechnology and related issues. Specific areas of interest addressed in the surveys included: the likely impacts of biotechnology on U.S. agriculture, the direction of economic development in Iowa, and concerns about state and national issues.

Table 1. Response rates of surveys

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<tr>
<th>Respondent Groups</th>
<th>N</th>
<th>Response Rates</th>
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<tbody>
<tr>
<td>Iowa Farm Operators</td>
<td>2,219</td>
<td>61%</td>
</tr>
<tr>
<td>Iowa Legislators</td>
<td>83</td>
<td>55%</td>
</tr>
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We report here on the results from a group of nine variables which pertain to various directions of economic development in Iowa, and four variables dealing with production impacts of biotechnology on U.S. agriculture (see
Each of these items was structured as a traditional five-point Likert fixed-response question, with the responses including: "strongly agree" (coded as 1), "agree," "undecided," "disagree," and "strongly disagree." In addition, fourteen items dealing with state and local concerns are reported. These items were also structured as traditional Likert fixed response questions, but a seven-point scale was used, ranging from "not concerned" (coded as 1) to "very concerned" (coded as 7). The nine economic development items were factor analyzed using the method of principal components, followed by varimax rotation of the extracted factors (Harman, 1976). Two factors were generated: one dealing primarily with global economic development strategies \( Y_1 \), and the other with university biotechnology research \( Y_2 \). The factor analysis process was repeated for the variables dealing with state and local concerns, the result being three factors of primary interest: one dealing with environmental concerns \( X_1 \), a second dealing with mainstreet community development concerns \( X_2 \), and a third dealing primarily with general issues of rural communities \( X_3 \). Reliability of the resulting five scales, and a sixth scale consisting of production impacts of biotechnology on U.S. agriculture \( X_4 \), was evaluated using Cronbach's Alpha (Cronbach, 1951).

As can be seen in Table 2, the resulting reliability coefficients across respondent groups were quite respectable.
Table 2. Reliability analysis of independent and dependent variables

<table>
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<th>Variable</th>
<th>Farmers</th>
<th>Legislators</th>
<th>Combined Sample</th>
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<tr>
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<tr>
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<tr>
<td>Biotechnology Development ($Y_2$)</td>
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<td>.58</td>
<td>.71</td>
</tr>
</tbody>
</table>

*Reliability coefficients given as Cronbach’s Alpha.

Thus, all six factors were retained for regression analysis. Figures 1 and 2 show the regression model specified in the analysis. Since the economic development scale ($Y_1$) and university biotechnology research ($Y_2$) were highly correlated, they were specified as dependent variables. Hence, they were viewed as policy responses to environmental concerns ($X_1$), local concerns ($X_2$), and rural concerns ($X_3$). Furthermore, the policy responses were mediated by the perceived production effects of biotechnology on U.S. agriculture ($X_4$). The intervening impact of perceived production effects of biotechnology on U.S. agriculture was nonsignificant for
Figure 1. Regression model and beta coefficients between independent and dependent variables among legislators.

Figure 2. Regression model and beta coefficients between independent and dependent variables among farmers.
legislators, while it played a significant role in perceptions of economic development responses for farmers concerned about local and rural issues. Thus, for legislators, both perceptions of university biotechnology research and various economic development initiatives appear to be in direct response to various state and local concerns, regardless of the effect biotechnology may have on agricultural production.

On the other hand, farmers appear to mediate their support for economic development initiatives and university biotechnology research through their perceptions of the actual consequences of biotechnology research. Hence, farmers are not quite so apt to recognize economic development initiatives and biotechnology research as solutions to state and local concerns without first taking into account the effects of biotechnology on their productive capacity.

These results point out two important things: first, Legislators are willing to accept economic development strategies, including biotechnology, at face value in order to respond immediately to state and local concerns that have been expressed in the face of the farm crisis; secondly, farmers are only willing to support economic development strategies, especially biotechnology research, to the extent they can be made to appear relevant to their particular situation. Farmers' support of economic development and biotechnology is dependent, to some degree, on the extent to which it is rationalized as being an appropriate strategy. It appears
that policymakers' support is not dependent on such a rationalization process, at least not in the context of the farm crisis. Clearly, this is not reflective of the legislative constituency surveyed in this study. This finding suggests that perhaps policymakers were influenced by interest group pressures exerted during the farm crisis in formulating economic development policy.
Public purpose encompasses the goal for which governmental action is performed; the legislature, by enacting laws, chooses the method by which that goal is accomplished. The discretion of the legislature in choosing that method is extremely broad, and an act of the legislature will be invalidated by a court only with a clear demonstration that the public interest is not being served. Traditionally, research at state universities has been funded from various federal government sources and from appropriations of state legislatures. Individual researchers have enjoyed a large degree of freedom to choose and direct research projects, as long as the general purposes of appropriations have been met. In light of the Iowa legislative appropriations of lottery revenues to Iowa State University for "economic development and research and development purposes at an institution of higher education," (Iowa General Assembly, 1986) unless biotechnology research can be proven to be of benefit to the economy, the public purpose in this case, the real purpose of such research should be heavily scrutinized.

Clearly, university-industry linkages in biotechnology are being viewed not only as serving the needs of the parties involved, but of local communities, the state or nation as well. Biotechnology is being used as a leading focus of economic development for faltering state economies. Creating
university-industry interaction means providing an infrastructure for local or regional high-technology development, and it means improving the efficiency of technology transfer and maintaining the pace of international competition. University-industry interactions in biotechnology research thus represent public policy innovation at a national level.

At the agency level, land grant universities have become implementors of public policy innovation. Facing times of resource scarcity, public universities are more than willing to step forward as the agency to provide the desired response to needed public policy innovations. Lagging technological innovation, reduced federal support of research, scarcity of highly trained scientists and engineers, the deteriorating state of university research equipment, and potential economic benefits to universities through collaboration with industries have created a virtual hysteria among land grant universities in creating university-industry linkages. Public universities are desperately seeking to design policies and strategies to garner resources to meet their financial needs, under the rubric of meeting the needs of the rural community, the state, and the nation in the process.

The term "economic development" is being used as a catch-all phrase to legitimize virtually any substantial form of state governmental expenditure. Economic development is being used in defense of biotechnology research at Iowa State
University and laser research at the University of Iowa, and
to lend face validity to the creation of closer interactions
between universities and agribusiness. The rationale is that
doing research for business will stimulate economic
development. But serious questions remain to be answered:
Has economic development been substituted as the primary
purpose of Iowa’s universities, rather than the traditional
pursuit of truth through instruction and research? Can rural
economic development ever be stimulated if Iowa’s policymakers
continue to use the term "economic development" as a short-hand term to legitimize university biotechnology research? Is
the term "economic development" being used by Iowa’s
policymakers in a rational and realistic sense? Moreover,
will revenue-raising programs, such as those hoped for by
Iowa’s policymakers through the ISU research park, be
seriously hampered until policymakers can see beyond the
economic development facade?

As economic development stands now, there is no doubt
that Iowa State University and the local communities in
central Iowa will raise their revenues. But will citizens of
the state of Iowa as a whole begin to wonder when they will
enjoy the anticipated payoffs from appropriating millions of
dollars to a biotechnology program at Iowa State University
that many argue was never truly meant to stimulate economic
development? Exactly what role can universities play in
economic development? More importantly, what role should
universities play in economic development? These are tough questions that demand careful consideration. Through active participation in and active scrutiny of the policy process in which biotechnology has emerged, perhaps answers to these questions can be examined.
NOTES

1 For items dealing with impacts of biotechnology on agriculture, Farm Poll response categories were "very desirable" (coded as 1), "somewhat desirable," "uncertain," "somewhat undesirable," and "very undesirable." For items dealing with economic development, Farm Poll response categories were "strongly support" (coded as 1), "support," "uncertain," "oppose," and "strongly oppose."

2 \( Y_1 \) consisted of six items, while \( Y_2 \) consisted of three items, as listed in the Appendix. The values of \( Y_1 \) ranged from 6 ("strongly disagree") to 30 ("strongly agree"), with a scale mean of 23.4 and standard deviation of 3.4. The values of \( Y_2 \) ranged from 3 ("strongly disagree") to 15 ("strongly agree"), with a scale mean of 12.4 and standard deviation of 2.1.

3 \( X_1 \) consisted of six items, while \( X_2 \) and \( X_3 \) consisted of four each, as listed in the Appendix. The values of \( X_1 \) ranged from 6 ("not concerned") to 42 ("very concerned"), with a scale mean of 34.3 and a standard deviation of 7.0. The values of \( X_2 \) and \( X_3 \) ranged from 4 ("not concerned") to 28 ("very concerned"). The scale mean for \( X_2 \) was 20.4, and for \( X_3 \) the scale mean was 23.2. Standard deviations were 4.7 and 5.0 for \( X_2 \) and \( X_3 \) respectively.

4 \( X_4 \) consisted of four items as per the Appendix. The values of \( X_4 \) ranged from 4 ("strongly disagree") to 20 ("strongly agree"), with a scale mean of 13.3 and a standard deviation of 2.9.
REFERENCES


Fehr, Walter. 1987. Letter to Dr. David Kline, Chairman of the Iowa State University Bioethics Committee, 16 September.


APPENDIX: FACTOR ITEMS
ENVIRONMENTAL CONCERNS ($X_1$)
Contamination of underground water supplies
Residues such as pesticides and herbicides in food products
Soil erosion
Adverse health effects from exposure to agricultural chemicals
The use of food additives and preservatives
The presence of pesticides, herbicides and other chemicals in drinking water

LOCAL CONCERNS ($X_2$)
Outmigration of Iowa residents to other states
Consolidation of local schools
Condition of county and state roads
Quality of local services and facilities

RURAL CONCERNS ($X_3$)
Loss of farm population
Foreign ownership of farmland in Iowa
Corporate ownership of farmland in Iowa
Closings of local mainstreet businesses

PRODUCTION IMPACTS OF BIOTECHNOLOGY ON U.S. AGRICULTURE ($X_4$)
Biotechnology will help solve the problem of farm surpluses by finding new uses for crops and livestock.
Through biotechnology, scientists will be able to develop new species of animals.
Research in biotechnology will increase the efficiency of feed conversion in livestock production.
Greater quantities of crops and livestock products will be available for sale as a result of biotechnology.
GENERIC ECONOMIC DEVELOPMENT STRATEGIES ($Y_1$)

Emphasize tourism in the state

Diversify agricultural production to include specialty crops

Encourage Iowa's universities and colleges to focus on economic development

Focus on main street business development

Provide tax incentives to companies to locate in the state

Focus on retention and expansion of existing industries

UNIVERSITY BIOTECHNOLOGY RESEARCH ($Y_2$)

Attract biotechnology industries

Fund more biotechnology research for new products and uses for agriculture produce

Encourage more industry-university collaboration in research projects
SECTION III. OVERCOMING BARRIERS TO COOPERATIVE RESEARCH
INTRODUCTION

Little is known about the dynamics of the rituals by which universities and industries come together, or the mechanisms by which the two (or more) organizations negotiate the relationship, make it work on a day-to-day basis, or terminate it when either the contract expires or irreconcilable differences surface. A large volume of work currently is being directed at the study of matters such as barriers to the formation and operation of university-industry relationships and the costs or benefits which accrue from such arrangements. There is, however, more to the issue than many superficial financial assessments would suggest. One important fact worth remembering is that government funding of university research has not ended. Rather, its percentage rate of increase has slowed. As of 1980, nearly 60% of all federal basic research funding (almost $5 billion) was directed to universities, while two-thirds of all research and development (R&D) expenditures were from federal agency sources (Kiefer, 1980).

The advent of biotechnology has provided a new setting and new rationales for collaboration among universities, state governments, and industries. Decreased federal funding of basic research has led universities to relate their search for financing closely to corporate technological needs. In addition to providing a means of direct financing, cooperation
with industry serves as a source of support for upgrading facilities and equipment. Corporate funding provides resources, which help a university maintain and strengthen its existing academic programs and aid in developing programs in emerging sciences such as biotechnology. Moreover, university administrators can often operate much more effectively when in direct and regular communication with those who are funding research projects (Matthews and Norgaard, 1984).

Industry's need for researchers and technicians is served through closer coordination with universities. Such coordination provides industry with a means of keeping up with new scientific developments. In addition, collaborative research efforts between universities and industries help to reduce the randomness with which the fruits of innovation are brought to the public, thereby improving the currently low yield of innovations. Finally, university-industry coordination allows firms to adapt their organizational structure to improve internal communication, thereby gaining ready access to educational institutions (Matthews and Norgaard, 1984).

Given that about one-half of the annual federal R&D monies destined for universities and colleges ends up in biochemical and biomedical research projects oriented toward disease control or eradication, it should not be surprising that both universities and companies scramble for these funds. Given that these funds are oriented toward applied (and highly
profitable outcomes), neither should it be surprising that companies in these areas have made themselves a part of the federal funding process through cooperative research agreements.

Spikins (1979) indicates that, after recently reexamining their relationship with industries, universities have been driven by two motives for establishing closer ties with industries: increased revenues, and a "return to the public" motive. Industry, on the other hand, can expect an obvious return on its investment (Spikins, 1979). After reviewing historical patterns and trends of university-industry relationships, Martin (1980) concludes that personal contact between academics and industry are crucial, with initiatives coming from both directions and with some organization overseeing their developments.

Surprisingly, only a very small number of studies of this major financial phenomenon have emerged. Among the most frequently cited such studies of recent years are those of Blumenthal, Gluck, Louis, and Wise (1986a), and Blumenthal, Gluck, Louis, Stoto and Wise (1986b). In a survey of over 1,200 faculty members at 40 major American universities Blumenthal et al. (1986b) revealed that biotechnology researchers with industrial support published at higher rates, patented more frequently, participated in more administrative and professional activities, and earned higher salaries than did colleagues without such support. At the same time,
faculty with industry funds were more likely than other biotechnology faculty to report that their research resulted in the generation of trade secrets and that commercial considerations influenced their choice of research projects. Although the data did not establish a causal connection between industrial support and the reported facets of faculty behavior, the findings strongly suggest that university-industry research relationships contain both benefits and risks for academic institutions.

Blumenthal et al. (1986a) also found that almost one-half of all biotechnology companies funded some university research. This industry funding may be as high as one-half of total university funding for biotechnology research in the United States, and is returning a higher rate of patents per dollar invested than is any other form of corporate research. While Blumenthal et al. (1986a) reported that 46% of industry respondents were sponsoring university research in 1984, Reichel, Woodman, Shelley, and Lasley (1987) found, in a similar study, that by 1987 66% of U.S. biotechnology companies were supporting university research and, even more impressive, that 78% of the companies expected to be funding such research in the future. Thus, the evidence from Blumenthal et al. (1986a) indicated a growing movement toward industrial support of university biotechnology research, and the Reichel et al. (1987) research verified that the trend is gaining momentum.
Nonetheless, traditional university values, such as openness of communications among university researchers, may be jeopardized in these relationships. In addition, McHenry (1985), in presenting an industry perspective on university-industry relationships, includes an interesting list of potential problem barriers: (1) the need by universities to publish results; (2) patent problems; (3) conflicts of interest; (4) license exclusivity; (5) product liability; (6) antitrust violations; and (7) public reactions to university-industry collaboration. Furthermore, he suggests that the organizational structure of industry research operations is in the process of changing.

University-industry linkages take many forms and can emerge in many ways. Whetten (1981), in reviewing the interorganizational relations literature, indentified three structural forms of coordination: mutual adjustment, corporate, and alliance. The mutual adjustment structure consists of organizations with few, if any, shared goals toward which the units progress. On the other hand, the corporate structure represents a division of labor among specialized units, each of which performs a specific function toward the overall interagency system goal. The alliance structure is intermediate between the corporate and mutual adjustment structures, as it represents efforts to coordinate autonomous organizations without the authority of a formal hierarchy. Mulford and Klonglan (1982) distinguish among
three different types of coordination structures: authority, negotiation, and influence. The authority structure consists of a central authority with a high degree of formalization and sanctions. The negotiation structure implies the development of formalization by the participating organizations and a moderate level of sanctions. The influence structure represents a low degree of formalization and almost no sanctions.

Ruscio (1984) notes that the recent arrangements between universities and industries seem to have characteristics of an alliance, because they involve negotiation and greater commitments from partners. However, Ruscio (1984) suggests that:

Whereas most university-industry interaction takes the form of an alliance, it is perceived by universities to be corporate; as a result universities enter an arrangement with the intent of minimizing the dangers inherent in a corporate form instead of maximizing the benefits of an alliance form. (p. 217)

Zeitz (1980) goes further in suggesting that, given the option, organizations would prefer not to establish interorganizational relations in as much as these relations can constrain their subsequent actions.

Ruscio (1984) also lists several reasons why interorganizational patterns of coordination have emerged between universities and industries. The primary reason is a
desire to control an environment made more uncertain due to dramatic research findings that promise lucrative commercial applications for industry, combined with cutbacks in federal funding for university research. He also identifies the potential barriers to interaction as a low degree of understanding of the role that universities and industries are to play in coordination (low domain consensus) and an extremely low level of ideological consensus. Ruscio (1984) further suggests that, because of the presence of multiple and shared goals, increased university-industry relations might dilute the strength of each institution.

In this vein, Kerr (1974) maintains that the university and the corporation share goals only partially, in spite of the necessity to find solutions to societal problems. Kendrick (1982) observes that the university-industry relationship is a complex one that cannot be analyzed by simple formulas, and he believes it is clearly in the public interest to accommodate separate needs and motivations of universities and of the private sector. From Kendrick’s perspective, this relationship is basically a compromise wherein each institution alters its goals and objectives.

Findings by Boyle (1986) suggest that there are a variety of circumstances which lead companies to tap the R&D capabilities of the academic sector. Moreover, it appears that the original circumstances leading to collaboration affect the types of projects carried out and the types of
industry commitment given to such projects. For example, if a company approaches a university because of a lack of in-house corporate R&D capability, the project will more likely involve development work rather than fundamental research. Furthermore, David (1982a) maintains that an increase in industry-supported academic research is economically and socially desirable. David (1982a) discusses the university-industry interactions in terms of industry objectives and compares specific forms of research agreements, emphasizing research consortia and long-term sponsored research programs.

Perhaps what is needed for effective university-industry cooperative research, then, is a more in-depth understanding of the needs and goals of the parties involved, and a greater effort to disseminate the findings gleaned from research (Saxon, 1979). The major problem facing industry appears to be in assessing the nature of what university research may be of value. Barker (1985) recommends that industries establish liaison with a research-oriented university and that someone take on the task of organizing readily accessible information on that university's research interests and goals. Since researchers in universities and industries lack clear guidelines for overcoming the problems involved in differing needs and goals, they tend to use different approaches to such problems. Tolbert (1985) points out that some crucial questions which need to be answered at the outset of university-industry collaborations are: "What's in it for
each partner and how is it to be protected?"; "How long is the period of cooperation to be?"; and "What are the rights and responsibilities of each participant?" (p. 48).

Baldwin and Green (1984), in reviewing the literature on university-industry relations, identified several underlying interests of universities and industries. On the university side, these interests include: replacement of lost federal funds; avoidance of complex federal regulations and "red tape"; the potential for long-term support outside of government; help with financing of sophisticated technology required for state-of-the-art teaching and research; access to specialized industrial equipment; support for graduate students; a broader and more relevant educational experience for graduate students; professional stimulation for faculty members; and potential marketing of university innovations, with royalties returned to the university and to individual faculty members. Industry areas of self-interest include: access to highly-trained graduate students as potential employees; access to competent scientists without having to develop extensive in-house capabilities; new ideas, approaches, and products that enhance the competitive position both of industry groups and of individual companies; and improved capabilities for meeting government standards for the environment, health, and safety.

Mulford and Klonglan (1982) note several facilitators and barriers to organizational coordination. Facilitators
include: domain consensus; comparable organizational objectives and functions; availability of funds tied to coordination; involvement of a small number of organizations, awareness of interdependence; standardized organizational activities; a perceived crisis; informal ties between members and trustees; and unmet needs that cross common boundaries. Barriers include: threats to autonomy; professional staff fears; disagreement among resource providers; lack of domain consensus; different expectations from federal, state, and local levels; a low priority given to coordination; uncertainty regarding costs and benefits; and unavailability of resources.

In studying university-industry research relationships, Fowler (1984) found that the university's greatest concern was the right to publish, as contrasted with industry's need to protect proprietary information. Likewise, industry's in-house research capabilities produced the most significant limiting factor, according to industry respondents. Of secondary concern to both universities and industries was the corporate orientation toward short-term profits and product improvements. Fowler's survey research also revealed that only 34% of those from industry thought that universities should strive to perform significantly more work oriented toward industry.

Obstacles to coordination have also been found to include attitudes, administrative philosophy, and professional work
styles (Baldwin and Green, 1984). In addition, Perpich (1983) suggest four areas where the perspectives of university and industry representatives may differ. These include: (1) program relevance (what industry is proposing versus what the university can do); (2) appropriate time frames (industry’s need for faster payoff, and university’s need for longer basic research commitments); (3) protection of proprietary information and patent rights, and appropriate administration of licensing and royalty arrangements; and (4) conflicts of interest (potentially difficult for the university and its faculty to participate in industry-supported projects or in research corporations created by a university). Thus, gaps exist between academe and industry due to differences in goals, motivations, philosophies, and perspectives (Battenburg, 1980). Obstacles to mutually beneficial agreements between universities and industries are reported to include differences in orientation, differences in perspective (David, 1982b), and poor communication between university and industry researchers (Rahn and Segner, 1976).

In short, the antecedents and benefits of coordination, as well as the impediments to coordination, that have been described by the interorganizational relations literature have also been identified in studies focusing primarily on university-industry relationships. The direction of federal science and R&D policies has brought industrial support of biotechnology to the forefront of many university research
agendas. In addition, disturbing state economic climates and indications of a more decentralized process for federal regulation of biotechnology have led state legislators, university researchers and administrators, industry representatives, and often the general public, to view biotechnology as an appropriate focus of financing and coordination (Reichel, Lasley, Woodman, and Shelley, 1988; Shelley, Woodman, Reichel, and Kenney, 1990; Shelley, Woodman, Reichel, and Lasley, 1990).

An interorganizational relations approach to understanding the nature and direction of university-industry-government relationships provides an ideal conceptual framework in which to identify the changes that have occurred, or that will occur in the future, in various institutions involved in or affected by an emphasis on biotechnology funding and research. This approach also serves a second purpose. It provides a means by which the attitudes of the various actors involved in coordinating university-industry biotechnology research can be ascertained in order to determine if potential barriers to such coordination exist. If barriers are in fact found to exist, the interorganizational relations model proposes ways in which the university-industry-government triad can better coordinate its activities to overcome the problems inherent in university-industry research partnerships. From this viewpoint, it was hypothesized that the inherent differences in history and
goals between industrial and educational entities result in inevitable barriers to coordination in research and development. It was further hypothesized that the perception held by an actor of coordination barriers determines the measures employed to overcome these barriers. The surveys used in this study were designed to evaluate these hypotheses.
METHODOLOGY

Subjects

The three primary institutions involved in the interorganizational network—university, industry, and state government—are represented by various individual actors within each institution affecting or effected by negotiated transactions among the three organizations. These actors were the target of the present study, which attempted to define facilitators to interorganizational coordination within the university-industry interface. It was assumed that these actors identified within the primary organizations held representative notions regarding conflicting expectations that may arise out of linkages among the primary organizations, particularly those between universities and industries. Therefore, these actors were targeted in assessing the antecedents to coordination as suggested by interorganizational relations theory and by the university-industry interaction literature.

In particular, virtually all administrators at Iowa State University, with the rank of DEO through vice president, were mailed surveys (161, of which 71% responded). In addition, the CEOs of all known biotechnology companies in the United States were mailed questionnaires (342, of which 38% responded). Finally, a survey instrument was sent to all
members of the Iowa state legislature (150, of which 55% responded).

Instruments

The samples were designed to produce a diversity of views on issues related to university research in biotechnology and related issues. Specific areas of interest addressed in the surveys (but not necessarily repeated for all respondent groups) included: university participation in biotechnology research; the role of research parks in economic development; university relations with biotechnology companies (regarding contracts, patents, and the like); and barriers to cooperative research between industries and universities and ways to reduce them.

A total of nine questions were asked of all sets of respondents. Of these, two were structured as "yes/no" questions and are not presented here. The remaining group of seven common-core questions pertains to various approaches to reducing coordination barriers, as suggested in the literature. Ten questions were asked of both university administrators and state legislators. These items primarily dealt with impediments to cooperative research, as perceived by the respondent groups. Similarly, ten such items were presented to both the industry and state legislature groups.

Each of the survey items was structured as a traditional
Likert five-point, fixed response question, with the responses including: "strongly agree" (coded as "1"), "agree," "uncertain," "disagree," and "strongly disagree" (coded as "5").

Statistical Analyses

Frequency distributions of subjects' responses to the individual survey items are presented in Appendix B. The matrices of item correlations that resulted from subjects' responses to the survey were factor analyzed separately for the three respondent groups by the method of unweighted least squares (Harman and Jones, 1966). Five factors for the industry group, four factors for the university group, and seven factors for the state group were extracted, and rotations to an an orthogonal varimax criterion of simple structure were examined (Kaiser, 1958). Individual factors were identified by those items that loaded highly on these factors. Factor-based scores for each subject were obtained by summing his or her responses to the items which composed each factor. Items were summed using unit weights.

Multiple discriminant analyses were performed separately for the data on industry, university, and state respondents. Factor-based scores that resulted from the factor analysis of the coordination barrier data served as the discriminating variables for the suggested approaches to reducing such
barriers. In other words, factors representing suggested approaches to reducing coordination barriers were defined as the dependent variable, while two or more coordination barrier factors were designated as independent variables, depending upon which group of respondents was being assessed. Standardized scores were computed for each of the independent variables. In addition, several interaction terms were computed; three for the industry group, one for the university group, and ten for the state group. These interaction terms were computed as the products of all pairwise multiplications of the independent variables.

Thus, a multivariate analysis of variance (MANOVA) specification treated barrier reduction factors as joint dependent variables, and specified six coordination barrier covariates for the industry group, three covariates for the university group, and fifteen for the state group. A discriminant analysis identified the discriminant functions, and produced pooled within-group correlations between the discriminant functions and the discriminating variables, as well as canonical correlations between the two sets of factors for each respondent group. The results correspond to canonical correlation analysis, in which one set of continuous dependent variables is related to another set of continuous variables. Finally, path analyses were performed for each respondent group to further decipher the relationships among the coordination barrier and barrier reduction factors.
RESULTS

Table 3 summarizes the results of factor analysis of the subjects' responses to the surveys for industry, university, and states legislative groups. The table reports the factor names, the number of items constituting each factor, the relevant respondent groups, the factor means and standard deviations, representative sample sizes, the percentages of common variance for each factor, and factor score reliabilities. Examples of items constituting each factor are presented in Table 4.

The results from multiple discriminant analyses for each of the three groups are shown in Tables 5 and 6. The multivariate Wilk's lambda test results in Table 5 indicate that, for the industry and state groups, the predictor set has a statistically significant impact on the dependent variables. For the university group, however, no significant relationship is found.

Table 6 shows the eigenvalues, percentage of variance, cumulative percentage of variance, and canonical correlations for each discriminant function. For all three groups, two discriminant functions were statistically significant. Furthermore, while two dimensions were fit for each of the three groups, the results suggest that one dimension will suffice, particularly for the industry and university respondents. Of the two eigenvalues, the first has most of
Table 3. Statistics for extracted factors

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<td>3.08</td>
<td>76</td>
<td>34.8</td>
<td>.73</td>
</tr>
<tr>
<td><strong>VI. Communication (4)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td>8.91</td>
<td>3.10</td>
<td>131</td>
<td>27.2</td>
<td>.80</td>
</tr>
<tr>
<td>University</td>
<td>8.93</td>
<td>2.23</td>
<td>111</td>
<td>22.6</td>
<td>.69</td>
</tr>
<tr>
<td>State</td>
<td>8.96</td>
<td>3.16</td>
<td>74</td>
<td>26.1</td>
<td>.65</td>
</tr>
</tbody>
</table>

^a Reliability estimates are coefficient alphas.

^b Number of items comprising the factor.
Table 3. Continued

<table>
<thead>
<tr>
<th>Factor</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
<th>% Common Variance</th>
<th>Reliability $^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>VII. Structural Policies (3) $^b$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td>6.64</td>
<td>2.18</td>
<td>131</td>
<td>15.0</td>
<td>.69</td>
</tr>
<tr>
<td>University</td>
<td>7.39</td>
<td>1.77</td>
<td>111</td>
<td>17.0</td>
<td>.61</td>
</tr>
<tr>
<td>State</td>
<td>7.80</td>
<td>1.96</td>
<td>74</td>
<td>18.3</td>
<td>.59</td>
</tr>
</tbody>
</table>

the explained variance associated with it, while the second eigenvalue is associated with relatively little explained variance. Pedhazur (1982) recommends that a squared canonical correlation of less than .10 be treated as not meaningful. Using this criteria, the first function for the industry respondents is meaningful (squared canonical correlation = .183), but the first function for the university respondents is not (squared canonical correlation = .088). Therefore, only the first function was retained for further analysis for the industry respondents, and no function was retained for the university respondents. For the state legislative group of respondents, the first canonical correlation is very strong (squared canonical correlation = .561), and the second canonical correlation is also substantial in magnitude (squared canonical correlation = .195). Thus, both functions were retained for further analysis for the state group.

Table 7 shows the statistically significant canonical
Table 4. Extracted factors with representative items

<table>
<thead>
<tr>
<th>Factor name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Academic Freedom</td>
<td>Concern that industry will try to control research, and that industry sponsorship will unduly influence university research.</td>
</tr>
<tr>
<td>II. University Structural Barriers</td>
<td>Reliance on peer review system for publication, and an &quot;ivory tower&quot; attitude is common among university scientists.</td>
</tr>
<tr>
<td>III. University Functional Barriers</td>
<td>University scientists don’t focus on market-oriented research, and their need to publish conflicts with proprietary interests of industry.</td>
</tr>
<tr>
<td>IV. Industry Structural Barriers</td>
<td>Industry perceives outside research as more costly than in-house, doesn’t appreciate peer review, and exerts influence on the direction, methods, and results of research.</td>
</tr>
<tr>
<td>V. Industry Functional Barriers</td>
<td>Industry desires immediate result, is biased towards technological ideas, loses sight of the university’s teaching function, expects that universities operate like a business, and applies the same investment criteria to research as to other investments.</td>
</tr>
<tr>
<td>VI. Communication</td>
<td>Industry must utilize wider ranges of university faculty, researchers need to use more cross-sector communication, industry must allow more open communication among researchers, and industry should increase its pooling of funds to support university-based research centers so that smaller firms can join in university research.</td>
</tr>
</tbody>
</table>
Table 4. Continued

<table>
<thead>
<tr>
<th>Factor name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VII. Structural Policies</td>
<td>University corporate guidelines must become more liberal, universities must become more pragmatic in their operation, and federal laws regulating products derived from government-sponsored work at universities need to be revised.</td>
</tr>
</tbody>
</table>

Table 5. Wilk’s lambda statistics for canonical models

<table>
<thead>
<tr>
<th>Group</th>
<th>Value</th>
<th>Approx. F</th>
<th>Hypoth. DF</th>
<th>Error DF</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>.78</td>
<td>2.41</td>
<td>12.00</td>
<td>220.00</td>
<td>.006</td>
</tr>
<tr>
<td>University</td>
<td>.91</td>
<td>1.65</td>
<td>6.00</td>
<td>202.00</td>
<td>.136</td>
</tr>
<tr>
<td>State</td>
<td>.35</td>
<td>2.37</td>
<td>30.00</td>
<td>104.00</td>
<td>.001</td>
</tr>
</tbody>
</table>

structure coefficients, or loadings, for the meaningful canonical functions. The structure coefficients represent the correlations between the variables and the canonical function. In other words, a squared canonical structure coefficient represents the amount of variance shared by a variable and a canonical function. As a rule of thumb, Pedhazur (1982) suggests that structure coefficients greater than or equal to .30 be treated as meaningful.

For the state group, the first canonical function is primarily a bipolar factor, with University Functional
Table 6. Canonical discriminant functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Eigenvalue</th>
<th>% Variance</th>
<th>Cumulative % Variance</th>
<th>Canonical Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDUSTRY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>.225</td>
<td>83.13</td>
<td>83.13</td>
<td>.428</td>
</tr>
<tr>
<td>2</td>
<td>.046</td>
<td>16.87</td>
<td>100.00</td>
<td>.209</td>
</tr>
<tr>
<td>UNIVERSITY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>.096</td>
<td>96.24</td>
<td>96.24</td>
<td>.296</td>
</tr>
<tr>
<td>2</td>
<td>.004</td>
<td>3.76</td>
<td>100.00</td>
<td>.061</td>
</tr>
<tr>
<td>STATE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1.281</td>
<td>84.06</td>
<td>84.06</td>
<td>.749</td>
</tr>
<tr>
<td>2</td>
<td>.243</td>
<td>15.94</td>
<td>100.00</td>
<td>.442</td>
</tr>
</tbody>
</table>

Barriers (.38) on one side and the University Functional Barrier-Industry Structural Barrier interaction effect (-.51) on the other. It appears, then, that the first function for the state group reflects high university functional barriers, and low interaction effects relating the barriers caused by the university's function to the barrier of industry's structure. Although other variables do not play a significant role in the first function, they do dominate the second function. Similar, to the first function, the second function for state respondents is bipolar in nature. University Structural Barriers (.55), Industry Functional Barriers (.44), and the university function-industry structure and university structure-function (.61) interaction terms are on one side of the factor, and on the other side are Academic Freedom (-.47),
Table 7. Statistically significant canonical structure coefficients for meaningful canonical functions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td><strong>INDUSTRY</strong></td>
<td></td>
</tr>
<tr>
<td>Academic Freedom</td>
<td>.51</td>
</tr>
<tr>
<td>University Structural Barriers</td>
<td>.47</td>
</tr>
<tr>
<td>University Structural Barriers-Functional Barriers Interaction</td>
<td>.32</td>
</tr>
<tr>
<td><strong>STATE</strong></td>
<td></td>
</tr>
<tr>
<td>Academic Freedom</td>
<td>-.47</td>
</tr>
<tr>
<td>University Structural Barriers</td>
<td>.55</td>
</tr>
<tr>
<td>University Functional Barriers</td>
<td>.38</td>
</tr>
<tr>
<td>Industry Structural Barriers</td>
<td>-.41</td>
</tr>
<tr>
<td>Industry Functional Barriers</td>
<td>.44</td>
</tr>
<tr>
<td>University Structural Barriers-Functional Barriers Interaction</td>
<td>.61</td>
</tr>
<tr>
<td>Academic Freedom-University Functional Barriers Interaction</td>
<td>-.74</td>
</tr>
<tr>
<td>Industry Structural Barrier-Functional Barriers Interaction</td>
<td>-.49</td>
</tr>
<tr>
<td>University Structural Barriers-Industry Structural Barriers Interaction</td>
<td>-.58</td>
</tr>
<tr>
<td>University Functional Barriers-Industry Structural Barriers Interaction</td>
<td>-.51</td>
</tr>
</tbody>
</table>

University Functional Barriers (-.41), and the interaction effect between the two (-.74), as well as the university-industry structure (-.58) and industry structure-function (-.49) interaction effects. Interestingly, the university function-industry structure interaction term played a significant role in both functions, and only five variables, all of which were interaction terms, failed to play a significant role in either function: Academic Freedom-

Among the variables with high structure coefficients on the first function for the industry group were: Academic Freedom (.51), University Structural Barriers (.47), and the university structure-function interaction term (.32). These same variables also had meaningful loadings for the state group. Also similar to the state group is the fact that the Academic Freedom-University Structural Barriers variable did not load significantly. It is important to note, however, that, unlike with the state group, the University Functional Barriers variable does not load significantly on the first function for the industry group.

Path models elaborating the relationships among the factors identified in Table 3 are presented in Figure 3 for each respondent group. It is particularly notable that the strongest explanatory power ($R^2 = .40$) is attained for Factor VII in the state legislators' model. State structural policies are conditioned largely by university structural barriers (Factor II), university functional barriers (Factor III), and industry functional barriers (Factor V). The otherwise generally low $R^2$ values in Figure 3 show that substantially different relationships were obtained among industry and university respondents than those which exist
among state legislators.

Figure 3. Path structures of coordination barriers
With the exception of the university group, perceptions about barriers to organizational coordination appear to be potentially strong predictors for determining the measures that should be employed to reduce such barriers (see Figure 3). Perhaps because universities are still at an adolescent stage in their attempts at structuring organizational coordination, or perhaps because they are in a rush to create organizational coordination, the variables used in this study failed to explain adequately university-based notions regarding the best approaches to reducing coordination barriers. Nonetheless, given the results of the state and industry analyses, the more plausible explanation is that university administrators simply may be ignoring the fact that coordination barriers exist. Thus, until university administrators realize that they cannot micromanage organizational linkages with industry, arrangements between academia and industry may seriously threaten the future freedom of academic expression and opinion. University administrators must also realize that they cannot maintain an "ivory tower" stance when it comes to formulating traditional institutional arrangements which demand a certain degree of compromise.

Whetten (1981) argues, in a more theoretical fashion, that the structure of interaction creates the context for
coordination, but that it does not represent the process of coordination itself. Consequently, it is instructive to examine the factors influencing an organization's decision to enter into a coordination agreement: (1) administrators must have a positive attitude; (2) they must recognize an organizational need for coordination that is salient enough to justify the costs inherent in coordination; (3) they must have a knowledge of potential partners; (4) an assessment of compatibility and desirability must be made; and (5) a capacity for maintaining coordination linkages must be reached.

Reducing the problem barriers inherent in university collaborative efforts with industry will require both university- and industry-based initiatives. University administrators must realize that academic institutions are not organizationally equipped to respond by themselves to the full range of impediments to cooperative research. This study has formulated scales for empirically testing assumptions suggested in the literature regarding university-industry research relationships. Perhaps this study will act as a catalyst for further necessary empirical investigation in this increasingly important field.

The interorganizational model seems to be the best approach for testing empirically the propositions that have been suggested in the literature addressing the consequences of university-industry research coordination and cooperation.
Because very little research has been conducted in the area of university-industry relationships, the networking approach that the interorganizational relations model offers seems to be the most appropriate mechanism through which to gain a broader, theoretical understanding of the concerns raised by the proliferation of university-industry linkages.

While most authors agree on the nature and usefulness of the R&D functions of universities, the question remains as to how best to provide funding for academic R&D activities. Fusfeld (1976) provides some specific suggestions for effective working relationships among government, industry, and university sectors: an understanding of each sector's objectives and functions by the other sectors; participation by each sector in the planning, problem definition, and recommendation phases; and a mechanism for reviewing progress and the transfer of results. Doan (1978) offers two proposals for interlocking university and industry research more closely, thereby enhancing the effectiveness of the United States' research effort as a whole. In "Proposal One" he suggests a three-stage approach: first, fundamental research is carried out in university laboratories under joint university-industry collaboration; second, the two parties would then prepare a research proposal agreeable to both parties and submit it to the National Science Foundation (NSF); and, third, the normal NSF review procedures would follow.
"Proposal Two," Doan suggests, parallels Proposal One, except that the incentive for industries would be through long-term tax credits or tax deductions for organizations having successful proposals generated through his model. Ideas such as these might help industry to meet its goals. Unfortunately, the suggestions of Doan (1978) and others do not address the problems relating to the proper role and function of the university and its research. It may well be that the most productive direction for future research on this problem may turn not on the examination of what universities and industries either do or should do, but on the structure of the relationship between these two kinds of organizational entities.

Fusfeld (1980) maintains that the link between universities and industries fulfills a unique role in advanced industrial societies. Furthermore, a bridge between universities and industries must be built to strengthen the United States national technological community in light of changes in federal funding patterns. Clearly, the concern for economic growth has focused attention on society's use of technical resources. One mechanism for enhancing the effectiveness of science research is a better understanding of the functions and limitations of university-industry linkages.
REFERENCES


APPENDIX:

FREQUENCY DISTRIBUTIONS OF INDIVIDUAL SURVEY ITEMS
Table 8. Frequency distributions of individual survey items

<table>
<thead>
<tr>
<th>Item</th>
<th>SA</th>
<th>A</th>
<th>U</th>
<th>D</th>
<th>SDa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universities are concerned that industry will try to control what research is done in biotechnology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDUSTRY (N=120)</td>
<td>03%</td>
<td>50%</td>
<td>32%</td>
<td>12%</td>
<td>03%</td>
</tr>
<tr>
<td>STATE (N=76)</td>
<td>05%</td>
<td>40%</td>
<td>38%</td>
<td>16%</td>
<td>01%</td>
</tr>
<tr>
<td>Universities are overly concerned that industry-sponsored research will improperly influence the direction of future university research.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDUSTRY (N=120)</td>
<td>07%</td>
<td>48%</td>
<td>28%</td>
<td>14%</td>
<td>02%</td>
</tr>
<tr>
<td>STATE (N=76)</td>
<td>01%</td>
<td>24%</td>
<td>41%</td>
<td>30%</td>
<td>04%</td>
</tr>
<tr>
<td>An &quot;ivory tower&quot; attitude is too common among university scientists.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDUSTRY (N=119)</td>
<td>12%</td>
<td>39%</td>
<td>20%</td>
<td>26%</td>
<td>03%</td>
</tr>
<tr>
<td>STATE (N=76)</td>
<td>12%</td>
<td>26%</td>
<td>36%</td>
<td>25%</td>
<td>01%</td>
</tr>
<tr>
<td>Scientists in universities tend to rely too heavily on the peer review system for publication.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDUSTRY (N=121)</td>
<td>09%</td>
<td>31%</td>
<td>20%</td>
<td>37%</td>
<td>03%</td>
</tr>
<tr>
<td>STATE (N=77)</td>
<td>03%</td>
<td>29%</td>
<td>53%</td>
<td>14%</td>
<td>01%</td>
</tr>
<tr>
<td>University scientists do not focus sufficiently on applied research appropriate for marketing products.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDUSTRY (N=121)</td>
<td>10%</td>
<td>45%</td>
<td>21%</td>
<td>21%</td>
<td>02%</td>
</tr>
<tr>
<td>STATE (N=74)</td>
<td>07%</td>
<td>30%</td>
<td>30%</td>
<td>31%</td>
<td>03%</td>
</tr>
<tr>
<td>The university's insistence on the freedom to publish research results conflicts with industry's need to protect research results through patents.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDUSTRY (N=119)</td>
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<td>10%</td>
<td>26%</td>
<td>08%</td>
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<td>09%</td>
<td>54%</td>
<td>29%</td>
<td>07%</td>
<td>01%</td>
</tr>
</tbody>
</table>

aSA = "Strongly Agree"; A = "Agree"; U = "Undecided"; D = "Disagree"; SD = "Strongly Disagree."
Table 8. Continued

<table>
<thead>
<tr>
<th>Item</th>
<th>SA</th>
<th>A</th>
<th>U</th>
<th>D</th>
<th>SD^a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research performed by outside organizations is perceived by industry as being more costly than research done in-house.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>02%</td>
<td>18%</td>
<td>50%</td>
<td>30%</td>
<td>01%</td>
</tr>
<tr>
<td>STATE (N=73)</td>
<td>04%</td>
<td>16%</td>
<td>56%</td>
<td>23%</td>
<td>00%</td>
</tr>
<tr>
<td>Industry lacks appreciation for the scientific research method's characteristics of communication and peer review.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNIVERSITY (N=112)</td>
<td>04%</td>
<td>40%</td>
<td>20%</td>
<td>32%</td>
<td>04%</td>
</tr>
<tr>
<td>STATE (N=74)</td>
<td>15%</td>
<td>30%</td>
<td>30%</td>
<td>24%</td>
<td>01%</td>
</tr>
<tr>
<td>Industry exerts influence on the direction, methods, and results of research.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNIVERSITY (N=113)</td>
<td>08%</td>
<td>59%</td>
<td>13%</td>
<td>18%</td>
<td>02%</td>
</tr>
<tr>
<td>STATE (N=76)</td>
<td>22%</td>
<td>45%</td>
<td>22%</td>
<td>11%</td>
<td>00%</td>
</tr>
<tr>
<td>The desire on the part of industry for immediate, short-term results.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNIVERSITY (N=114)</td>
<td>17%</td>
<td>61%</td>
<td>09%</td>
<td>11%</td>
<td>01%</td>
</tr>
<tr>
<td>STATE (N=76)</td>
<td>17%</td>
<td>51%</td>
<td>26%</td>
<td>05%</td>
<td>00%</td>
</tr>
<tr>
<td>Industry has a bias toward technological ideas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNIVERSITY (N=113)</td>
<td>11%</td>
<td>42%</td>
<td>31%</td>
<td>13%</td>
<td>03%</td>
</tr>
<tr>
<td>STATE (N=74)</td>
<td>04%</td>
<td>31%</td>
<td>31%</td>
<td>34%</td>
<td>00%</td>
</tr>
<tr>
<td>Industry may lose sight of the university's teaching function.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNIVERSITY (N=114)</td>
<td>17%</td>
<td>45%</td>
<td>14%</td>
<td>22%</td>
<td>03%</td>
</tr>
<tr>
<td>STATE (N=75)</td>
<td>17%</td>
<td>45%</td>
<td>14%</td>
<td>22%</td>
<td>03%</td>
</tr>
</tbody>
</table>
Table 8. Continued

<table>
<thead>
<tr>
<th>Item</th>
<th>SA</th>
<th>A</th>
<th>U</th>
<th>D</th>
<th>SD²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry expects that universities should operate like a business.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>UNIVERSITY (N=114)</td>
<td>09%</td>
<td>38%</td>
<td>20%</td>
<td>32%</td>
<td>02%</td>
</tr>
<tr>
<td>STATE (N=75)</td>
<td>16%</td>
<td>49%</td>
<td>19%</td>
<td>15%</td>
<td>01%</td>
</tr>
<tr>
<td>Industry applies the same investment criteria to research as to other investments.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNIVERSITY (N=114)</td>
<td>08%</td>
<td>46%</td>
<td>21%</td>
<td>24%</td>
<td>01%</td>
</tr>
<tr>
<td>STATE (N=74)</td>
<td>10%</td>
<td>39%</td>
<td>28%</td>
<td>22%</td>
<td>01%</td>
</tr>
<tr>
<td>Industry using a wider range of faculty members when seeking consultants or researchers.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDUSTRY (N=123)</td>
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SECTION IV. THE FEDERAL GOVERNMENT AND CONFLICTS OF INTEREST
INTRODUCTION

In terms of public policy, the 1980s may best be described as the "Technology Decade." Underlying most of the public policy interest in technological development, especially high technologies, was a concern that the nation's innovative capacity, scientific prowess, and productivity was declining in the face of international competition. Faced with the lagging performances of such industries as semiconductors, steel, and automobiles, as well as a mounting trade deficit, Congress has made a number of proposals for boosting the developments of new industrial technologies.

Traditionally, new high-technology products are an important source of prestige and of a favorable balance of payments, while innovation fosters gains in employment and productivity. The general perception of the last decade is that the position of the United States as the center of technological innovation and high technology development has been substantially eroded. Other countries, Japan in particular, have demonstrated more productive and efficient approaches to both innovation and technology transfer. The United States may have already lost its ability to compete in many markets involving high technology.

Pinning their economic development hopes on high-technology industries, policy makers stress the importance of interaction between universities, government laboratories and
industries, to foster innovation. Government officials recognize that the relationships between industry, government, and academia are not as strong in the United States as those in other technologically advanced countries such as West Germany and Japan. In its preoccupation with foreign competition and development, Congress has formulated new policies with regard to industrial innovation. Consequently, legislation in the past decade has been directed toward encouraging and strengthening university-industry-government research and development (R&D) interaction. By 1983, over 200 state and local economic development initiatives, all of which had some feature directed at high-technology development, were underway. All state governments now operate some program aimed at promoting university-industry-government interaction to spur economic growth.

As research relationships between universities, industries and federal laboratories have become increasingly incestuous, however, concerns about the conflicts of interest that such relationships breed continue to mount. A National Institutes of Health (NIH) advisory committee concluded in 1981 that there were serious potential problems with the influx of industrial monies into the area of medical and biomedical research, including patent rights, the free flow of information, and the transformation of universities into industrial training institutes.

Other problems have emerged as university scientists
begin to hold equity interests in companies with whom they collaborate. Particular incidents include graduate students being forced to abandon projects upon discovering that faculty advisors had turned the research concept over to a company in which the faculty held proprietary interests,\textsuperscript{5} faculty members assigning graduate students to work directly in company laboratories in which the professors had economic interests,\textsuperscript{6} a professor heading a company that was given exclusive rights to market a drug that the professor developed with federal grant money,\textsuperscript{7} and fabrication of data by faculty members who hold equity interests in companies that will directly benefit from the results of their drug trial research.\textsuperscript{8}

Responding to congressional concerns that such financial conflicts of interest taint federally funded research, NIH, the primary federal funding agency for biomedical research, proposed conflict of interest guidelines for its university contract and grant recipients, which would have required anyone involved in NIH-funded research to make "full disclosure of all financial interest and outside professional activities."\textsuperscript{9} These guidelines were summarily withdrawn under harsh criticism from grant recipients that such guidelines might harm industrial competitiveness, subject researchers to overly burdensome financial disclosure requirements, stifle technology transfer from federally sponsored research to the private sector, and that they were too vague about what constituted a conflict of interest.\textsuperscript{10}
Unlike university scientists, government scientists must operate within the confines of existing federal conflict of interest law, a morass of criminal statutes and administrative regulations. The increasing R&D collaborations between federal and industrial scientists, which Congress has encouraged, effectively create situations that are inconsistent with existing conflict of interest law. Striking a balance between the seemingly competing policy interests of preserving public trust in federal employees and encouraging technology transfer from government laboratories to private industry has become both a challenge and a frustration for government officials. This research note examines the constitutional, administrative, and public policy problems inherent in regulating conflicts of interest in the technology transfer area under both existing law and future guidelines.
In agency law, the conflict of interest concept generally refers to "conduct that tempts an agent to deal unfairly by preferring his own interests to the interests of the [principal]." Regulating conflicts of interest in the public sector has been a hotly debated issue since shortly after the spoils system of the Jacksonian Presidency. Thus, since the mid-1800s, conflict of interest regulations have defined two goals: (1) to prevent the use of public office for private gain; and (2) to maintain public confidence in the integrity and objectivity of decision-making in executive-branch agencies.

Two challenges face policy makers when attempting to regulate conflicts of interest in the public sector. At the congressional level, high standards and public accountability must be enforced without making every violation a partisan issue. At the administrative level, the challenge is to attract qualified persons to public service who understand the trust that public service implies.

The primary and continuing problem has been limiting opportunities in which officials gain private advantage without, at the same time, precluding public agencies from recruiting and retaining as employees or consultants, especially qualified persons drawn from the private sector. Consequently, a variety of federal statutes, executive orders,
and administrative regulations have been promulgated, resulting in rather complex reporting and other administrative requirements and constraints for federal employees.

Reporting Requirements

Conflicts of interest during federal service are guarded against, in part, by requiring certain civil servants and political appointees to file detailed reports concerning financial matters and institutional responsibilities under the Ethics in Government Act of 1978. The act relies on public financial disclosure as a means of ensuring that public rather than private purposes are served by executive branch personnel classified as GS-16 or above. A disclosure report indicating the source, type, and amount or value of income from any source must be filed by government personnel within 30 days of assuming office. Similar financial information is required of spouses and dependent children. Knowing and willful violators of the act's requirements may incur civil penalties up to $5,000, and negligent violators are subject to a $1,000 fine.

The innovative aspects of the statute lie in its detailed reporting requirements and its provision that requires public reporting. With limited exceptions to accommodate the national interest, all reports must be made available to the public and retained for six years. Although the dominant philosophy
underlying the act is one of disclosure, aspects of its requirements extend beyond disclosure and purport to restructure the personal financial affairs of affected officers. Agency officials or the Director of the Office of Government Ethics review the reports and determine whether conflicts of interest exist and recommend corrective action, such as divestiture, or limiting duties in order to eliminate the conflict of interest. Moreover, outside earned income of all presidentially-appointed employees, in nonjudicial full-time positions at the level of GS-16 or above, is limited to 15% of the employee’s government salaries. While the Ethics in Government Act sought to take a proactive stance toward conflicts of interest involving high-level government officials, the definitions of conflicts of interest has been governed, since 1962, by Title 18, sections 203, 205, and 208, and by Executive Order 11,222 and its implementing agency regulations. Criminal Prohibitions Due to the difficulty of formulating, applying and enforcing standards dealing with employee’s personal motivations or beliefs that potentially create favoritism in the performance of public duties, federal conflict of interest law is limited to considerations of conflicts between official duties and personal economic interest. This focus may be due,
in part, to the perception on the part of Congress that the "prevailing ethical concern of the populace is economic." Thus, conflicts of interest at the federal level are often defined in terms of an employee "placing himself in a position where a conflict exists between his private financial interests and the interests of the public he is to serve."  

Policy objectives underlying statutes proscribing certain conduct as criminal include achieving government efficiency, equal treatment of equal claims, and public confidence, preventing the use of public office for private gain, and preserving the integrity of government policy-making institutions. Balancing these policy objectives with those expressed in federal technology transfer mandates creates problem areas for agencies struggling to implement the technology transfer policy objectives.

Federal criminal provisions address four problem areas: (1) outside activities in certain matters involving the United States; (2) particular types of post-employment activities; (3) self-dealing; and (4) the receipt of certain forms of outside compensations.

**Outside activities**

One principle underlying the federal conflict of interest laws is that public officials should not, in general, be permitted to step out of their official roles to assist private entities of persons in their dealings with the government. Two statutory provisions, sections 203 and 205 of
Title 18 of the United States Code, are essentially coextensive as to prohibited services. In essence, both sections limit representational activity by federal employees before federal agencies or courts on "any particular matter" in which the United State is a party or has a direct and substantial interest.

The basic prohibition of section 203 is against receiving "any compensation for . . . any services rendered . . . in relation to any proceeding . . . before any department." The main purpose of this section was to secure the integrity of executive action against undue influence on the part of members of the Government whose favor might have much to do with appointment to, or retention in, the public position of those whose official action it was sought to control or direct. Hence, this section is intended to reach any situation in which the judgment of a Federal agent might be clouded because of payments or gifts made to him by reason of his position or otherwise than as provided by law for the proper discharge of his official duty. Even if corruption is not intended by either the donor or donee, there is still a tendency in such situations to provide conscious or unconscious preferential treatment or inefficient management of public affairs, and this section is a congressional effort to eliminate such inherent temptations.

The Justice Department has indicated broadly that "any utilization of official position to serve a private client,
whether to influence the action of others or not, seems within the ban of the statute." Thus, there is authority to suggest that section 203 may encompass services which are in furtherance of a Government proceeding or contract although the services themselves are not rendered before a Federal department or agency.

Section 205 is unambiguously limited to representational activity. The statutory language prohibits a federal employee from acting as "agent or attorney . . . before any department, [or] agency . . . ." Furthermore, the House and Senate committee reports use the words "representative activity" or "representational activity" in describing the ban of section 205.

Post-employment activities

A former federal employee is barred for life from knowingly acting as an agent for anyone, in connection with matters in which he participated personally and substantially, while an employee of the Government. However, this provision is not without exception where scientific research is involved:

[I]n order to make sure that a scientific agency is not cut off from the benefits which may accrue in an important situation from permitting the appearance of a former employee with outstanding scientific qualifications, [Congress] has added a proviso permitting such appearance, despite the provisions of subsection (a)
upon an agency certification [by the head of the agency involved], published in the Federal Register, that the national interest would be served thereby. This exemption can be invoked only (1) in favor of an individual "with outstanding technological qualifications," (2) in connection with "a particular matter," and (3) where the matter is "in a scientific or technological field."

Self-dealing

A federal employee is prohibited from participating personally and substantially as a Government officer or employee in a Federal matter in which he, his minor child, spouse, or partner or organization in which he is serving has a financial interest. The primary purpose of this section is to insure honesty in the Government's business dealings by preventing Federal agents from advancing their own interests at the expense of the public welfare. This provision established an objective standard of conduct, and whenever a Government agent fails to act in accordance with that standard he is guilty of violating this section, regardless of whether positive corruption existed. Thus, a financial interest may exist where a real possibility of gain or loss is present, but the gain or loss need not be probable for this section to apply; all that is required is that a real, as opposed to speculative possibility of gain or loss exists.

In enacting this provision, Congress plainly intended that prohibiting participation by government employees in
decisions affecting organizations, with whom the employees were negotiating or had arrangements concerning prospective employment, would expand the reach of this section. Congress was, however, evidently concerned with permitting qualified persons to move between the public and private sectors, and with facilitating the Government's recruitment and retention of talented personnel. Thus, to penalize by criminal prosecution indefinite and inchoate links to outside firms, such as unsolicited offers of future employment or even unilateral hopes and plans, would defeat the congressional purpose. 41

The purpose of this section is, rather, to insure honesty in the Government's business dealings by preventing Federal agents who have interests adverse to those of the Government from advancing their own interests at the expense of the public welfare. 42 Therefore, for example, one may not have a personal financial interest in the outcome of advice that one gives as a federal employee. 43

The restrictions of Title 18, section 208 may be waived if the employee first advises the appointing Government official of the nature and circumstances of the federal proceeding and makes full disclosure of the financial interest. In order to satisfy the waiver provision, the employee must receive, in advance, a written determination that the interest is not so substantial as to be deemed likely to affect the integrity of his services. 44 Alternatively, a
general rule or regulation may be published in the Federal Register indicating the type of financial interest that has been exempted from the approval requirement as being too remote or too inconsequential to affect the integrity of Government employees' services.\textsuperscript{45}

**Outside compensation**

Federal conflict of interest law also embodies a prohibition against discretionary transfers of value to a public official from a private source.\textsuperscript{46} The key language bars the receipt from any source other than the Government of "any salary, or any contributions to or supplementation of salary, as compensation for . . . services as an officer or employee . . . ."\textsuperscript{47} The prohibition, however, does not apply to a special government employee or to an employee serving without compensation from the federal government.\textsuperscript{48} Nor does it prohibit a government official from receiving compensation for services rendered in a nonofficial capacity, such as private consulting fees.

**Miscellaneous provisions**

A potpourri of additional criminal laws are tangentially related to conflicts of interest. In particular, criminal provisions prohibit an employee from acting as the agent of a foreign principal registered under the Foreign Agents Registration Act.\textsuperscript{49} Furthermore, federal employees are subject to criminal prosecution for the unauthorized use of documents relating to claims from or by the Government,\textsuperscript{50} and
are prohibited from mutilating or destroying a public document. Other provisions prohibit federal employees from disclosing trade secrets and similar information which the employee obtains in the course of performing official duties, or committing fraud or making false statements in a Government matter.

Administrative Regulations

Government-wide administrative regulations dealing with conflicts of interest have existed since the 1960s. In 1965 President Johnson issued an Executive Order which sought to prevent federal employees from having a direct or indirect financial interest that conflicts substantially, or appears to conflict substantially, with his or her official duties. The executive order and implementing regulations were more stringent than the criminal statutory prohibitions, because an employee need not have a financial interest that actually conflicts with his or her duties to violate the executive order.

Hearings on the 1962 conflict of interest statutes emphasized that much of the conflict of interest regulation could be dealt with administratively. Administrative conflict of interest policies, therefore, have been directed at the regulation of potential harm. As a result, administrative regulation assumes that the "appearance" of a
conflicting interest "poses a serious enough threat to objective decision making and public confidence in that objectivity to warrant a prohibition on conduct that might create a conflict of interest or the appearance thereof."

Theoretically, the purpose of conflict of interest regulation at the administrative level is three-fold: (1) to prohibit conduct that increases the temptation that often leads to dereliction; (2) to give definite guidance to employees by forcing them to consider carefully temptations they confront, thereby reducing the likelihood that officials will be caught in a precarious situation; and (3) to facilitate enforcement by alleviating the need for specific wrongdoing or damage to be shown. When weighed against technology transfer interests, however, certain of the regulations bear little resemblance to the important governmental purposes they purport to carry out. Moreover, many of the regulations may be unconstitutionally vague and overbroad in their application to government scientists.

In general, the regulations provide that employees should:

avoid any action . . . which might result in, or create the appearance of:

(a) Using public office for private gain;
(b) Giving preferential treatment to any person;
(c) Impeding Government efficiency or economy;
(d) Losing complete independence or impartiality;
(e) Making a Government decision outside official channels; or

(f) Affecting adversely the confidence of the public in the integrity of the Government. 59

Each agency is required to appoint a counselor for interpretations on questions of conflicts of interest, and to notify all employees of the availability of counseling services, including how and where they are available. 60 The regulations, however, are often not always interpreted consistently, as they impose complex and burdensome requirements on government officials regarding gifts, 61 outside employment, 62 misuse of government property, 63 adverse financial interests, 64 wrongful use of official information, 65 indebtedness, 66 and gambling and betting. 67 In the area of technology transfer, only three of these requirements directly apply to conflicts of interest: (1) limitations on outside activities; (2) adverse financial interests; and (3) wrongful use of official information.

Outside activities

The Department of Agriculture has defined "outside activity" as any outside work or activity, other than official duties, performed by a government employee. 68 In general, federal employees are prohibited from engaging in outside activities that are incompatible with the full and proper discharge of their official duties. 69 Incompatible activities include the acceptance of anything of monetary value that
creates a real or apparent conflict of interest.\textsuperscript{70}

Agencies have implemented this provision with varying degrees of prohibitional clarity.\textsuperscript{71} Those agencies involved heavily in scientific research have established comprehensive guidelines to handle the demand for many of their scientists to perform off-duty consulting functions for private parties. The Departments of Health and Human Services and Agriculture, for example, require that administrative approval be obtained prior to performing any professional or consultative services.\textsuperscript{72} Moreover, requests to perform outside activities in a consultative capacity are generally carefully screened to avoid conflicts of interest or the appearance of such conflicts.\textsuperscript{73} At the extreme level, the National Institutes of Health goes so far as to limit the amount and type of compensation that its scientists can receive as consultants.\textsuperscript{74} Only the Department of Agriculture, however, provides a regulatory definition of the terms "conflict of interest" and "appearance of conflict of interest,"\textsuperscript{75} even though the terms appear regularly in agency approval and enforcement policies.

**Adverse financial interests**

All federal agencies are required to have a system for reviewing employee financial and employment statements that is designed to disclose real or apparent conflicts of interest of employees.\textsuperscript{76} At a minimum, each agency must require employees classified GS-13 or above who are responsible for activities "where the decision or action has an economic impact on the
interests of any non-Federal enterprise," to file statements of employment and financial interests. Additionally, however, an agency may require any other employees to file financial and employment disclosures "in order to avoid involvement in a possible conflicts-of-interest situation . . ." All such statements are considered confidential and only a select few employees are authorized to review and retain the statements.

Federal employees are prohibited from having even an "indirect" financial interest that conflicts, or appears to conflict, substantially with their government duties. This prohibition also restricts an employee from relying on information obtained through government employment in entering into a financial transaction. The practical result of this provision is to extend the criminal prohibition against a federal employee, participating in a matter in which he or she has a financial interest, to situations where the financial interest does not actually conflict, but merely appears to conflict with official duties. Indeed, many agencies have interpreted such a blanket prohibition as the intent of President Johnson's Executive Order 11,222.

Wrongful use of official information

A federal employee may not use information obtained by virtue of government employment, which has not been made publicly available, to further a private interest. The regulation is unclear about the precise meaning of "furthering
a private interest," and some commentators argue that, considering the number of policy and constitutional issues involved, this regulation should not be interpreted to extend beyond furthering private financial interests. In this respect, this prohibition is perhaps representative of a major problem currently underlying conflict of interest regulations—how far should they extend into the technology transfer realm? Answering this question demands a careful examination of the policy dimensions underlying technology transfer initiatives by the federal government.
Technological innovation is a positive force that can drive both economic growth and industrial productivity. It provides improved commercial products and processes, and creates jobs and income as new industries are born or existing industries expand. Technological innovation has generally been perceived by policy makers as necessary to restore competitiveness in basic industries, especially in the rapidly growing high technology fields. A great deal of technology available for utilization has been produced in federal laboratories or financed with federal dollars. Much of this technology, however, has not been transferred to the commercial sector efficiently. Many analysts of the U.S. economy warned that the roots of the economic recession of the late 1970s were in a longer term economic malaise which arose out of a failure of American industry to keep pace with the increased productivity of foreign competitors. Therefore, beginning with the Carter administration, Congress sought ways to improve the movement of federally owned or originated technology from federal laboratories to industry and state and local governments, a process commonly referred to as technology transfer.
Stevenson-Wydler Act of 1980

As concerns grew about U.S. competitiveness during the 1970s, Congress began questioning whether the federal government was receiving an adequate return from its research and development (R&D) expenditures. In 1980 Congress passed the Stevenson-Wydler Technology Innovation Act, making technology transfer part of the mission of all federal agencies carrying out R&D. At the time this act was passed, the National Aeronautics and Space Administration (NASA) was the only federal agency that had technology transfer as part of its mission. The Stevenson-Wydler Act was an important first step in improving the utilization of federal technology.

The goal of the Stevenson-Wydler Technology Innovation Act was to reverse a trend where some of the nation’s most innovative basic scientific discoveries were being turned into commercial products overseas. The Act sought to make ideas with commercial potential, originating in federal laboratories, more readily available to those in the private sector with the capability and incentive to exploit them. It also sought new ways to encourage cooperative technology development among the private sector, universities, and government. In so doing, the Act required federal agencies to establish an Office of Research and Technology Applications (ORTA) at their laboratories that would identify technologies and ideas with potential applications in other settings.
The Act envisioned federal scientists working side-by-side with their university or industry counterparts on projects that were co-funded by their institutions.\(^2\)

Bayh-Dole Patent and Trademark Amendments of 1980

In a series of amendments to the patent and trademark acts, Congress sought to provide for a uniform policy governing the disposition of patent rights in government funded research.\(^3\) The then-existing melange of 26 different agency policies on vesting of patent rights in government-funded research sparked a uniform national policy "designed to cut down on bureaucracy and encourage private industry to utilize government funded inventions through the commitment of the risk capital necessary to develop such inventions to the point of commercial application."\(^4\) Specifically, the legislation established a presumption that ownership of all patent rights in government funded research will vest in any contractor who is a non-profit research institution or a small business.\(^5\) In effect, the amendments gave universities and small businesses the right of first refusal on any invention created, in whole or in part, with federal funding. The practical result was to increase university-industry collaboration as universities that developed and patented fundamental technologies under federal funding were allowed to manage and promote their discoveries.\(^6\)
Federal Technology Transfer Act of 1986

Background

Although the patent and trademark amendments had proven to be an effective means of stimulating industry-university interaction, the technology flow between federal laboratories and industry envisioned by the Stevenson-Wydler Act had not been implemented. Despite the Bayh-Dole Act and the Stevenson-Wydler Act, only 5% of government patents had been licensed and federal laboratories still faced problems and disincentives in trying to transfer technology. To facilitate the implementation of the nation's technology transfer policy goals, President Reagan explicitly endorsed recommendations of the 1983 White House Science Council Federal Laboratory Review Panel, better known as the "Packard" report.

The Packard report recommended granting formal authority to federal laboratories to enter into cooperative research projects with industry, universities, and nonprofit organizations. To encourage cooperation in federal laboratory research, the Packard report also recommended that the authority of federally operated laboratories be extended to include the granting of patent rights to private sector organizations.

In response, Congress enacted the Federal Technology Transfer Act of 1986 (FTTA), which had the practical effect of
amending the Stevenson-Wydler Act.\textsuperscript{100} The FTTA authorized agencies to permit their laboratories to enter into cooperative research and development agreements (CRDAs) with private entities, including the authority to accept from or provide resources to, collaborating parties.\textsuperscript{101} The definition of a CRDA is broad. Under a CRDA a federal agency, through its laboratories, may provide personnel, services, facilities, equipment, or other resources (but not funds), with or without reimbursement, to one or more nonfederal parties who, in turn, may provide funds, personnel, services equipment, or other resources toward the conduct of specified R&D efforts that are consistent with the agency's mission.\textsuperscript{102} The FTTA also provided legal authority to laboratories to grant collaborating parties the rights to inventions made during such arrangements, and authorized an agency to allow its laboratories to negotiate patent licenses.\textsuperscript{103} Federal scientists received creativity incentives consisting of no less than 15% of patent-generated royalties resulting from a government inventions.\textsuperscript{104}

**Agency implementation of the FTTA**

Federal agencies have taken numerous actions to implement the FTTA, with mixed results. According to a recent survey of the twelve agencies reporting implementation,\textsuperscript{105} the majority of CRDAs have involved either the Public Health Service\textsuperscript{106} of the Department of Health and Human Services, or the Agricultural Research Service (ARS) of the United States
Department of Agriculture. As of late 1989, ARS had entered into 66 CRDAs with industrial firms and had at least 32 additional CRDAs in negotiation. Since December 1986 the Public Health Service has reported signing 100 CRDAs, with 80 additional ones under negotiation, and the Department of Defense has reported 45 CRDAs in place or under negotiation. In general, the number of reported inventions increased by 40% for some agencies between FY1987 and FY1988, and future royalties may be substantial. Current royalty distributions, however, remain meager—a mere $4,617,070 among the 12 agencies implementing the FTTA, $3,946,263 of which was earned by NIH.

Concerns common to federal agencies have involved barriers that still exist in implementing the FTTA. Officials from many federal laboratories and agencies believe that the limited authority to conduct proprietary research constrains effective technology transfer. Prospective industrial collaborators are concerned that proprietary information will be made available to competitors under the Freedom of Information Act (FOIA). A few select agencies have taken affirmative steps to deal with this concern. In any event, providing assurances to industrial collaborators that proprietary information shared under a CRDA will be held in confidence should not prove problematic, since FOIA allows an agency to exempt from disclosure matters that are "trade secrets and commercial or financial information obtained from
a person and privileged or confidential."\textsuperscript{115}

**Addressing conflict of interest concerns**

The greater concern for many agencies is the types of conflicts of interest that CRDAs breed.\textsuperscript{116} In particular, collaborative work under CRDAs can create conflicts with an agency's primary mission, and financial interests in a collaborating company can cause unique problems. Any agency implementing the FTTA is required to "review [its] employee standards of conduct for resolving conflict of interests to make sure they adequately establish guidelines for situations likely to arise through the use of [CRDAs] . . . ."\textsuperscript{117}

Furthermore, if "an agency is unable to resolve potential conflicts of interest within its current framework, it shall propose necessary changes to be forwarded to its authorizing committees in Congress."\textsuperscript{118}

As agencies struggle under congressional mandates to resolve existing and potential conflict of interest dilemmas created by CRDAs and current conflict of interest law, President Bush has ordered the Office of Government Ethics to promulgate "regulations that establish a single, comprehensive, and clear set of executive-branch standards of conduct that shall be objective, reasonable, and enforceable."\textsuperscript{119} Consequently, agencies are faced with implementing CRDAs within the limits of current conflict of interest regulations, with an eye toward suggesting possible changes in existing law. The key is to propose standards of
conduct that are "objective, reasonable, and enforceable" in light of a public policy environment currently stressing closer collaboration with private industry. A review of existing conflict of interest situations unique to the technology transfer forum may help resolve this dilemma.
APPLICABILITY OF CONFLICT OF INTEREST LAW TO TECHNOLOGY TRANSFER

Common Problem Areas

Generally, an "actual" conflict of interest is a situation in which an employee's outside interests, usually financial in nature, conflict with the full, fair and impartial performance expected of that employee in his or her official federal duties. An "apparent" conflict of interest, although not defined or regulated by Congress, has been defined formally by the Department of Agriculture as any situation in which a reasonable person might conclude that a conflict of interest exists or may exist in the near future if the situation is allowed to continue. 120

An example of an apparent conflict of interest might be where a government employee working under a CRDA has a fiancee who is an employee of the collaborating company. Although no federal statutory law is violated under this circumstance, this situation may, nonetheless, be interpreted by the supervising agency as creating an appearance of favoritism toward the company, in violation of agency regulations. 121 Other instances which might create an apparent conflict of interest arise when a federal employee might be perceived as using public office for private gain, 122 impeding Government efficiency or economy, 123 losing complete impartiality in the
performance of Government duties, 124 making official decisions outside of proper channels, 125 or otherwise affecting adversely the confidence of the public in the integrity of the Government. 126

Financial interests

A "financial interest" has been defined as any interest of monetary value which may be directly or predictably affected by the official action of an employee. 127 Congress has specified no minimum amount of value or control that constitutes a financial interest; one share of stock constitutes a financial interest. However, stocks in business entities held by an intermediary such as a mutual fund may be too remote or inconsequential to affect the integrity of an employee's services, and therefore may be waivable financial interests under Title 18, section 208(b). Examples of financial interests include stocks, salaries and consultant agreements.

In addition, federal employees are prohibited from receiving compensation from a source other than the Government for the performance of his or her official duties, which includes work under a CRDA. 128 Government employees cannot receive payment for overtime work from a collaborating party under a CRDA, nor may the employee accept royalty payments directly from a nonfederal party. For purposes of that provision, however, the Office of Government Ethics has determined royalties received from the Government under the
PTTA or under Title 35 of the patent law are not prohibited compensation, implying that so long as royalty payments are funneled through the federal government, they are legal. Because of this fact, one could logically conclude that potential royalties from inventions under a CRDA should not constitute a prohibited financial interest in a collaborating company under Title 18, section 208.

By law, a government employee cannot participate personally and substantially in a "particular matter" if he or she has a financial interest in one of the non-federal parties. The employee's financial interests include those of a spouse, minor child, or an organization with which he or she is serving or negotiating for future employment. The Justice Department has interpreted the term "particular matter" broadly to include virtually any sort of governmental activity, including rulemaking and the formulation of general policy, which would have a direct and predictable effect on the employee's financial interest. Therefore, a government employee is prohibited from collaborating under a CRDA with a company in which he, his spouse or minor child, or an organization with which he is serving or negotiating for prospective employment has a financial interest.

The effects of applying this provision to the CRDA arena are dramatic. For instance, a government employee cannot simultaneously consult and collaborate under a CRDA for the same company, even if the two projects are wholly independent
of each other. Nor may the employee own even a single share of stock in the company with whom he desires to collaborate. Furthermore, while involved in the CRDA, the employee is prohibited from negotiating for post-CRDA employment with a non-federal collaborating party.

Problems also arise where an employee's spouse is concerned. A government employee would be prohibited from collaborating under a CRDA with a company where his or her spouse is employed, regardless of the merits of the proposed project. Moreover, where a federal employee's spouse is a member of a firm likely to seek an exclusive patent license on an invention being developed by the employee, the employee would be prohibited from actively participating in discussions leading to licensing.

Perhaps the most complicated scenarios involve companies with spin-offs or venture capital backing. What happens where an employee is consulting with a company funded by the same venture capital group that finances a company with whom the employee wishes to establish a CRDA? What if the employee is a consultant to a company which has a spin-off with whom the employee wishes to enter into a CRDA? The financial interest involved in such cases is so remote that it is unlikely to affect adversely the integrity of the government employee involved, and the policy goal of encouraging technology transfer might be better served by allowing the CRDA collaboration to move forward. Thus, the applicability of
federal law might be appropriately waived under such circumstances.\textsuperscript{133}

**Representational activity**

Federal criminal law prohibits federal employees from representing others before a Federal agency or court concerning any "particular matter."\textsuperscript{134} Representational activity includes any communication with the intent to influence.\textsuperscript{135} Thus, a government employee cannot attempt to influence a federal agency on behalf of another concerning a license or other right to an invention developed under a CRDA (as where the employee and a company plan a joint commercial exploitation of a government invention as an outside activity). Taken to a logical extreme, an employee may not negotiate on behalf of a company, in which he or she is the sole stockholder, because the company is a separate legal entity. A government employee is not, however, prohibited from participating in negotiations on his or her own behalf with the government concerning rights to an invention.

**Proprietary information**

Proprietary information includes trade secrets and similar information. As has been discussed, federal employees are prohibited from disclosing trade secrets and similar information obtained in the course of performing official duties.\textsuperscript{136} Effective collaboration under a CRDA may require the disclosure of proprietary information to federal employees. Although agreements to maintain confidentiality
are permitted under the Freedom of Information Act in the agency's discretion, proprietary information should be limited to the amount necessary to carry out the research plan of a CRDA to remove communication barriers among government scientists.

Disclosure of unpublished research results is similarly within the discretion of agency directors. Nonetheless, agreements to keep CRDA research results confidential to the extent permitted by law until they are disclosed by mutual agreement or otherwise published in the scientific literature or presented at public forum may be necessary to preserve the government's intellectual property rights.

**Post-employment restrictions**

Former government employees are prohibited for life from acting as another's representative to the government in a particular matter involving a specific party or parties. A CRDA with which an employee was substantially involved may constitute such a particular matter. An employee's participation in a CRDA must have been personal and substantial in order to constitute a violation of this provision. To participate "personally" means directly, and includes the participation of a subordinate when actually directed by the former Government employee in the matter. "Substantially" means that the employee's involvement must be of significance to the matter, or form a basis for a reasonable appearance of such significance. Examples of
substantial involvement might include approval, disapproval, recommendation of and the rendering of advice about a CRDA. It requires, however, more than official responsibility, knowledge, or involvement on an administrative or peripheral issue. Thus, mere participation in research projects while a government employee, prior to the formulation of a CRDA, should generally not restrict the former government employee from entering into a CRDA at a later date.

In certain cases, whether a CRDA should be treated as a particular matter involving specific parties may depend on the employer's own participation in events which gave particularity and specificity to the CRDA in question. For example, if a government employee (1) personally participated in a stage of the CRDA formulation where significant requirements were discussed and one or more collaborators was selected to perform services thereunder and (2) actively urged that such a CRDA be approved, but the CRDA was actually approved only after the employee left, the CRDA may nevertheless be a particular matter involving a specific party as to the government employee.

In order to constitute a prohibited activity, the CRDA must involve specific parties both at the time that the Government employee acts in an official capacity and at the time in question after Government service. The CRDA may continue in another form or part and still meet this condition. In determining whether two particular CRDAs are
the same, the extent to which the CRDAs involve the same basic facts, related issues, the same or related parties, time elapsed, the same confidential information, and the continuing existence of an important Federal interest should be assessed.  

The most common situations in which a former employee would be barred from CRDA collaboration occur where an employee files a patent application on an invention created in a government laboratory and advises the agency that a CRDA should be pursued with company X on the invention. If the employee leaves the agency and the CRDA with company X is approved, the employee is prohibited from representing company X on the CRDA.

**Preferential treatment**

Administrative regulations mandate that federal employees should avoid even the appearance of giving preferential treatment to any person. Often, however, agencies may be faced with the desire on the part of collaborating companies to retain an exclusive license to inventions created under a CRDA. While the promise of exclusive licenses to inventions created under a CRDA may be necessary to attract private companies, the government can retain some control over the inventions, and simultaneously alleviate any appearance of preferential treatment, by: (1) issuing separate licenses for the same invention for different purposes; (2) requiring that companies provide products commercialized under the license at
reasonable prices; or (3) terminating a commercial license if a company failed to bring a product to market in a timely manner, thereby alleviating any appearance of preferential treatment. 145

A related problem in this area is that multiple CRDAs with the same collaborator may give the appearance of favoritism in collaborator selection. To combat this problem, the Public Health Service has developed a policy for ensuring fairness of access to CRDAs based on various notification activities, such as Federal Register announcements, federal laboratory directory listings, and collaboration forums. 146 Only where the government is the sole desired collaborator and is not promising proprietary rights to the other party is any type of public announcement deemed unnecessary. 147

Potential Solutions

The fact that CRDAs should be conducted effectively, objectively and without improper influence is axiomatic. No one would dispute that federal employees should not engage in any conduct prejudicial to the Government and avoid conflicts of private interests with public duties and responsibilities. There may be, however, circumstances in which the public interest in technology transfer generally outweighs the public interest in avoiding an apparent conflict of interest. In order to deal effectively with such situations, agencies
should be prepared to evaluate each CRDA proposal on a case-by-case basis to review conflict of interest determinations.

Reporting requirements

In many respects, current administrative reporting and monitoring requirements can easily be incorporated into CRDA approval processes. Currently, all agencies are required to maintain deputy ethics counselors who provide authoritative advice and interpretative guidance on conflict of interest matters. Additionally, certain classes of employees are required to file financial disclosures, and administrative regulations provide that financial disclosure can be required of any employee where federal action has an economic impact on a non-federal party’s interests. CRDAs have just such an economic impact.

Essentially, agencies involved in CRDA activity could require employees to submit financial disclosure forms in conjunction with CRDA proposals. In so doing, agency deputy ethics counselors could then review the proposal and disclosure form to determine whether a conflict of interest was indicated and attempt to resolve the conflict before the CRDA is approved. Furthermore, the filing of supplementary statements is required, providing a continual monitoring device of potential conflict of interest developments in CRDAs currently in place. Methods of resolving financial conflicts of interest may include a change of assignment, withdrawal from the CRDA, construction of a trust, financial divestiture,
or the granting of a waiver.

**Waivers**

If an employee indicates that a conflict of interest may exist with a proposed CRDA, he or she should be allowed to request a waiver as a means of going forward with the CRDA. In determining whether a waiver is appropriate under the circumstances, the deputy ethics counselor should review the conflict of interest in question. If the counselor determines that a financial interest "is not so substantial as to be deemed likely to affect the integrity of the services which the Government may expect from the . . . employee" involved in the CRDA, a waiver should be granted.

A standing waiver may also be granted for a recurring situation which is generally too remote or inconsequential to affect the integrity of a federal employee's services. Upon recommendation by the deputy ethics counselor, this type of waiver would be published as a general rule or regulation in the Federal Register.

**Institutionalized policy guidelines**

The FTTA requires all agencies implementing its authority to evaluate their conflict of interest guidelines, and to propose any necessary changes to Congress. At the very least, agencies should promulgate interpretative policy guidelines regarding the applicability of agency regulations to technology transfer situations.

Technology transfer in federal agencies is an evolving
mission. Circumstances may exist where the public interest in a particular project or in technology transfer generally outweighs the public interest in avoiding an apparent conflict of interest. In instances where the potential public benefits of technology transfer are great, agencies should maintain a willingness to consider or reconsider the guidelines and decisions made pursuant to them, and to grant a waiver in any appropriate situation. Furthermore, agencies should consider potential constitutional constraints in applying current conflict of interest regulations.

Constitutional and Policy Considerations

Perhaps the foremost consideration in developing conflict of interest standards is to determine whether a rational justification exists for agency regulation. Generally, a showing should be made that the employee's capacity to perform his government duties are jeopardized or in conflict with other factors as a result of a particular situation. Failing such a policy finding, promulgating and enforcing conflict of interest regulations becomes nothing more than arbitrary and capricious action on the part of the agency. Any rational justification for regulating the conduct of federal employees must rest on the assumption that, for some specified reason, selecting government employees for regulation is necessary. Defining the problem and assessing a
The need for regulation is, however, only the first step. Determining the means by which regulation is to take place is the more difficult task.

The danger of vagueness

As a matter of due process, a law is void on its face if it is so vague that persons "of common intelligence must necessarily guess at its meaning and differ in its application." A law that fails to define clearly the conduct it proscribes "may trap the innocent by not providing fair warning" and may in practical effect impermissibly delegate "basic policy matters to policemen, judges and juries for resolution on an ad hoc and subjective basis, with the attendant dangers of arbitrary and discriminatory application." The failure of agency regulation to define explicitly the terms "conflict of interest" and the "appearance of a conflict of interest" implies a lack of consensus over when and where such situations actually exist. While federal criminal law specifies activities that are prohibited, administrative regulation effectively reserves a right for an agency to deem any number of activities as at least apparent conflicts of interest. The potentially overbroad use of the "appearance of" concept is both standardless and unconstitutional.

First Amendment rights of government scientists

Several theories for considering the rights of scientists have been proposed. Some scholars argue that science has a
specially protected status under the Establishment Clause of the Fourteenth Amendment, because the prohibition on governmental establishment of religion was motivated in large part by the strong intent to prevent religion from interfering with science.\(^{161}\) An additional basis of protection under the First Amendment for research conducted by government scientists may also rest on the thesis that the First Amendment guarantee of freedom of speech also protects some kinds of action.\(^{162}\) To exercise one's right to speak, one must also be free to think, formulate concepts and hypotheses, perform calculations, and if one is dealing with scientific ideas, to plan and carry out experiments. This reasoning is analogous to the rationale for the protection given to the press in newsgathering. The right to gather information is necessary and integral to exercise the right to publish or disseminate information. The Supreme Court has in some situations distinguished between "pure speech" and action, and has suggested that restrictions on the latter are more easily justified.\(^{163}\) In restricting actions, the Court will consider whether the action is essential to generating or communicating information.\(^{164}\)

The government may not condition public employment on an individual's relinquishment of constitutional rights upon which it could not directly infringe (i.e., freedom of expression an association).\(^{165}\) "According to this standard, a showing of requisite necessity must be made before a
researcher can be forced to relinquish his right to conduct nonfunded research by institutional conditions placed on his employment. Restricting government employees from consulting with private industries while not on official duty imposes on the government the burden of establishing that doing so is of paramount or vital importance that cannot be achieved by less restrictive means, the benefits of which outweigh the loss of the constitutionally protected right to research. If the government cannot meet this test, the regulation functions as an unconstitutional prior restraint on government scientists.

Regardless of the extent of constitutional protection afforded scientists, all federal employees possess First Amendment rights to criticize matters of general concern to them as citizens. When the criticisms involve the operations of the agencies in which they are employed, however, the courts have indicated that the right to speak must be tempered by the needs of the entire polity for an efficient government. The rationales governing the case law involve the courts balancing the employee’s right to exercise free speech against the government’s right as an employer.

Separation of powers concerns

Congress has identified certain activities of government employees that are sufficiently reprehensible to be deemed criminal. Executive branch administrative regulation,
however, takes a far broader approach in defining employee misconduct. Presumably, the executive branch, being responsible for the enforcement of law, can develop regulations to ensure that the bounds of conduct proscribed by Congress are not exceeded. In enacting the criminal prohibitions, however, Congress granted no enforcement authority to federal agencies; such criminal laws are enforced by the justice department.

The ultra vires doctrine generally prohibits administrative acts beyond conferred authority.\textsuperscript{171} This doctrine helps ensure that fundamental policy choices will be made by the legislature, and not by officials within the executive branch. It also promotes predictability for those benefited or burdened by regulation, and tends to work against arbitrariness or caprice on the part of administrators because it cabins their discretion in the enforcement process.

Arguably, each branch of government has inherent power to regulate the conduct of its officials. Where such regulation conflicts with the intent or scope of law enacted by Congress pursuant to constitutionally proscribed powers, the explicit should prevail over the implicit. Thus, because Congress is given explicit and sole authority to regulate commerce,\textsuperscript{172} conflict of interest policy bearing directly on laws passed pursuant to the Commerce Clause should be interpreted in light of Congressional law, as opposed to administrative policy, unless Congress provides otherwise. In other words, Congress
has expressed a substantial governmental interest in stimulating commerce via technology transfer which may outweigh administrative regulations by way of the separation of powers doctrine. From this point of view, because executive conflict of interest regulations affect commerce, they are inapplicable to the technology transfer arena absent specific Congressional delegation.

The more contemporary view, however, incorporates the view that the branches of government are not mutual, but are interdependent. This perspective posits that all three branches of government enjoy both a certain degree of autonomy and subservience to the other branches of government:

Each agency is subject to control relationships with some or all of the three constitutionally named branches and those relationships give an assurance—functionally similar to that provided by the separation-of-powers notion for the constitutionally named bodies—that they will not pass out of control . . . . [W]hat we have, then, are three named repositories of authorizing power and control, and an infinity of institutions to which parts of the authority of each may be lent. The three must share the reins of control; means must be found of assuring that no one of them becomes dominant. But it is not terribly important to number or allocate the horses that pull the carriage of government. 

Although Government is structured such that no single
branch should become dominant over another, each has constitutionally proscribed powers unique to it. One such unique congressional power is the regulation of commerce. Administrative conflict of interest regulations should in no way hinder the ability to implement policy authorized pursuant to the Commerce Clause. Deference to congressional regulatory power regarding technology transfer can best be expressed through agency proposals, made pursuant to the FTTA,\textsuperscript{174} for Congress to modify existing conflict of interest norms.
CONCLUSIONS

Several policy considerations must be taken into account in evaluating the application of conflict of interest regulations to technology transfer initiatives of government agencies. A primary purpose of the FTTA was to ameliorate the effects of otherwise inadequate compensation of government scientists. When government competes in the wider marketplace for services of experts, conflict of interest laws become part of the job package. If the laws are unduly restrictive, conflict of interest regulations may have the deleterious effect of deterring highly qualified persons from entering government service. Any reassessment of existing conflict of interest laws should consider the impact their changes will have on attracting and retaining quality personnel.

Attempting to avoid all appearances of conflicts of interest may mean sacrificing other important public policy values. Such absolutes are neither realistic nor in the public interest. Modification of the laws need not be viewed as a sacrifice of the public interest to the cause of private gain. The ultimate interest of the government in modification of these laws may be just as great as that of private persons or even greater.
REFERENCES


6. Id.


[hereinafter Roberts].

14. Id. at 201.


17. The disclosure report includes information concerning the source, date, and amount of any honorariums aggregating $100 or more in value. 5 U.S.C. sec. 202(a)(1)(A) (1989). Dividends, rents, interest, and capital gains need not be disclosed in such detail. Although the source and type of income must be shown, the amounts may be indicated within specified ranges, such as "greater than $5,000 but not more than $15,000." 5 U.S.C. sec. 202(a)(1)(B)(iv) (1989). In addition, any gifts of transportation, lodging, food, or entertainment aggregating more than $250, from a source other than a relative, are subject to reporting, unless received as "personal hospitality of an individual" or worth less than $35. 5 U.S.C. sec. 202(a)(2)(A)-(B) (1989). Reimbursement aggregating more than $250 must also be reported, including the source's identity and a brief description. 5 U.S.C. sec. 202(a)(2)(C) (1989). The identity and category of value of any interest in property in a trade or business, or property held for investment or production of income having a fair market value greater than $1,000, must be disclosed, but personal debts of relatives and personal savings accounts of less than $5,000 are excluded. 5 U.S.C. sec. 202(a)(3) (1989).

The identity and category of value of liabilities greater than $10,000 owed to a creditor, other than a relative, must be reported, except for mortgages on personal residences and certain loans secured by personal property. 5 U.S.C. sec. 202(a)(4) (1989). Unless the other party to a transaction is the reporting person's spouse or dependent child, transactions in real property, other than a personal residence, and in securities that exceed $1,000, must be reported. 5 U.S.C. sec. 202(a)(5) (1989).

The disclosure report requires the listing of positions held during the reporting year, or if it is a first report, during the two preceding years. While no disclosure is required concerning honorary positions, or those held in religious, social, fraternal, or political organizations, disclosure is required for positions as an officer, director, trustee, partner, proprietor, representative, employee, or consultant of any business enterprise, nonprofit organization,
labor organization, or educational or other institution. 5 U.S.C. sec. 202(a)(6)(A) (1989). All compensation in excess of $5,000 received by nonelected officials must be reported for the two preceding calendar years, with a brief description of the duties performed. 5 U.S.C. sec. 202(a)(6)(B) (1989).


30. United States v. Evans, 572 F.2d 455 (5th Cir. 1978).


39. Id.


43. Id.


55. 45 C.F.R. para. 73.735-802(a)(2) (1988).

60. 5 C.F.R. para. 735.105 (1988).
64. 5 C.F.R. para. 735.204 (1988).
68. 7 C.F.R. para. 0.735-2(h) (1989).


72. 45 C.F.R. para. 73.735-706(a)(3) (1989) (Department of
Health and Human Services); 7 C.F.R. para. 0.735-13(c) (1989) (Department of Agriculture). For detailed discussions of the administrative approval processes of the Agricultural Research Service and the National Institutes of Health, see Agricultural Research Service, Outside Employment Guide (May 1989) and National Institutes of Health Policy Manual 2300-735-4, Outside Work and Activities (Sept. 1, 1988).

Professional and consultative work has been defined by the Department of Health and Human Services as:

performance of work requiring knowledge of an advanced type in a field of science or learning customarily acquired by course of specialized instruction and study in an institution of higher education, or hospital which requires the exercise of judgment and direction in its performance and is primarily intellectual in nature as opposed to manual, mechanical or physical work.

45 C.F.R. para. 73.735-704(c) (1989).

73. 45 C.F.R. para. 73.735-704(a) (1989); 7 C.F.R. para. 0.735-13(d)(2) (1989).

74. "Total compensation from consulting with profit-making organizations . . . is limited to $25,000 per year, with no more than $12,500 from any individual company . . . . Compensation may not include stock options, nor may the employee own stock in the company for which he/she consults." National Institutes of Health Policy Manual 2300-735-4, at 17 Outside Work and Activities (Sept. 1, 1988).

75. "'Conflict-of-interest' means a situation in which a Federal employee’s private interest, usually of an economic nature, conflicts with his or her Government duties." 7 C.F.R. para. 0.735-2(c) (1989). "'Appearance of conflict-of-interest’ means a situation where it could reasonably be concluded that an employee’s private interest is in conflict with his or her Government duties and responsibilities, even though there may not actually be such a conflict." 7 C.F.R. para. 0.735-2(c) (1989).


77. 5 C.F.R. para. 735.403(b) (1988). The Office of Personnel Management (OPM) designates the information required in financial disclosures, and an agency cannot include any questions that go beyond the OPM’s requirements without prior approval. 5 C.F.R. para. 735.401 (1988). For purposes of the reporting requirements, the employee’s financial interests include those of a spouse, minor child, or other member of the employee’s immediate household. 5 C.F.R. para. 735.407 (1988).
78. 5 C.F.R. para. 735.403(c) (1988).
84. Vaughn, supra note 12, at 38.
86. See Report of the President's Advisory Committee on Industrial Innovation (Sept. 1979).
87. For a detailed definition of technology transfer, see Congressional Research Service, Technology Transfer: Utilization of Federally Funded Research and Development (April 14, 1988) (Issue Brief IB85031).


99. Id.; Technology Transfer Hearings supra note 18, at 20.


103. Id.


106. The Public Health Service includes the National Institutes of Health (NIH), the Alcohol, Drug, and Mental Health Administration (ADAMHA), the Center for Disease Control (CDC), and the Food and Drug Administration (FDA). Each agency has established an internal mechanism for implementing the FTTPA. Implementation of the Federal Technology Transfer Act: Hearings Before the Subcomm. on Science, Research and Technology of the House Comm. on Science, Space and Technology, 101st Cong., 1st Sess. 183 (1989) (statement of Reid Adler, Director of the Office of Invention Development, National Institutes of Health) [hereinafter FTTPA Hearings].

107. See FTTPA Hearings supra note 106, at 152, 153. Most of
these CRDAs are directed at developing vaccines to fight animal disease and improving animal and plant production methods. USDA, Industry Work Together on New Technologies for Agriculture, Feedstuffs, Aug. 28, 1989, at 25.

108. Id. at 182. NIH is the signatory party in about 80% of PHS’ CRDAs. Id.


110. Id. at 523.

111. GAO Report supra note 105, at 28.

112. Id. at 38.

113. FTTA Hearings supra note 106, at 523.

114. NIH/ADAMHA’s policy statement limits disclosure of confidential and proprietary information "to the amount necessary to carry out the research plan of the CRADA." FTTA Hearings supra note 106, at 207. Licensing and CRDA policy statements have been developed by NIH/ADAMHA to promote the free exchange of ideas and information by, for example, preserving the freedom of federal investigators to publish the results of their research. Id. at 207.


120. 7 C.F.R. para. 0.735-2(d) (1989).

121. See, e.g., 5 C.F.R. para. 735.201a(b) (1988): "An employee shall avoid any action . . . which might result in, or create the appearance of . . . [g]iving preferential treatment to any person."

122. 5 C.F.R. para. 735.201a(a) (1988).

123. 5 C.F.R. para. 735.201a(c) (1988).
124. 5 C.F.R. para. 735.201a(d) (1988).

125. 5 C.F.R. para. 735.201a(e) (1988).

126. 5 C.F.R. para. 735.201a(f) (1988).

127. 45 C.F.R. para. 73.735-801(b)(1) (1989). See also United States v. Gorman, 807 F.2d 1299, 1303 (6th Cir. 1986) (financial interest exists where there is a real possibility of economic gain or loss as a result of government action).


131. Id.


138. Under patent law, public knowledge of an invention destroys its patentability. Once a patent application on an invention has been filed, however, intellectual property rights for that invention are preserved.


140. 5 C.F.R. para. 737.5 (1988).

141. Id.

142. Id.

143. Id.

144. 5 C.F.R. para. 735.201a (1988).
Although these tactics have been proposed by the National Institutes of Health with CRDAs involving AIDS research, harsh criticism has been voiced over the ability to enforce such clauses, raising the fear that future agreements designed to bring new drugs to market will offer little economic protection to consumers. See Erdman, AIDS Drugs: Is the Government Research Program a Helping Hand for Patients, or a Handout for the Pharmaceutical Industry?, Public Citizen, May/June 1989, at 17.

FTTA Hearings supra note 106, at 171-177.


(1974).

164. Id.


168. This situation has recently arisen at the United States Geological survey when an agency employee, using his expertise on his own time to help a private cause, criticized another federal agency's plan. See Marshall, Ethics Debate Sends Tremors Through USGS, 246 Sci. 570 (1989).


172. U.S. Const. Art. I., sec. 8, cl. 3.


175. See Technology Transfer Hearings supra note 18.


177. Neely, supra note 158, at 55.
SUMMARY AND DISCUSSION

This dissertation has presented four reflections of socioeconomic aspects of biotechnology as it relates to technology transfer. As has been noted, the policy implications of such research is varied. On the one hand, as section one points out, the rapid increase of industry support of university research in high technology areas like biotechnology threatens traditional academic norms and values as universities become "co-opted" by the corporate dollar. On the other hand, as section two notes, policy makers widely recognize the potential economic benefits that biotechnology promises. Thus, although critical analysis of the nature of university involvement in biotechnology will continue to be healthy, it may not be the most helpful type of research for policy makers. Rather, future investigations, such as that in section three, into the methods by which effective technology transfer can be accomplished without sacrificing traditional institutional missions or values, may be the most policy-relevant in this area.

Future research should continue to focus on the public policy implications of biotechnology. As Sections two and four have demonstrated, current technology transfer policies often conflict with other policy agendas. For instance, technology transfer may not always be the most effective response to concerns of rural constituencies, and it may
directly contradict the more established policy norms of preserving public trust and preventing appearances of conflicts of interest. Future evaluations are needed of the feasibility and desirability of reconciling competing public policies. It is this author's hope that sociological inquiry continue to be a part of not only the socioeconomic policy investigations, but those involving ethical, health and safety, and environmental issue categories as well.
LITERATURE CITED


APPENDIX A:

SURVEY SENT TO UNIVERSITY ADMINISTRATORS
The state of Iowa has made a major commitment to support research on biotechnology and molecular biology at Iowa State University. A portion of the funds made available to Iowa State for this purpose was earmarked for research and curriculum development in the important area of bioethics, which addresses the social and economic consequences of developments in the life sciences.

The confidential survey that you now have was put together by two Iowa State faculty members involved in our bioethics work, William Woodman of the Department of Sociology and Mack Shelley of the Departments of Statistics and Political Science. The purpose of this survey is to establish some very useful baseline data on opinions among Iowa State administrators about the impact of biotechnology research funding on faculty/student relationships and on the academic curriculum. It is very important that you respond to this confidential questionnaire in order to help the university meet its commitment to the legislature that it would undertake a systematic evaluation of biotechnology’s impacts on Iowa State.

I encourage you to take just a few minutes to respond to these questions and to return your completed questionnaire to the address that is shown on the last page. DO NOT write your name on the survey. Your responses will be published with parallel findings from other surveys. It is very important that these be returned through campus mail by August 15. Please note that the number on the top of the questionnaire is there merely so that the researchers can follow up on questionnaires that have not been returned. At the conclusion of sampling, the list (and it will be the ONLY list) of identifying information will be destroyed. Thank you for your cooperation.
BIOTECHNOLOGY SURVEY

I. Please place a checkmark ✓ or X indicating the most appropriate answer.

1. How well informed do you feel yourself to be about the likely benefits and problems associated with biotechnology?
   - Very well informed
   - Somewhat well informed
   - Cannot Answer/No Response
   - Relatively uninformed
   - Not at all informed

2. How much have you read or heard about biotechnology?
   - Read or heard a great deal about biotechnology
   - Read or heard some things about biotechnology
   - Cannot Answer/No Response
   - Read or heard little or nothing about biotechnology
   - I am unfamiliar with biotechnology

II. EXTERNAL IMPACTS: Listed below are some predictions about the anticipated impacts of biotechnology on U.S. agriculture. How strongly do you feel about these statements? (Please circle only one response for each statement.)

Biotechnology will help solve the problem of farm surpluses by finding new uses for crops and livestock.............1 2 3 4 5

Advances in biotechnology will probably benefit persons with large farm operations more than persons on middle-sized and small farms...........................................1 2 3 4 5

Through biotechnology, scientists will be able to develop new varieties of animals..................................1 2 3 4 5

Research in biotechnology will increase the efficiency of feed conversion in livestock production..................1 2 3 4 5

Biotechnology will lead farmers to become more dependent upon large corporations for many of their inputs, such as seeds, growth hormones, and feed additives.................................1 2 3 4 5

Greater quantities of crops and livestock products will be available for sale as a result of biotechnology...............1 2 3 4 5
III. UNIVERSITY PARTICIPATION: Please indicate your reaction to the following statements by circling the response which most closely corresponds to your opinion.

Biotechnology research at universities is an appropriate emphasis of research funding..............................................1 2 3 4 5
Graduate students will be unlikely to benefit from a biotechnology research focus..............................................1 2 3 4 5
Universities should press for state funding for new biotechnology work.........................................................1 2 3 4 5
The results of university biotechnology research will be of little benefit to industry..........................................1 2 3 4 5
Biotechnology research holds the promise of a more successful future for agriculture........................................1 2 3 4 5
I am concerned that effective safety precautions need to be taken with all biotechnology research on campus.................................................................1 2 3 4 5
Universities should work less closely with private businesses and industry, including the agri-business sector........1 2 3 4 5
Scientists, rather than the agri-business community, should determine what types of problems need to be investigated.......1 2 3 4 5
New discoveries by university scientists should be patented by the university and sold to the highest bidder, who would then make these products commercially available........................................1 2 3 4 5
The amount of private consulting by university faculty (non-contract or non-grant) should be curtailed.......................1 2 3 4 5
More public funds should not be used to support the development of new uses for agricultural commodities..................1 2 3 4 5
A biotechnology emphasis at universities will change the balance of Teaching Assistant versus Research Assistant support........1 2 3 4 5
Links between universities and biotechnology companies may determine the topics of theses and dissertations on which graduate students work.................................................................1 2 3 4 5
IV. COORDINATION BARRIERS: How strongly do you feel that the following barriers impede cooperative research between industries and universities?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The desire on the part of industry for immediate, short-term results</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industry exerts influence on the direction, methods, and results of research</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industry applies the same investment criteria to research as to other investments</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industry expects that universities should operate like a business</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industry may lose sight of the university's teaching function</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industry lacks appreciation for the scientific research method's characteristics of communication and peer review</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>5</td>
</tr>
<tr>
<td>Industry perceives that the university often does not understand what industry needs in the way of product-oriented research</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Research performed by outside organizations is perceived by industry as being more costly than research done in-house</td>
<td>1</td>
<td>2</td>
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<td>4</td>
<td>5</td>
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<tr>
<td>Industry has a bias toward technological ideas</td>
<td>1</td>
<td>2</td>
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</tr>
<tr>
<td>Industry patent policies create an impediment</td>
<td>1</td>
<td>2</td>
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<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

How strongly do you agree with the following criteria for accepting or rejecting industry funding?

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compatibility between the proposed project goals and the research/educational goals of the university</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>The degree to which the research contains a common area of interest to professors and to the university</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>The amount of funding received</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>The ability to agree upon clear research guidelines in advance of the contract</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Pre-funding agreements on patent, copyright, and publication guidelines</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
V. UNIVERSITY/INDUSTRY: From my point of view, the most important roles of research connections between universities and industries are:

Mark the:

Most important item with: "1" (choose only one)
Less important item with: "2" (choose only one)
Least important item with: "X" (choose only one)

Replacement for lost federal funds.
Avoidance of federal/state "red tape" and regulation of research.
Acquiring state-of-the-art teaching & research technology at universities.
Direct financial support for graduate students.
Richer & more applied experiences for graduate students.
Professional stimulation for university faculty.
A means for marketing university faculty innovations, with royalties returned to the university and to individual faculty.
Other (please specify)

How strongly do you agree that university contracts with private companies result in:

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>More applied research.................................................................1 2 3 4 5</td>
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<tr>
<td>Pressures for faculty to spend more time on commercial activities..............................1 2 3 4 5</td>
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<tr>
<td>Undermining intellectual exchange and cooperative activities within and between departments..........................1 2 3 4 5</td>
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<tr>
<td>Patent royalties which would increase university revenues.................................1 2 3 4 5</td>
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<tr>
<td>Conflict among faculty supporting or opposing such activities.....................................1 2 3 4 5</td>
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<tr>
<td>Job opportunities for students..............................................................1 2 3 4 5</td>
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<tr>
<td>Unreasonable delays in the publication of new findings..........................................1 2 3 4 5</td>
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<tr>
<td>Enhanced scholarly productivity..............................................................1 2 3 4 5</td>
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<tr>
<td>Altered standards for promotion and tenure....................................................1 2 3 4 5</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
VI. REDUCING PROBLEM BARRIERS: How strongly do you regard the following as possible ways to reduce barriers to cooperative research in the future?

Some universities in need of funding becoming more liberal in their corporate guidelines as competition for funds increases.....1 2 3 4 5
Universities becoming more pragmatic in their operation........1 2 3 4 5
Industry allowing more open communication among researchers......1 2 3 4 5
More cross-sector communication, especially between researchers (rather than administrators).................................1 2 3 4 5
Increased pooling of industry funds to support university-based research institutes and centers as a way for smaller firms to participate in university research.................................1 2 3 4 5
Industry utilizing a wider range of university faculty members when seeking consultants or researchers..................1 2 3 4 5
Revising federal laws and regulations that govern innovations and patents derived from government-sponsored work at universities................................................1 2 3 4 5

VII. DIRECTIONS OF COOPERATIVE RESEARCH: Please indicate your reaction to the following questions by circling one response for each statement.

Should universities strive to perform significantly more work oriented toward industry and market needs?...............1 2 3
Should universities agree with industrial sponsors to withhold research results from publication until patent protection can be obtained?.........................1 2 3
VIII. INTERNAL IMPACTS: For each of the following, what type of impact will biotechnology funding at Iowa State University have in the next few years?

Faculty Morale.........................................................1 2 3 4 5
Faculty Job Satisfaction.........................................1 2 3 4 5
Faculty Salaries.....................................................1 2 3 4 5
Quality of Undergraduate Instruction.......................1 2 3 4 5
Quality of Graduate Instruction..............................1 2 3 4 5
Quality of Graduate Students..................................1 2 3 4 5
University Prestige................................................1 2 3 4 5
Faculty-Student Relations.......................................1 2 3 4 5

As you know, the Biotechnology Council, consisting of ISU faculty members, sets policy and determines research allocations for biotechnology. What is your opinion of its performance to date?.................................1 2 3 4 5

As you may know, some Graduate Research Assistants in the biotechnology field will be paid around $15,000/year in order to attract the best students into the programs. Are you aware of this approach?..............1 2 3

If yes, do you favor this approach?...............................1 2 3

Have you received either complaints or support from faculty for this policy?........................................1 2 3

Have you received either complaints or support from graduate students for this policy?..........................1 2 3

Have any faculty members expressed the feeling that the acceptance of such R.A.'s at differential salaries would disrupt their research groups and/or current students?............1 2 3
IX. ABOUT YOU: Please provide some additional data about yourself so that we may know a little about those who filled out our questionnaires.

Age____

What is your title? ___Vice-President ___Program Head

___Dean ___DEO

___Associate Dean ___Assistant or Intern

___Other, please specify__________________________

How long have you been in your present position?__________________________

Have you ever held similar positions at other academic institutions? YES NO

If yes, what was that position?__________________________

In what field did you earn your highest degree?__________________________

In what year did you receive your first ISU appointment?__________

Please add any additional comments you would like to make__________________________

__________________________________________________________________________

__________________________________________________________________________

Please return by August 15, 1987. Your cooperation is appreciated and important. Thank you for participating in this survey. Please return your completed survey through campus mail in the return envelope provided.
APPENDIX B:
SURVEY SENT TO BIOTECHNOLOGY COMPANIES
To the Respondent:

The state of Iowa has recently made a major commitment to support research on biotechnology and molecular biology at Iowa State University. A portion of the funds made available to Iowa State for this purpose was earmarked for research and curriculum development in the important area of Bioethics, which addresses the social and economic consequences of developments in the life sciences.

By way of background, two Iowa State University professors (William Woodman and Mack Shelley) have been compiling data from an ISU survey of Iowa farmers, and directly surveying faculty, graduate students, and administrators about anticipated social and other changes which will follow from future developments in biotechnology. They are interested in adding to that matrix the views of those biotechnology companies actively doing research in biotechnology.

I encourage and beseech you to take a few minutes to respond to these questions and to return your completed questionnaire in the enclosed stamped, preaddressed return envelope. We will be happy to provide you with a summary of the results of this survey, if you so indicate on the questionnaire.

Please note that the number on the front of the survey is merely for purposes of keeping track of returned questionnaires (to prevent redundant follow-up letters). After the questionnaires are returned, that intermediate list of names and numbers will be destroyed, making it impossible to identify any respondent.

Thank you again for your cooperation in this research effort.

Sincerely yours,

Dr. Gordon Eaton
President
I. UNIVERSITY PARTICIPATION: Please indicate your reaction to the following statements by circling the response which most closely corresponds to your opinion. (Please circle only one response for each statement.)

Biotechnology research at universities is an appropriate emphasis of research funding. ................................. 1 2 3 4 5

Graduate students will be unlikely to benefit from a biotechnology research focus. ................................. 1 2 3 4 5

Universities should press for state funding for new biotechnology work. ................................. 1 2 3 4 5

The results of university biotechnology research will be of little benefit to industry. ................................. 1 2 3 4 5

Biotechnology research holds the promise of a more successful future for agriculture. ................................. 1 2 3 4 5

I am concerned that effective safety precautions need to be taken with all biotechnology research on campus. ................................. 1 2 3 4 5

Universities should work less closely with private businesses and industry, including the agri-business sector. ................................. 1 2 3 4 5

Scientists, rather than the agri-business community, should determine what types of problems need to be investigated. ................................. 1 2 3 4 5

New discoveries by university scientists should be patented by the university and sold to the highest bidder (who would then make these products commercially available). ................................. 1 2 3 4 5

The amount of private consulting by university faculty (non-contract or non-grant) should be curtailed. ................................. 1 2 3 4 5

More public funds should not be used to support the development of new uses for agricultural commodities. ................................. 1 2 3 4 5

A biotechnology emphasis at universities will change the balance of Teaching Assistant versus Research Assistant support. ................................. 1 2 3 4 5

Links between universities and biotech companies may determine the topics of theses and dissertations on which graduate students work. ................................. 1 2 3 4 5
II. COOPERATIVE RESEARCH: Many university administrators and faculty feel that universities should participate in industry-sponsored biotechnology research. How strongly do you feel that the following are valid reasons for university-industry research collaboration?

<table>
<thead>
<tr>
<th>Reason</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The university is a source of inexpensive research for industry.........</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>University and industry researchers have different perspectives on biotechnology</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Universities offer new ideas, products, and approaches that help to enhance a company's competitive position</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Universities are soliciting research support from industry because of cutbacks in government funding</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Cooperative research facilitates technology transfer by moving research more rapidly into the industrial sector</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Cooperative research provides the opportunity for universities to focus upon current problems in an attempt to better serve society</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Cooperative research increases the prestige of graduate programs</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Cooperative research provides faculty and students with &quot;real life&quot; experience</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Cooperative research provides highly trained graduate students as future industry employees</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Research collaboration improves industry's ability to meet government quality and safety standards</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Cooperative research allows the discussion of different views on the ethical and social implications of biotechnology</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Cooperative research enables universities to secure funds that are needed to obtain better research facilities</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Universities provide industry with competent research scientists without in-house expense</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Cooperative research aids industry in searching for new ideas to stay ahead of foreign competition</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
III. IMPACTS: Listed below are some predictions about the anticipated impacts of biotechnology on U.S. agriculture. How strongly do you feel about these statements?

- Biotechnology will help solve the problem of farm surpluses by finding new uses for crops and livestock. 

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

- Advances in biotechnology will probably benefit persons with large farm operations more than persons on middle-sized and small farms.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

- Through biotechnology, scientists will be able to develop new varieties of animals.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

- Research in biotechnology will increase the efficiency of feed conversion in livestock production.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

- Biotechnology will lead farmers to become more dependent upon large corporations for many of their inputs, such as seeds, growth hormones, and feed additives.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

- Greater quantities of crops and livestock products will be available for sale as a result of biotechnology.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

IV. COORDINATION BARRIERS: How strongly do you feel the following to be impediments to cooperative research?

- The goals of universities and businesses are fundamentally at odds.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

- University scientists tend to disdain the "profit motivation" of private companies.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

- Scientists in universities tend to rely too heavily on the peer review system for publications.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

- An "ivory tower" attitude is too common among university scientists.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

- Science in universities cannot maintain the pace of creativity needed in private companies.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

- University scientists do not focus sufficiently on applied research appropriate for marketing products.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

- The university's insistence on the freedom to publish research results is in conflict with industry's need to protect the results of research through patents and proprietary know-how.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

- University patent policies are too burdensome.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

- Universities are overly concerned that industry-sponsored research will improperly influence the direction of future university research.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5

- Universities are concerned that industry will try to control what research is done in biotechnology.

Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree
--- | --- | --- | --- | ---
1 | 2 | 3 | 4 | 5
V. REDUCING PROBLEM BARRIERS: How strongly do you agree with the following approaches as ways to reduce barriers to cooperative research? (Please circle only one response for each statement.)

<table>
<thead>
<tr>
<th>Approaches</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some universities in need of funding becoming more liberal in their corporate guidelines as competition for funds increases</td>
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<td>More cross-sector communication, especially between researchers (rather than administrators)</td>
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<td>Increased pooling of industry funds to support university-based research institutes and centers as a way for smaller firms to participate in university research</td>
<td></td>
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<td>Industry utilizing a wider range of university faculty members when seeking consultants or researchers</td>
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</tr>
<tr>
<td>Revising federal laws and regulations that govern innovations and patents derived from government-sponsored work at universities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

VI. DIRECTIONS OF COOPERATIVE RESEARCH: Please indicate your reaction to the following questions by circling one response for each statement.

<table>
<thead>
<tr>
<th>Questions</th>
<th>YES</th>
<th>NO</th>
<th>DON'T KNOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Should universities strive to perform significantly more work oriented toward industry and market needs?</td>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Should universities agree with industrial sponsors to withhold research results from publication until patent protection can be obtained?</td>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Should universities agree with industrial sponsors to withhold research results from publication when the industrial sponsor needs to keep the results confidential for competitive reasons?</td>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>In general, do you believe that there has been a significant improvement in university-industry research relationships in the last five years?</td>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Are you currently participating in any type of industrial research park(s)?</td>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>If yes, please list the name(s) of the park and/or participating universities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If no, what types of incentives would draw your firm into an industrial research park?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VII. YOUR FIRM: Please provide some general information about your firm.

Do you currently sponsor any university research? YES NO.

If yes, approximately what percent of your annual budget (excluding government, foundation, etc. funds) is spent on such support? %

Do you expect to fund any university research in the future? YES NO. If yes:

Approximately what percent of your annual budget (excluding government, foundation, etc. funds) do you expect to spend on such research? %

In what areas do you expect to sponsor university research?

Approximately how many people does your firm employ?

What is your estimated number of R&D employees?

How many of your R&D staff hold a degree beyond the bachelor's?

Approximately what percentage of your annual budget is spent on R&D?

VIII. ABOUT YOU: Please provide some additional data about yourself so that we may know a little about those who filled out our questionnaires.

Age Sex Title of your position

How long have you been in your present position in the company?

Have you held similar positions before in other companies? YES NO

Did you hold a university faculty or professional position at any earlier time (excluding graduate assistantships and the like)? YES NO

If yes, what was that position?

What is the highest degree you have earned? What field?

How would you characterize your present role (check all that apply)?

Management
Sales
Research
Other (please specify)

Do you wish to receive a copy of the survey results? YES NO

Please add any additional comments you would like to make

Please return by August 15, 1987. Your cooperation is appreciated and important. Thank you for participating in this survey. Please return your completed survey in the postage-paid return envelope provided.
APPENDIX C:
SURVEY SENT TO IOWA FARM OPERATORS
Dear Iowa Farm Operator:

In 1982, Iowa State University made the commitment to regularly survey farm families to gain their opinions and ideas on rural and farm issues. The Iowa Farm and Rural Life Poll is a cooperative effort between ISU College of Agriculture, the Cooperative Extension Service and the Iowa Department of Agriculture and Land Stewardship.

I hope that you will participate in the Poll and become part of this effort to help farm families' voices be heard on the important issues facing rural Iowa. The questionnaire should only take 20-30 minutes to complete.

The information you provide will be summarized and used by Iowa State University staff to prepare reports and design programs to help improve the quality of life for farm families. Data from the surveys are made available to state and national policy-makers as proposals and legislation are considered.

In this survey we are seeking your opinions on needed directions in agricultural policy, economic development and quality of life. In addition, the survey includes general questions about your farm operation and your family. Let me emphasize that all of the information you provide is strictly confidential.

Please complete and return your questionnaire as soon as possible. It can be returned in the enclosed, postage-paid business reply envelope. The last page of the questionnaire is for you to send in your ideas or topics that you would like to see included in future surveys. As soon as the information is processed, I will send you a summary of the findings. If you have questions or comments about the project, feel free to call me collect at the number listed below.

Thank you for participating in the Iowa Farm and Rural Life Poll.

Sincerely,

Paul Lasley
Extension Sociologist & Director
Iowa Farm and Rural Life Poll
(515) 294-0937
IOWA FARM AND RURAL LIFE POLL
1988
(To be completed by the farm operator)

ECONOMIC DEVELOPMENT

There is much discussion over the direction of economic development in the state. We would like your opinion on what directions you think the state should pursue. Please circle the number corresponding to your opinion for each of the following economic development ideas.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Support</th>
<th>Somewhat Support</th>
<th>Uncertain</th>
<th>Somewhat Oppose</th>
<th>Strongly Oppose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Emphasize tourism in the state</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. Attract biotechnology industries</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. Emphasize more local processing of grains and livestock</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. Emphasize more manufacturing jobs in nonagricultural industries</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Place more state emphasis on agricultural exports</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. Fund more biotechnology research for new products and uses for agriculture produce</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. Encourage more industry-university collaboration in research projects</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. Diversify agricultural production to include specialty crops</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. Encourage Iowa's universities and colleges to focus on economic development</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. Focus on main street business development</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. Provide tax incentives to companies to locate in the state</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. Focus on retention and expansion of existing industries</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
### STATE AND NATIONAL ISSUES

How concerned are you about the following issues? Please indicate your level of concern for each of the issues by circling the number that best represents your feelings.

<table>
<thead>
<tr>
<th>Issue</th>
<th>Not Concerned</th>
<th>Very Concerned</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Contamination of underground water supplies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Interest rates to borrowers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Inflation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Prices for farm products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Federal budget deficit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Unemployment in your area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Loss of farm population</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Foreign ownership of farmland in Iowa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Corporate ownership of farmland in Iowa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Closings of local mainstreet businesses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Residues such as pesticides and herbicides in food products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. Soil erosion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. Adverse health effects from exposure to agricultural chemicals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. Outmigration of Iowa residents to other states</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. Consolidation of local schools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. Condition of county and state roads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. Quality of local services and facilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. The use of food additives and preservatives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31. The presence of pesticides, herbicides and other chemicals in drinking water</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
32. Increasingly it is recognized that farm profitability is dependent upon successful marketing strategies. To help us improve our educational programs, please answer the following questions.

<table>
<thead>
<tr>
<th>How frequently do you:</th>
<th>At least Once per day</th>
<th>Weekly</th>
<th>Once or Twice a Month</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Check the cash market</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>b. Follow the futures market</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>c. Chart the daily market</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>d. Follow the general market trend</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>e. Try to forecast the market</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

33. Have you used any of the following marketing tools in pricing grain or livestock within the past two years?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Forward cash contract</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>b. Price later contract</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>c. Minimum price contract</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>d. Futures market for hedging</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>e. Agricultural commodity options</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

34. Please indicate the degree to which the following factors are problems in marketing your farm products.

<table>
<thead>
<tr>
<th></th>
<th>Not a Problem</th>
<th>Minor Problem</th>
<th>Moderate Problem</th>
<th>Major Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Not enough accurate information on market prices and trends</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>b. Not enough timely information on market prices and trends</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>c. Conflicting market information</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>d. Not taking enough time to watch the markets</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>e. Lack adequate understanding about marketing alternatives</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
35. Which of the following do you regularly use to gain information in making pricing and marketing decisions for grain or livestock?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Newspaper</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>b. Magazine</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>c. WOI-AM Market News</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>d. Other Radio</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>e. Television</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>f. Telephone recording</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>g. Lenders</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>h. Local Buyer</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>i. Extension meetings</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>j. Extension newsletters or release</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>k. Market advisory service</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>l. Agri-View (formerly AIDS)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>m. Other electronic data service</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

36. Please rank your need for educational programs on the following marketing topics. Circle the number that best fits your judgment of your needs, with 1 representing the lowest area of need and 5 indicating the area where you have the greatest need for marketing your farm products, including both crops and livestock.

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Use of options markets for price insurance</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>b. Use of futures markets for hedging</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>c. Basis patterns and how to use them</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>d. Uses of PIC certificates in grain marketing</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>e. How to combine options markets and futures for price protection</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>f. Delayed pricing and forward pricing contracts</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>g. Developing a marketing strategy based on production costs and financial risk-bearing ability</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>h. Making the marketing decision; how to develop discipline to make sales</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>i. Technical analysis: charting, chart buy and sell signals, moving averages, chart formations</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>j. How to keep up-to-date on market conditions and prospects</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>
STATE LAND OWNERSHIP POLICY

Listed below are some state farmland policy issues. How do you feel about each of these proposals? (Please circle one number for each proposal which most closely reflects your feelings.)

<table>
<thead>
<tr>
<th></th>
<th>Strongly Support</th>
<th>Somewhat Support</th>
<th>Uncertain</th>
<th>Somewhat Oppose</th>
<th>Strongly Oppose</th>
</tr>
</thead>
<tbody>
<tr>
<td>37. Relaxing current state laws limiting non-resident aliens (foreign investors from owning farmland</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>38. Relaxing current state laws limiting non-farm corporations from owning farmland</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>39. Limiting absentee ownership of farmland by individuals</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>40. Requiring all farm land owners to report on the amount of land they own</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>41. Limiting the amount of farm land that speculators can own to 1500 acres</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

QUALITY OF LIFE

42. Below are some general statements about how well you think people are living in your community. Some of the questions refer to "quality of life" which means the degree of satisfaction with all aspects of life. Please circle one number which most closely reflects your feelings.

<table>
<thead>
<tr>
<th></th>
<th>Become Much Better</th>
<th>Become Somewhat Better</th>
<th>Remain The Same</th>
<th>Become Somewhat Worse</th>
<th>Become Much Worse</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. During the past five years, has the quality of life for farm families in your community</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>b. During the past five years has the quality of life for your family</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>c. In the next five years will the quality of life for farm families in your community</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>d. In the next five years will the quality of life for your family</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>e. In the next five years will the overall economic prospects for Iowa farmers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
FINANCIAL CONDITIONS IN FARMING

There is a continuing debate on the financial health of farming. Some people argue that the problem is being exaggerated, while others claim the financial condition is a very serious problem. One of the difficulties in addressing the situation is the lack of information about the financial health of Iowa farmers. To help us establish the seriousness of the problem, we'd like you to answer the following questions.

43. As of January, 1988, what was the estimated current market value of your farm assets?

_________________________ (Total Assets)

44. As of January, 1988, what were your estimated total liabilities, including all loans for land, machinery, buildings and livestock?

_________________________ (Total Liabilities)

45. How do you feel about the current financial condition of Iowa farmers?. (Please circle the one response that most closely represents your feelings.)


46. How do you feel about the current financial condition of agribusiness firms in your area?


47. How do you feel about the current financial condition of financial institutions in your area?


48. How concerned are you about your farm's financial condition?


49. For 1987, what were your family's total health care costs (including hospital, physician, pharmacy, and laboratory charges paid by insurance)? Please include insurance premiums you paid during the year.

_________________________ dollars

50. What percent of your total health care costs were paid by your health insurance?

_________________________ percent
CONSERVATION POLICY

51. How well informed are you about each of the following conservation provisions in the 1985 Farm Bill?

<table>
<thead>
<tr>
<th>Provision</th>
<th>Not at all Informed</th>
<th>Relatively Uninformed</th>
<th>Somewhat Informed</th>
<th>Very well Informed</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Conservation Compliance</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>b. Conservation Reserve Program (CRP)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>c. Sodbuster Program</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>d. Swampbuster Program</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

52. Do you have any "highly erodible" cropland?

☐ No (Go to Question 54)
☐ Don't know (Go to Question 54)
☐ Yes; If yes, how many acres? ________ acres

53. Of these highly erodible acres:

a. How many, if any, are enrolled (as of January 1, 1988) in the Conservation Reserve Program?

__________ acres

b. Are you planning to bid any acres in the CRP in the future?

☐ No
☐ Yes; If yes, how many acres? ________ acres

c. What plans do you have for your highly erodible cropland that is not currently enrolled in the CRP?

☐ All of this land will all eventually be enrolled in the CRP.

☐ Some or all of this land will be put under conservation compliance (i.e., will have an approved conservation plan).

☐ I plan no further conservation action on these erodible acres, which means that I will not be eligible for USDA commodity price programs.

☐ Unsure/undecided
54. Listed below are some predictions that people have made about the possible impacts of the Conservation Reserve Program in Iowa in the next ten years. We would like your opinion of the likelihood of these things happening. If you feel the prediction will very likely happen, you should circle 1. If you feel the prediction is very unlikely to happen, you should circle 5. As a result of the CRP, do you anticipate a(n):

<table>
<thead>
<tr>
<th>Very Likely</th>
<th>Somewhat Likely</th>
<th>Uncertain</th>
<th>Somewhat Unlikely</th>
<th>Very Unlikely</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Substantial reduction of soil loss on highly erodible land</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>b. Improvement of the financial well-being of farmers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>c. Decline in the quality of life in rural communities</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>d. Substantial reduction in surpluses of farm commodities</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>e. Encourage more outside investment in Iowa farmland</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>f. Fewer farm chemicals in the groundwater</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>g. Increased financial stress on local agribusiness</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>h. Increased number of people leaving their farms</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>i. The government will carry out and enforce the conservation provisions of the 1985 Farm Bill</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

55. Would you please indicate how you feel about the following statements?

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Somewhat Agree</th>
<th>Uncertain</th>
<th>Somewhat Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Greater regulation is needed on the use of chemicals in agriculture</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>b. The government should be able to force farmers to adopt soil conservation practices if they have erosion problems</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>c. Farmland forfeited to the FmHA should have conservation easements placed upon it before being resold</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>d. Our natural resources should be used wherever possible to increase the economic growth of local areas</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
e. Economic development that results in the destruction of wildlife habitat should be stopped

Strongly Agree | Somewhat Agree | Uncertain | Somewhat Disagree | Strongly Disagree
---|---|---|---|---
1 | 2 | 3 | 4 | 5

f. The government should require that all farmers implement an approved conservation plan

Strongly Agree | Somewhat Agree | Uncertain | Somewhat Disagree | Strongly Disagree
---|---|---|---|---
1 | 2 | 3 | 4 | 5

g. Air and water pollution standards should not be so strict that they slow down economic growth

Strongly Agree | Somewhat Agree | Uncertain | Somewhat Disagree | Strongly Disagree
---|---|---|---|---
1 | 2 | 3 | 4 | 5

h. The government should impose stricter testing of agricultural chemicals before they are released

Strongly Agree | Somewhat Agree | Uncertain | Somewhat Disagree | Strongly Disagree
---|---|---|---|---
1 | 2 | 3 | 4 | 5

i. The government should impose more control over the way individuals and companies use our natural resources

Strongly Agree | Somewhat Agree | Uncertain | Somewhat Disagree | Strongly Disagree
---|---|---|---|---
1 | 2 | 3 | 4 | 5

56. What percentage of the land in your farming operation (include both owned and rented acres) has an approved soil conservation plan? (percent)

57. If you have a plan, in what year was this plan approved or last updated by your county conservation district committee? (year)

58. Approximately what percent of this plan has been implemented? (percent)

FAMILY CHARACTERISTICS

Please tell us about your family. This information is needed to ensure the study represents all farmers in the state. (This information is strictly confidential.)

59. What is your age: 

60. Years of education: 

61. Which of the following categories best represents your total family income for 1987? (includes income from all sources)

a. Less than $2500
b. $2500 to $9,999
c. $10,000 to $19,999
d. $20,000 to $34,999
e. $35,000 to $49,999
f. $50,000 to $74,999
g. $75,000 or more
FARM CHARACTERISTICS

Please tell us about your farm operation. This information is strictly confidential.

62. How many acres do you own? ________________

63. How is your farm organized? Please circle the appropriate category.
   a. Sole proprietorship
   b. Family farm corporation
   c. Partnership
   d. Limited partnership
   e. Authorized corporation
   f. Corporation
   g. Trust

64. How many acres do you rent/lease from others? ________
   (If you don't rent or lease land from others, go to Question 66.)

65. If you rent or lease land from others, who owns the land? Please identify the landowner for each separate farm or tract of land you rent from others.

<table>
<thead>
<tr>
<th>Landowner Description</th>
<th>TRACT 1</th>
<th>TRACT 2</th>
<th>TRACT 3</th>
<th>TRACT 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>A local person who lives in the county</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>A person who lives in an adjacent county</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>An investor who lives in Iowa</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>An investor who lives outside the state</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>A lender or financial institution</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>An Iowa corporation</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>A corporation whose headquarters is</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>outside of Iowa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A non-resident alien (foreign investor)</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>either an individual or corporation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don't know who owns the land</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

66. What was your approximate gross farm sales for 1987?
   a. Less than $2500
   b. $2500 to $9,999
   c. $10,000 to $19,999
   d. $20,000 to $39,999
   e. $40,000 to $59,999
   f. $60,000 to $79,999
   g. $80,000 to $99,999
   h. $100,000 to $199,999
   i. $200,000 to $299,999
   j. $300,000 to $399,999
   k. $400,000 to $499,999
   l. $500,000 or more
What issues or topics would you like to be included on the Iowa Farm and Rural Life Poll next year?

General Comments:

Thank you for your help.

Paul Lasley
Director of the
Iowa Farm and Rural Life Poll
APPENDIX D:
SURVEY SENT TO IOWA LEGISLATORS
Dear Legislator:

As you know, the State of Iowa made major commitments in the last two years to support research in biotechnology and molecular biology at Iowa State University. A portion of the funds was earmarked for research and curriculum development in the important area of Bioethics, which addresses the social and economic impacts of developments in the life sciences.

Two Iowa State University professors, William Woodman and Mack Shelley, with their research assistant Brian Reichel have been compiling data from an ISU survey of Iowa farmers. They are also asking faculty, graduate students, university administrators, and biotechnology companies about anticipated social and other changes which might follow from future developments in biotechnology. Now they want to add to that matrix the views held by Iowa legislators.

Please take a few minutes to respond to the questions prepared by my colleagues and return your completed questionnaire in the enclosed stamped, preaddressed envelope. We will be happy to provide you with a summary of the results of the survey, if you so indicate on the last page. The number on the front of the survey is merely for the purpose of keeping track of returned questionnaires (to prevent redundant follow-up letters). After the questionnaires are returned, that intermediate list of names and numbers will be destroyed, making it impossible to identify any respondent.

Thank you again for your cooperation in this research effort.

Sincerely yours,

D. J. Zaffarano
Vice President for Research
I. **ECONOMIC DEVELOPMENT**: There is much discussion over the direction of economic development in the state. We would like your opinion on what directions you think the state should pursue. Please circle the number corresponding to your opinion for each of the economic development ideas.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Emphasize tourism in the state</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. Attract biotechnology industries</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. Emphasize more local processing of grains and livestock</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. Emphasize more manufacturing jobs in nonagricultural industries</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Place more state emphasis on agricultural exports</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. Fund more biotechnology research for new products and uses for agricultural produce</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. Encourage more industry-university collaboration on research projects</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. Diversify agricultural production to include specialty crops</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. Encourage Iowa's universities and colleges to focus on economic development</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. Focus on mainstreet business development</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. Provide tax incentives to companies to locate in the state</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. Focus on retention and expansion of existing industries</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
II. **STATE AND NATIONAL ISSUES**: How concerned are you about the following issues? Please indicate your level of concern for each of the issues by circling the number that best represents your feelings.

<table>
<thead>
<tr>
<th>Issue</th>
<th>Not Concerned</th>
<th>Very Concerned</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Contamination of underground water supplies</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>2. Interest rates to borrowers</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>3. Inflation</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>4. Prices of farm products</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>5. Federal budget deficit</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>6. Unemployment in your district</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>7. Loss of farm population</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>8. Foreign ownership of Iowa farmland</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>9. Corporate ownership of Iowa farmland</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>10. Closings of local mainstreet businesses</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>11. Residues such as pesticides and herbicides in food products</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>12. Soil erosion</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>13. Adverse health effects from exposure to agricultural chemicals</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>14. Outmigration of Iowa residents to other states</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>15. Consolidation of local schools</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>16. Condition of county and state roads</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>17. Quality of local services and facilities</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>18. The use of food additives and preservatives</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>19. The presence of pesticides, herbicides, and other chemicals in drinking water</td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>
BIOTECHNOLOGY SURVEY

III. Please place a checkmark (☑) or X indicating the most appropriate answer.

1. How well informed do you feel yourself to be about the likely benefits and problems associated with biotechnology?
   - Very well informed
   - Somewhat well informed
   - Cannot Answer/No Response
   - Relatively uninformed
   - Not at all informed

2. How much have you read or heard about biotechnology?
   - Read or heard a great deal about biotechnology
   - Read or heard some things about biotechnology
   - Cannot Answer/No Response
   - Read or heard little or nothing about biotechnology
   - I am unfamiliar with biotechnology

IV. IMPACTS: Listed below are some predictions about the anticipated impacts of biotechnology on U.S. agriculture. How strongly do you feel about these statements? (Please circle only one response for each statement.)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotechnology will help solve the problem of farm surpluses by finding new uses for crops and livestock</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advances in biotechnology will probably benefit persons with large farm operations more than persons on middle-sized and small farms</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Through biotechnology, scientists will be able to develop new varieties of animals</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research in biotechnology will increase the efficiency of feed conversion in livestock production</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biotechnology will lead farmers to become more dependent upon large corporations for many of their inputs, such as seeds, growth hormones, and feed additives</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greater quantities of crops and livestock products will be available for sale as a result of biotechnology</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
V. UNIVERSITY PARTICIPATION: Please indicate your reaction to the following statements by circling the response which most closely corresponds to your opinion.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotechnology research at Iowa State University is an appropriate emphasis of research funding</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graduate students will be unlikely to benefit from a biotechnology research focus</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iowa State University should press for state funding for new biotechnology work</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The results of university biotechnology research will be of little benefit to industry</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biotechnology research holds the promise of a more successful future for agriculture</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am concerned that effective safety precautions need to be taken with all biotechnology research on campus</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iowa State University should work less closely with private businesses and industry, including the agri-business sector</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scientists, rather than the agri-business community, should determine what types of problems need to be investigated</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New discoveries by university scientists should be patented by the university and sold to the highest bidder, who would then make these products commercially available</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The amount of consulting by university faculty (non-contract or non-grant) should be curtailed</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More public funds should not be used to support the development of new uses for agricultural commodities</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A biotechnology emphasis at universities will change the balance of Teaching Assistant versus Research Assistant support</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Links between universities and biotechnology companies may determine the topics of theses and dissertations on which graduate students work</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VI. COOPERATIVE RESEARCH: Many university administrators and faculty feel that universities should participate in industry-sponsored biotechnology research. How strongly do you feel that the following are valid reasons for university-industry research collaboration?

<table>
<thead>
<tr>
<th>Reason</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>The university is a source of inexpensive research for industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University and industry researchers have different perspectives on biotechnology</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Universities offer new ideas, products, and approaches that help to enhance a company's competitive position</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Universities are soliciting research support from industry because of cutbacks in government funding</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Cooperative research facilitates technology transfer by moving research more rapidly into the industrial sector</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Cooperative research provides the opportunity for universities to focus upon current problems in an attempt to better serve society</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperative research increases the prestige of graduate programs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperative research provides faculty and students with &quot;real life&quot; experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperative research provides highly trained graduate students as future industry employees</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research collaboration improves industry's ability to meet government quality and safety standards</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperative research allows the discussion of different views on the ethical and social implications of biotechnology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperative research enables universities to secure funds that are needed to obtain better research facilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Universities provide industry with competent research scientists without in-house expense</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperative research aids industry in searching for new ideas to stay ahead of foreign competition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VII. COORDINATION BARRIERS: How strongly do you feel that the following barriers impede cooperative research between industries and universities?

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The desire on the part of industry for immediate, short-term results</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industry exerts influence on the direction, methods, and results of research</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industry applies the same investment criteria to research as to other investments</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industry expects that universities should operate like a business</td>
<td>1</td>
<td>2</td>
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<td>5</td>
</tr>
<tr>
<td>Industry may lose sight of the university's teaching function</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industry lacks appreciation for the scientific research method's characteristics of communication and peer review</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industry perceives that the university often does not understand what industry needs in the way of product-oriented research</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Research performed by outside organizations is perceived by industry as being more costly than research done in-house</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industry has a bias toward technological ideas</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industry patent policies create an impediment</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>The goals of universities and businesses are fundamentally at odds</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>University scientists tend to disdain the &quot;profit motivation&quot; of private companies</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Scientists in universities tend to rely too heavily on the peer review system for publications</td>
<td>1</td>
<td>2</td>
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<td>4</td>
<td>5</td>
</tr>
<tr>
<td>An &quot;ivory tower&quot; attitude is too common among university scientists</td>
<td>1</td>
<td>2</td>
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<td>5</td>
</tr>
<tr>
<td>Science in universities cannot maintain the pace of creativity needed in private companies</td>
<td>1</td>
<td>2</td>
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<td>4</td>
<td>5</td>
</tr>
<tr>
<td>University scientists do not focus sufficiently on applied research appropriate for marketing products</td>
<td>1</td>
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<td>5</td>
</tr>
<tr>
<td>The university's insistence on the freedom to publish research results is in conflict with industry's need to protect the results of research through patents and proprietary know-how</td>
<td>1</td>
<td>2</td>
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<td>4</td>
<td>5</td>
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<tr>
<td>University patent policies are too burdensome</td>
<td>1</td>
<td>2</td>
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<tr>
<td>Universities are overly concerned that industry-sponsored research will improperly influence the direction of future university research</td>
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<tr>
<td>Universities are concerned that industry will try to control what research is done in biotechnology</td>
<td>1</td>
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<td>5</td>
</tr>
</tbody>
</table>
How strongly do you agree with the following criteria for accepting or rejecting industry funding?

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compatibility between the proposed project goals and the research/educational goals of the university</td>
<td>1 2 3 4 5</td>
<td></td>
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<tr>
<td>The degree to which the research contains a common area of interest to professors and to the university</td>
<td>1 2 3 4 5</td>
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<tr>
<td>The amount of funding received</td>
<td>1 2 3 4 5</td>
<td></td>
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<tr>
<td>The ability to agree upon clear research guidelines in advance of the contract</td>
<td>1 2 3 4 5</td>
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<tr>
<td>Pre-funding agreements on patent, copyright, and publication guidelines</td>
<td>1 2 3 4 5</td>
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</tbody>
</table>

VIII. UNIVERSITY/INDUSTRY: From your point of view, what are the most important roles of research connections between universities and industries?

Mark the:

- Most important item with: "1" (choose only one)
- Less important item with: "2" (choose only one)
- Least important item with: "X" (choose only one)

___ Replacement for lost federal funds.
___ Avoidance of federal/state "red tape" and regulation of research.
___ Potential long-term support of research.
___ Acquiring state-of-the-art teaching & research technology at universities.
___ Direct financial support for graduate students.
___ Richer & more applied experiences for graduate students.
___ Professional stimulation for university faculty.
___ A means for marketing university faculty innovations, with royalties returned to the university and to individual faculty.
___ Other (please specify)
How strongly do you agree that university contracts with private companies result in:

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>More applied research</td>
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<tr>
<td>Pressures for faculty to spend more time on commercial activities</td>
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<tr>
<td>Undermining intellectual exchange and cooperative activities within and between departments</td>
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<tr>
<td>Patent royalties which would increase university revenues</td>
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<tr>
<td>Conflict among faculty supporting or opposing such activities</td>
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<tr>
<td>Job opportunities for students</td>
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<tr>
<td>Unreasonable delays in the publication of new findings</td>
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<tr>
<td>Enhanced scholarly productivity</td>
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<tr>
<td>Altered standards for promotion and tenure</td>
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</tbody>
</table>

**IX. REDUCING PROBLEM BARRIERS:** How strongly do you regard the following as possible ways to reduce barriers to cooperative research in the future?

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some universities in need of funding becoming more liberal in their corporate guidelines as competition for funds increases</td>
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<tr>
<td>Universities becoming more pragmatic in their operation</td>
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<tr>
<td>Industry allowing more open communication among researchers</td>
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<tr>
<td>More cross-sector communication, especially between researchers (rather than administrators)</td>
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<tr>
<td>Increased pooling of industry funds to support university-based research institutes and centers as a way for smaller firms to participate in university research</td>
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<tr>
<td>Industry utilizing a wider range of university faculty members when seeking consultants or researchers</td>
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<tr>
<td>Revising federal laws and regulations that govern innovations and patents derived from government-sponsored work at universities</td>
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</tbody>
</table>
X. DIRECTIONS OF COOPERATIVE RESEARCH: Please indicate your reaction to the following questions by circling one response for each statement.

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
<th>DON'T KNOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Should universities strive to perform significantly more work oriented toward industry and market needs?</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Should universities agree with industrial sponsors to withhold research results from publication until patent protection can be obtained?</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Should universities agree with industrial sponsors to withhold research results from publication when the industrial sponsor needs to keep the results confidential for competitive reasons?</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>In general, do you believe that there has been a significant improvement in university-industry research relationships in the last five years?</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

XI. ABOUT YOU: Please provide some additional data about yourself so that we may know a little about those who filled out our questionnaires.

Age_____ Sex_____ I was first elected as a: __Democrat
__________________Republican

I am currently a member of the: __Senate
__________________House of Representatives

In what year were you first elected to your present legislative seat?_______

My district is best characterized as being: __largely or entirely rural
__largely or entirely urban
__largely or entirely suburban
__a mix of the above

Are you currently serving, or will you be serving, on any legislative committee(s)?_______

If yes, which one(s)?____________________________________
____________________________________________________
XI. ADDITIONAL INFORMATION: Finally, please indicate your opinions about the future of biotechnology funding and research in Iowa.

In your legislative activity, apart from decisions that you made about whether to vote for or against it, have you, or do you expect to have had, any involvement in decisions about the research funding for biotechnology? 

YES NO DON'T KNOW

Thus far, do you believe that the state funding for biotechnology research at Iowa State University has been well spent?

1 2 3

In your view, is it appropriate that a portion of the biotechnology research funding is earmarked for investigation of the ethical dimensions of that research?

1 2 3

I believe that the current level of state funding for biotechnology research at Iowa State University should be:

_increased_

_decreased_

_kept the same_

My expectation as a legislator is that the state funding for biotechnology research at Iowa State University will result in: (check all that apply)

National academic recognition
The availability of new sources of funding
An enhanced reputation for the state as a supporter of applied research
Greater public knowledge of biotechnology
The creation of new jobs in the state
Heightened awareness of possible consequences of biotechnology developments
A more balanced state economy
Other (please specify)

Do you wish to receive a copy of the survey results? ___YES ___NO

Please add any additional comments you would like to make

_____________________________________________

_____________________________________________

Please return by March 31, 1987. Your cooperation is appreciated and important. Thank you for participating in this survey. Please return your completed survey in the postage-paid return envelope provided.
ACKNOWLEDGMENTS

My intimate association with biotechnology and bioethics would never have been possible without the staunch support of Drs. Woodman and Shelley. Throughout my graduate career Bill and Mack have served as friends, colleagues, mentors and employers. The ability of Mack and Bill to endure the bureaucratic politicking that has plagued the bioethics program like a Kafkaesque nightmare attests to their scholastic dedication. I deeply admire their political courage, insight, and wisdom, and thank them for both their friendship and guidance. Bill and Mack, I am forever indebted to the opportunities you have given me.

Much of this dissertation would not have been possible if not for the academic collaboration of Dr. Lasley. His willingness to collaborate in the investigation of biotechnology issues through the Iowa Farm Poll led directly to section two of this dissertation. Paul's door was always as open as his poker wallet, which, considering the degree to which his card-playing financed my dissertation photocopying costs, says a great deal about his willingness to communicate with students. Thanks Paul.

Special recognition is due to Dr. Warren. Without his aggressive and determined leadership of the Iowa State University Bioethics Committee much of the research presented in this dissertation would not have been possible. Mike
faithfully carried out the Committee's mandate and refused to let the Committee fold under his leadership. Although often unheralded, Mike's efforts did not go unnoticed or unappreciated by those, like myself, who cared about the future of the bioethics program at Iowa State University.

I would also like to thank Dr. Bultena for his counsel on Human Subjects matters. Without his invaluable assistance in such bureaucratic matters, the research project presented in section two might have been delayed inevitably. Gordon's thoughtful assistance and guidance as an involved committee member is deeply appreciated.

Portions of this research were aided by financial support from the Iowa State University Bioethics Committee, the Iowa State University Graduate College, the Joyce Foundation, and the Northwest Area Foundation. Section four would not have been possible without the help of Reid Adler and the Office of Technology Transfer of the National Institutes of Health.

This dissertation was made possible by the encouragement and patient support of my family.