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ABSTRACT

Changes in the institutional control of faculty behavior are examined, stressing that such control includes not only control by a faculty member's own university, but also, increasingly, regulation and other influences exerted by institutions outside the university. The review of the literature focuses on ways in which changes in the external environments of universities have affected professors' research. These changes are considered from three perspectives: (1) complications associated with different types of external organizations--academic associations, the federal government, private industry, and the organized public; (2) issues related to different disciplinary sectors internal to the university; and (3) aspects of the relationship between external and internal parties based on two types of theories of organization-environment interaction--resource dependence and institutional theories. It is concluded that: significant changes in the faculty-institution relationship are occurring; increasingly complex arrangements with external groups make control of faculty behavior more problematic; and as research relationships come to have the character of governmental or corporate contracts, the special norms of autonomy and self-regulation which have distinguished academic work in the past tend to have less certain status. Contains about 100 references. (SM)

Institutional Control of Faculty Research: Issues Emerging in the Academic Environment

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Ivory tower: "a secluded place that affords the means of treating practical issues with an impractical often escapist attitude; esp: a place of learning" (Webster's Ninth New Collegiate Dictionary).

What image does John Q. Public have of university professors? Well, they teach. They like books and probably read quite a bit. They spend their days in their offices, talking with students, reading, and thinking. They don't appear to have much to do with people on the outside. They probably aren't too good with mechanical or financial matters. In short, they live in a different world, in an ivory tower.

But Mr. Public's image of faculty life is increasingly at odds with professorial reality. More and more, faculty are in close contact with groups and organizations outside the university. Their funding comes from public agencies and private foundations, they consult with business and industry, their innovations and research findings are of interest to a wide range of external constituencies, and they encounter resistance in the form of well-organized public interest groups. Increasingly, contacts with groups external to the university impose constraints on faculty behavior, particularly with regard to faculty research.

This paper examines changes in the institutional control of faculty behavior. Such control includes not only control by a faculty member's own university,

but also, increasingly, regulation and other influence exerted by institutions outside the university. The focus here is on ways in which changes in the external environments of universities have affected professors' research. Ideals of faculty autonomy and academic freedom compete with increasingly complex constraints evolving from greater interaction with external organizations. We conside· these changes from three perspectives. First, we identify complications associated with different types of external organizations: academic associations, the federal government, private industry, and organized publics. Next, we distinguish issues related to different disciplinary sectors internal to the university. Finally, we consider aspects of the relationship between external and internal parties; we do so in light of two types of theories of organization-environment interaction: resource dependence and institutional theories.

Since this discussion focuses on faculty research, we do not specifically address institutional control of other aspects of faculty work. For example, faculty unionization, regulation of employment practices, and issues related to instruction are not covered here. Also, our primary concern is with issues e :rging in the academic environment; therefore, we do not address such issues as administrative control of faculty, patterns of faculty governance, or trustee-university relations.

Our discussion is based on a review of the relevant literature. At this point, we have searched the Current Index to Journals in Education (1983-1988) using the following descriptors and related terms: research, technology, science, profession, and ethics. We also searched the Social Science Index (1983-1988) as well as the complete indexes of Issues in Science and Technology and

Science, Technology, and Human Values. We examined the citation lists in articles read in order to identify other pertinent sources. Subsequent versions of this paper will be based on a wider search of the literature.

We first review aspects of faculty self-regulation and discuss some of the trends in academic research which have led to increased institutional control of faculty behavior.

FACULTY SELF-REGULATION

The traditional locus of control over faculty behavior has rested with the faculty itself. Academic research has been subject to a set of norms which have defined appropriate faculty behavior. In idealized form, these norms have expressed not only the privileges and responsibilities of academic researchers but also the distinctive characteristics of research conducted within universities and the nature of research-based linkages between universities and other organizations.

Fundamentally, the norms of faculty behavior derive from the principle that knowledge itself should drive the scholar's activities. Academic freedom, the freedom to pursue a line of investigation wherever it may lead, essentially asserts the primacy of the pursuit of knowledge over ideological agendas, politically or intellectually entrenched interests, and personal taste (Goldman, 1987:27; Grobstein, 1985:57). Caldart notes: "Academic freedom thus embodies two related concepts: that ideas should develop freely; out of intellectual curiosity, and that the free development of ideas will occur only in an academic environment protective of that freedom" (Caldart, 1983:26).

Autonomy is fundamental to the scholarly ethic and to the academic culture: "Downgrading all external controls, the culture of the profession everywhere emphasizes personal autonomy and collegial self-government. It portrays altruistic commitment, suggesting that it is a high form of service to society to create knowledge, transmit the cultural heritage, and train the young to fulfill their highest potential" (Clark, 1983:91).

Scholarly autonomy is not license to ignore all constraints but protection of the scholar's responsibility to be faithful to what Alexander has called the "impersonal morality of cognitive rationality" (Alexander, 1986). Scholarly norms arise out of this responsibility. Robert Merton identified a set of norms which govern faculty behavior in the sciences (1942:606). They are: 1) universalism, the separation of scientific statements from the personal characteristics of the scientist; 2) communality, the openness of research findings to all; 3) disinterestedness, the detachment of progress in research from personal motives; and 4) organized skepticism, the critical and public examination of scientific work (from Ben-Yehuda, 1986:2; see also Braxton, forthcoming, and Hackett, 1988, for recent discussions of Merton's framework). According to Burton Clark, these norms of science are essentially the basic norms of the entire academic profession (Clark, 1983:93). The long process of scholarly training and socialization generally leads academics to internalize these norms as standards for appropriate behavior (Ben-Yehuda, 1986).

Standards, however, do not always reflect the reality of human behavior. As Goldman points out, "In the real academic world there is competition, hence secrecy at least until publication, ruling political cliques within the academic

power structures (journal editors, department chairmen, grant administrators, etc.), and hence political as well as financial motives underlying many research programs" (Goldman, 1987:28). To the extent that these factors have become more prevalent in research, Chubin suggests "Perhaps not science but our perceptions of it have changed --- much in the same way that Merton's norms have come to represent the official ideology of scientists, but only a crude indicator of their practices" (Chubin, 1985:79). Ben-Yehuda has argued that, in fact, there are incentives built into the structure of science which induce researchers to violate the Mertonian norms (Ben-Yehuda, 1986; see also Chalk, 1985); Mitroff refers to these as "counter norms" (Mitroff, 1974). In addition, the opportunities to violate scientific norms without being detected or suffering any consequences are many (Sechrest, 1987). Compliance with the academic ethic is certainly not universal, but the norms continue to serve as descriptions of desirable, appropriate behavior in the academy: "However, the picture of working scientists sharing with their colleagues --- and therefore, with competitors --- all that they are learning, as they learn it, is something in the nature of a cultural myth ... Like all myths that are central to a culture, it has a firm basis in reality, but it exaggerates reality in order to serve its real purpose, which is to tell people how they ought to behave, not how they do behave" (Rosenzweig, 1985:47).

It appears, then, that it is not enough that the scholarly norms are rooted in ideals of academic freedom and the pursuit of knowledge. Practical dilemmas of everyday research test the authority of the institutionalized ethic. Are there correspondingly practical arguments for compliance with academic norms? Probably the most practical argument from the standpoint of an individual faculty member is that it is in his or her own best interest to act in accordance

with established norms (Zuckerman, 1977). The structure of academic research is premised on self-regulation, supported by the system of peer review. To the extent that self-regulation proves ineffectual, regulation from other quarters can be expected. Such regulation could radically change the conduct of university research.

In fact, control of faculty behavior by a variety of institutional actors is increasing (Olswang and Lee, 1984). It is not, of course, due solely to faculty reluctance in complying with traditional norms. Rather, autonomy and self-regulation are made more problematic by increasingly complex ties between academic researchers and parties in the university environment. For example, Chalk lists five trends which currently encourage secrecy, in opposition to the norm of openness: the increasing commercial value of scientific information, the increasing military value of science, the increase in global economic and political competition, the reduction in the delay between basic research and its applications, and competition for university funds and faculty positions (Chalk, 1985:30). Each of these factors relates to changes emerging in the environments of universities.

We now examine some of the changes in the academic environment which have complicated the traditional patterns of scholarly self-regulation.

THE CHANGING CONTEXT OF ACADEMIC RESEARCH

Weingart (1982) argues that the social context of research is changing very rapidly, and in ways that may result in the inevitable loss of professional autonomy in professional science. He points to three major threats to autonomy: First, there is an increasing disjuncture between the knowledge

that is being produced by science and the values of society at large. Thus, controversies over biotechnological efforts to develop new or altered life forms reaches beyond the specific research project to question the basis for posing the question. Second, science may be losing its internal consensus: there are debates about what constitute appropriate behavior and practices, and dissenters are turning to the public for support. Finally, tnere are definite changes taking place in the social order, largely pointing to the increasing complexity of government, and the increasing predominance of government as the chief or indirect client of many fields of science. While the demise of autonomy in academic research is not yet certain, it is useful to outline some of the specific changes in context that may support Weingart's concerns.

> *The search for truth is innocent and ennobling; and the eventual benefits to mankind...further secure the moral status of science. (Ravetz, 1971)*

Ravetz' view of scientific morality of research as an enterprise and scientists as individuals is shared by many. However, over the past decade and a half there has been increasing concern about the changing nature of the university, and the commitments of its key resource: the faculty (Alpert, 1985). Some of the issues associated with debates, such as the propriety of academic entrepreneurship (Blumenthal et al., 1986b), the level of faculty commitment to the university Knapp, 1962; Jauch, Gluek and Osborn, 1978) the rates and significance of faculty consulting for pay (Marsh and Dillon, 1980), the changing nature of the incentive system in the hard sciences (Merton, 1963; Ravetz, 1971) and the problem of scientific misconduct or fraud (Zuckerman, 1977) have been raised in the social science literature. In this

section we will briefly review the historical developments that led up to these concerns.

According to Etzkowitz (1984) the nature of the research enterprise, at least in the "hard sciences", began to change in the last quarter of the nineteenth century with pressures from within the scientific community to view their work as practical in its consequences. These initial efforts to construct an "applicable science" were modestly successful and were reinforced by the contributions (again initiated by scientists) to the rapid solution of problems during the two World Wars. At the same time, the increased complexity of the scientific endeavor led to pressures by scientists for external government funding, increased reliance on group research, and the contracts and grants procedures which often commit scientists to deadlines and "products". The above trends have resulted in scientific activity that is very different from the way in which science was typically conducted fifty years ago.

A review of Etzkowitz's paper and a number of empirical studies suggests that there are three basic changes that help to frame many of the current debates about the need to monitor scientific inquiry and the behavior of science: increasingly large scale research, consulting and other commitments outside the university, and an increasing emphasis on the commercial potential of academic research. These will be discussed briefly below.

Large scale research. Academic research increasingly requires big laboratories and facilities. Often these employ a number of people other than the principal scientist. Even in the social sciences, the scale of major research projects and the consequent need for paid research assistants has increased

significantly. Once established, big projects require a continued flow of funds to maintain the staff and work, and the individual scientist's fundraising skills become critical. Maintenance of the laboratory can, in some instances become an end in itself, displacing more purely scientific motivations.

This trend may have several consequences: increases in scale are hypothesized to reduce scientific creativity (Schultz, 1980), while increasing the likelihood of intrusion by the funding agency, and an emphasis on "management" rather than investigation (Herzog, 1971). Some, however, view the rise of complex, interdisciplinary research teams, and the managerial skills of those who orchestrate them, as a sign of research vitality (Louis, 1983), and at least one study of the impact of laboratory size on scientific productivity concluded that there was a small positive impact (Cohen, 1981).

The dimensions of the research enterprise may also affect the basis for evaluating individual performance. In many fields, the size and number of research grants has come to be a "quick and dirty" indicator of the individual's disciplinary prestige (Liebert, 1977; Hackett, forthcoming). Universities, either wittingly or unwittingly, have reinforced this trend. In two separate studies, departmental track records in fund raising have been shown to determine their power position in university budget-making more than external assessments of quality (Pfeffer and Salancik, 1974; Pfeffer and Moore, 1980). The impact of large-scale science on the personal incentive system for younger scholars has also been questioned. Scientists have traditionally worked to achieve recognition for personal scholarly accomplishments (Merton, 1968). However, in a large lab, it may be difficult to sort out the contributions of individuals: recognition tends to accrue to the head of the

research program. The growth in large-scale research and collaboration is also viewed as good preparation for cooperative work in industry, where "solo" projects are rare (Etzkowitz, 1984).

Consulting. In the past, academic endeavors have been characterized by their lack of concern for personal gain. As the barriers between pure and applied science began to break down during the second World War, the belief that scientists could maintain the ideal of basic research without sacrificing the opportunities for financial reward spread (Etzkowitz, 1984). Serious scholars began to consult to private industry to augment their incomes; many universities explicitly condoned this behavior with a written or informal "one fifth" rule, which permitted the academic up to one day a week for private work outside the university. A recent survey of university policies indicates that the majority have an explicit rule regulating the amount of time that a faculty member may consult for pay outside the university or the amount that may be earned from such activities (Blumenthal et al., 1986b). Such policies, however, are rarely vigorously enforced (Louis et al., 1988). Currently, consulting is the norm for most academics. Although the typical amount of money earned from consulting a decade ago was not very great, and consulting involvement does not appear to interfere with scholarly productivity, it is associated with a reduced commitment to teaching (Boyer and Lewis, 1985; Marsh and Dillon, 1980).

Commercial potential of academic research. Traditionally, academics have distinguished their special role as the originators of "new knowledge," as opposed to "applied knowledge". Thus, the academic reward system theoretically gives greater credit to research that extends the boundaries of

the field, and writers in both the natural sciences and social sciences often make distinctions between what properly belongs within academe and what belongs outside. In recent years, however, "hot" basic research has confounded this distinction by demonstrating potential commercial consequences almost immediately. This happened first in computer science but has occurred more recently in biochemistry, with biotechnological advances, and in physics, with new hopes for superconductivity research.

Changes in the context of academic research have brought about changes in the relationships between faculty and the growing number of institutions with which they interact. Before examining these changes in detail, we first review some of the developments in regulation of faculty behavior from the recent past.

The apparent increase in public concerns about regulation of academic research has not occurred in a policy vacuum, nor should it be viewed solely as a response to recent exposures of errant behavior on the part of scientists. Recent historical analysis shows that the regulatory role of government has increased steadily over the past 100 years. Schmandt (1984) outlines three phases of activity. The first focused on the regulation of the economic practices of emerging industries, such as railroads. The second, beginning in the New Deal, turned toward the regulation of finance and economic institutions, and labor practices. The third phase, which emerged about 20 years ago, has focused on health and the environment and, increasingly, on the control of risks associated with new technologies. As Schmandt points out: "These [new] industries owe their existence to their success in transforming scientific discoveries...into marketable products and processes...[They] use

scientific research directly as a production force. To do so, they must engage heavily in research and development" (Schmandt,1984: 25).

Brooks points out that shortly after World War II science policy in the United States became based on an informal "social contract" between universities and the federal government in which "a promise of social benefits [was] exchange[d] for an unusual degree of self-governance and financial support free of strings...One could say that the...academic community drew on the credit deriving from the wartime success...to strike a new bargain with society" (Brooks, 1988:50). Public expectations about the expected value of science were inevitably altered, as research benefited from an influx of federal support for field-initiated projects.

In the 1960s, with little public discussion, emerging high-technology industries began adding basic research to their in-house agendas. In the past 15 years there has been an increase in the number of fields in which industrial research laboratories provide a context more favorable to long-term, innovative basic research than universities (Brooks, 1988). It is estimated that about 50 percent of the national budget for basic research is allocated to scientists in non-university settings (Brooks, 1988). As Blumenthal et al. (1986a) indicate, large corporations tend to view their own in-house research scientists as an adequate source of basic research results for their own development purposes, and fund university research largely for philanthropic or network-building reasons. Although many university-based scientists still claim a great chasm in values between industry and university researchers researchers (Grobstein, 1985) there is little evidence to suggest ,

with respect to basic science, that there are significant differences (Blumenthal et al., 1986a).

It is, therefore, not especially surprising that, as government agencies became better able to monitor and regulate science in industry, and the public more accustomed to expect "return on investment" from the social contract with academic research, a climate more conducive to regulation of university-based researchers emerged.

A final aspect of the changing regulatory climate emerges from increased efforts by state governments to expand oversight to improve management practices and fiscal responsibility and to improve educational quality through assessment of student learning outcomes (Volkwein, 1987). The increasing emphasis on tightening up the system of public post-secondary education within states is affecting the flagship research universities as well as state colleges (Millet, 1984). While these efforts do not affect the researcher directly, they increase the perception that the public will benefit by decreasing autonomy within universities.

THE DOMAINS OF INSTITUTIONAL CONTROL OVER RESEARCH

The social science and educational literature reveals four significant institutional domains that have emerged as potential (and potent) influences over the way in which an individual university-based researcher conducts his or her work: the research community and professional associations, government, industry, and organized publics. These will be discussed in rough order of their emergence as actors in the regulatory environment.

The Research Community and Professional Associations

Although professional associations are, historically, the earliest institutional base for influencing the behavior of researchers, their current role is largely limited to credentialing, articulating values and standards, and negotiating actively for the interests of the profession in the political marketplace. Peer associations have, however, become a more powerful influence through their association with government agencies.

Modern professional associations (as differentiated from guilds) were well established by the end of the eighteenth century. The meetings of these associations rapidly became the mechanism for individual scientists to establish their credentials. One of the main innovations of the associations was the introduction of a peer review function, through which "the integrity of the proceedings of each society was ensured..by an editor who relied on an advisory board..to review prior to publication all members' contributions" (Atkinson and Blanpied, 1985:103-104). In addition, in the United States the American Association of University Professors was active in promoting the view of scientists as disinterested public servants as a justification for academic freedom (Slaughter, 1988). Thus, their historical role has been to ensure quality standards of published research and to protect researchers from political or bureaucratic intrusions.

Academic professional associations have also been active in developing guidelines for the ethical conduct of research that are specific to their research methods and their relationship with the larger university community and society, another aspect of quality control. In these

associations, unlike the medical and legal associations, the peer review function has not included an active role in policing and disciplining members who violate these norms. For example, a recent study in toxicology indicates that, if faced with a clear violation of research ethics on the part of a colleague, few scientists would turn to their professional associations as a means of dealing with it (Bronstein, 1986).

In the late 1940s peer review took on a very different role, as scientific associations successfully lobbied to maintain both the federal support that emerged after the war and their own autonomy. Peer review, through the initiation of advisory and review panels to set research priorities and evaluate the scientific merit of proposals, was the cornerstone of this agreement. The National Science Foundation, created in 1950, became the model for other agencies funding basic research (Brooks, 1988).

These advisory groups came to have significant influence over individual scientists, since they not only help to establish research priorities (thus determining what types of research will be funded), but also determine which specific projects will receive funds. Research indicates that many scientists have selected or adapted topics for research because of the research agendas set by the agencies' advisory boards (Blumenthal et al., 1986a).

More recently there have been more concerns raised about the efficacy of peer review as a mechanism of quality control. Broad and Wade (1982) argue that there is evidence suggesting that the research community has actively ignored the presence of fraud among its members, and Chubin (1985) discusses the unwillingness of scientists and their associations to collectively address

the need for changes in the peer review process. Steneck (1984) provides evidence that systematic investigation of research projects may reveal a sizeable percentage that deviate substantially from standards, contrary to association claims that misconduct is rare and therefore adequately controlled through publicity of the few exceptional events. He also suggests that "although fraud can be detected through peer review, peer review is not necessarily the only or even the best means to ensure proper conduct in research", because ethical issues extend beyond questions of technical and theoretical research quality (Steneck, 1984:13-14).

There is also concern that the quality control functions of peer review (what Broad and Wade call the "invisible boot" that kicks out flawed or inaccurate research studies and findings) may be declining in efficacy. The relative passivity of the scientific community in the face of increasing efforts by universities to circumvent the peer review process is, according to Atkinson and Blanpied, evidence that scientists "regard research support as an end in itself and entanglement with other issues as unnecessary" (Atkinson and Blanpied, 1985). Although some research has indicated that the peer review system operates to distribute funds fairly (according to merit), other research suggests that the review system does not work well in all disciplines, particularly those characterized by weak or conflicting theoretical and methodological paradigms. Increasingly, peer review is being asked to establish more open and fair standards: double-blind reviewing, where the author as well as reviewer are anonymous, and disclosure of financial or other conflicts of interest that may affect the reviewer's ability to dispassionately judge another's work (Sun, 1989). Where peer review is perceived by

researchers to be unfair, the ethical basis for the current system of peer quality control is undermined.

Government

Atkinson and Blanpied point out that: "The unique contract between science and government that has existed in the United States since the end of World War II rests on the assumption that science must remain autonomous, but that the public interest will best be served if scientists play a decisive role in determining how public funds are spent to support scientific research" (Atkinson and Blanpied, 1985:101). This relationship is not without tensions, however. In this section we will examine three aspects of government's relationship to university researchers.

Funding agencies. The federal government is the primary source of funds supporting research in universities, despite the lack of growth and subsequent decline in federal support in constant dollars (Thomson et al., 1983). In research universities, for example, the average percentage of total funding for health-related research supplied by private industry is four percent (NIH Data Book, 1984). As noted above, unlike every other developed country with a significant government investment in research, the allocation of basic research funds is controlled largely by scientists in universities rather than by government agencies. The mechanism for distribution and influence by scientists is peer review.

In general, the evidence suggests that university researchers look upon funding agencies primarily as their allies and as supporters of the principle of control by the professional community. Cherniavsky (1985), for example,

reports that computer science researchers found their funding agencies --- from NSF to DARPA --- to be helpful in mediating efforts by other government agencies to control their research.

Sissela Bok, however, points out that current funding mechanisms have unanticipated negative consequences on the scientific communication system.:

> The current system of financing research ... encourages misrepresentation in the interest of keeping unfinished work from undesired disclosure. Scientists who seek financial support for their work ... are now required to describe in some detail what they plan to do if they receive a grant. This process exposes their research in two ways: it opens research plans to potential competitors on the reviewing boards, and it disturbs the privacy of unfinished projects (Bok, 1982:35-36).

She goes on to report that scientists admit that they often falsify information about their research in proposals to prevent competition or misuse by peers.

Legislature and Administration. Until recently, legislative incursions into the regulation of basic research have been rare. In the 1960s, for example, virtually all of the concern about threats to open communication focused on classified research funded by the defense department. The scientist's response to contractual constraints on publication can be handled simply, by a refusal to take such funds.

In the past 20 years, however, there have been major advances in a variety of technical areas that have coincided with public concern about the economic and military position of the United Stated in the global setting (Cherniavsky, 1985). From the middle of the Carter administration on, there have been a number of policy initiatives to curb the flow of new information to

"unfriendly nations." By 1982, the American Association of University Professors felt compelled to make a statement about these efforts, emphasizing that the development of science is dependent on "free and spirited exchanges ... the path to safety lies in the opportunity to discuss ideas freely" (Rosenbaum et al., 1982). The National Academy of Sciences issued a similar report in the same year (Young, 1985).

The controversies were focused on several acts that authorized the imposition of restraints on the dissemination of technical information of certain types. Under the Arms Export Control and and the Export Administration Act respectively, the Department of State the Department of Commerce were authorized to license the export of information or data that could be used in the design of military weapons (Ferguson, 1985). Use of these provisions to restrict the presentation of papers at conferences attended by foreign nationals caused major disruptions of several major conferences in areas such as magnetic bubble technology and infra-red optics (Ferguson, 1985). The major difference between the use of these acts and previous attempts to control the flow of information is that they were applied retroactively to any research project whose content was related to weapons or military development (Bok, 1982). Thus, the impact was felt even in field-initiated basic research. Cherniavsky (1985) studied the impacts of these constraints on three university-based research groups in computer science, a field where there are multiple regulations and strong incentives for the government to restrict the flow of information. Contrary to expectations, he found that all three research groups believed that there was greater freedom of communication than ten years earlier, and that they attributed this positive change to the growth of their disciplines and expansion of communication

networks that permitted easy exchange of information. Current barriers to communication were believed to arise more from the nature of results (patentability) rather than from government intervention. Rubinstein (1985) argues (a little hyperbolically) that the growth of computer networks builds an "open-access research laboratory" that will fuel an "explosion of innovation which will dwarf all that mankind has yet seen" (Rubinstein, 1985:105).

Legal System. We have made no systematic search of the legal literature to uncover data on the development of precedents with regard to the regulation or ownership of research. We therefore limit our remarks to a general discussion of legal issues represented in the social science and higher education journals.

Ferguson (1985) points out that there have been no federal, constitutional, legal cases testing the principles of the first amendment as applied to research knowledge. As research knowledge with commercial potential becomes increasingly defined as "intellectual property" that can be owned, rather than a public good, its status as speech protected by the first amendment may be challenged (Samuelson, 1987). While in the past this problem was perceived as relating largely to industrial work, Bok (1982) points out that it should be recognized as applying to both university and industrial research as the lines between these forms become less clear.

More direct control over research process, rather than results, may also occur. Three cases concerning the efforts of communities to regulate hazardous research are reported by Krimsky (1986). Of these, two resulted in legal suits,

both of which resulted in decisions favorable to the community's right to regulate research utilizing hazardous substances within its boundaries. In both cases the amounts of hazardous substances were very small, and there was conflicting testimony about the nature of a "worst case" research accident. However, Krimsky points out that both of these cases involved basic research in a non-university setting. The third case, involving Harvard University and biotechnological research, was settled by citizen review and negotiation, resulting in a decision favorable to the right to conduct the relevant inquiries.

Industry

In recent years, there has been a substantial increase in faculty involvement with private business and industry. Interaction with commercial organizations has taken many different forms and varies widely across institutional types and across disciplines. The issues raised by such interaction relate to the fundamental mission of public higher education, implicit and explicit terms of academic employment, and the distinctive intellectual motivation of research in the university setting (Bok, 1981; Wade, 1984).

Before World War II, private industry was the primary source of external support for U.S. universities, except in agriculture (Rosenzweig,1985:43). Corporate donations reflected a combination of charitable philanthropy and self-interest, based on industry's dependence on universities for educated employees (Fink, 1985:2). The critical role of science and technology during the war led to changes in traditional patterns of funding and, in particular, the role of the federal government in supporting academic research. In the twenty years following the end of World War II, enormous increases in government funding reduced industry's relative role as an external source of funds. As Robert Rosenzweig explains, however, subsequent declines in U.S. economic competitiveness and cutbacks in federal funding, coupled with successful industry-university collaborations in science-based industries (particularly electronics and computers), has led to a re-emergence of the industry role in support of academic research (Rosenzweig, 1985:43).

The federal government, moreover, has encouraged university linkages. For example, Weese (1985) describes three kinds of programs through which the National Science Foundation promotes such interaction. First, with respect to

its support of Engineering Research Centers, NSF puts importance on university-industry linkages in evaluation of proposals: "Integration of a center into engineering education and the involvement of industry engineers and scientists weigh heavily, particularly as these relate to the cross-disciplinary nature of the center and prospects for sharing equipment.... Industry participation is examined not only in terms of financial support but for the degree of interaction of industry scientists and engineers in research at the center" (Weese, 1985:647).

Second, Presidential Young Investigator awards, given to recent Ph.D.'s with tenure-track faculty appointments, encourage recipients to seek additional support from industrial sources. As of 1985, the minimum award of $25,000 could be increased by an additional $37,500 to match support obtained from industry.

Third, several programs of the Industrial Science and Technology Innovation Division of the Directorate for Scientific, Technological and International Affairs are targeted to increasing university-industry cooperative activities through grants.

In 1983, industry support accounted for about ten percent of external funding for research at research universities (NIH Data Book, 1984; Fink, 1985:4). Levels of support vary widely, however. A few major grants have received considerable attention, such as $23 million to Harvard University from Monsanto Company, $70 million to Massachusetts General Hospital from Hoechst (Caldart, 1983:25). Such arrangements are limited to relatively few universities and relatively few corporations. Among the 200 leading research

universities, only 25 receive more than ten percent of their research funds from industry (Fink, 1985:4). As of 1983, less than four percent of total research and development expenditures by industry went to universities; moreover, ten companies accounted for 25 percent of industrial support for universities, and two accounted for 20 percent (Culliton, 1983:150). Blumenthal, et al. (1986a) Note that the average grant to universities made by non-Fortune 500 firms engaged in biotechnology was $19,000.

Faculty interaction with industry takes many different forms. Faculty consulting is probably the most common: "Almost certainly, the most widespread connection between universities and industry consists of individual consulting agreements entered into by individual faculty. In many, perhaps most, cases, the institution would have no knowledge of the specifics of the agreements, and in some cases, they would have no knowledge even of their existence" (Rosenzweig, 1985:44; see also Blevins and Ewer, 1988:651). Other forms of cooperation include research grants, major contracts for long-term research, industry cooperatives funded by entire industries, centers for advanced technology funded jointly by state and private funds, university-industry consortia which act as "middleman institutions" between universities and commercial enterprises, and research institutes which are associated with universities but operate as legally separate entities (Fink, 1985:5; Bird and Allen, 1989:585; Blevins and Ewer, 1988:646; David, 1982:28). Faculty also have been known to invest in small ventures that are consumers of their own research, or to establish private, for-profit corporations with close ties to their academic institutions (Bayer, 1984; Blumenthal, et al., 1986a, 1986b).

The variety and increasing prevalence of faculty interaction with private business and industry, particularly in scientific and applied fields, raises a number of issues central to the conduct of academic research. Caldart characterizes the situation thus:

> In a very real sense, the universities are now experiencing a shift from corporate contribution to corporate investment in academia.....The specifics differ from situation to situation; yet all of these recent contacts between industry and academia share three features. As noted, all can be distinguished from philanthropic contributions, in that they are designed to provide direct financial gain to parties outside the university; in all cases, the research to be pursued is that which offers considerable commercial potential. Second, all delve, at least in part, into areas of "basic" research traditionally confined to non-commercial academic settings. And, third, all involve large sums of money (Caldart, 1983:25).

From the point of view of universities, there is much to gain in contacts with industry. One survey, for example, indicates that more than 50 percent of university life scientists agree to a great extent or some extent with the statements that research support from industry "provides resources for research that could not be obtained elsewhere" and "involves less red tape than federal funding" (Louis et al., 1989). At least one study has shown that the market for obtaining industry support is more open (e.g., less tied to the past productivity of the applicant) which may make this source more attractive to younger scholars or others with weak track records (Liebert, 1977). On the other hand, informed observers think that in recent years industry has more actively sought out well established scientists, which may mean that patterns of industry funding are changing. Finally, research assistantships rather than grants increasingly provide support for graduate students (Hackett, forthcoming): in the area of biology, where support from traditional federal sources has dropped, departments must welcome the

investments in student support that are made by 32 percent of all biotechnology firms (Blumenthal et al., 1986a.).

In addition to obvious financial benefits, there are advantages in being in touch with organizations which utilize research findings to develop new products and processes. To the extent that universities exist for the public good, they have an interest in seeing innovations derived from more basic research disseminated to the widest possible population. From the standpoint of industry, access to researchers at the cutting edge of knowledge, particularly technological knowledge, provide valuable advantages for commercial development. This access is viewed as the most important benefit of university research sponsorship by firms engaged in biotechnology (Blumenthal et al., 1986a). The same biotechnology study shows that industry funded university research has a higher payoff in terms of patent applications per research dollar than industry conducted R&D, while Peters and Fusfeld (1982) indicate that recruitment of talented new staff is very important.

There are disadvantages as well, however. The more complicated the task of research becomes, with more actors pursuing disparate, possibly even contradictory goals, with more at stake in both financial and personal terms, the more difficult it is to ensure that the project will be satisfactory to all concerned. We focus here on two broad concerns. On the university side, there is what Rosenzweig (1985) has termed "the challenge to academic integrity", the issue of maintaining the distinctive role of academic research in the face of the changing external context. On industry's side, there is the problem of ensuring that interaction with academe will continue to be advantageous or,

in a word, profitable. The most salient issue here is ownership of the products of sponsored or cooperative research.

Academic research exists in a normative context which defines the institutional role of the research task and the professional role of the academic researcher. In a university, research is assumed to be pursued along with instruction and public service. The implicit motive for research, as well as the basis for rewards in academic work, is the pursuit of new knowledge. Institutional autonomy for the university and academic freedom for the professor are predicated on the assumption that the independent demands of knowledge creation, tempered by a concern for the public good, determine the direction of academic work (Caldart, 1983:29).

Smith identifies balance between basic research and commercial objectives as one of the areas of potentially significant problems. "The relevance of a proposed line of inquiry to the essential missions of the university and the industry --- how to design a collaborative program that maintains balance between the university's pursuit of research as an integral part of the educational process, and industry's search for useful knowledge to be applied in the development of products, processes and services" (Smith, 1984:25).

Another issue is research direction. To the extent that external institutions seek to determine the direction of academic research on the basis of their interests as sponsors or partners, faculty members become subject to controls inconsistent with their professional roles and the purpose of their work (Blevins and Ewer, 1988:651). Ashford argues that at each critical decision point in the development of a research project, industrial funding can

influence the incentives which cause a researcher to choose one direction over another. More pointedly, he suggests that industry can coopt academic experts and control the content of university research (Ashford, 1983: 20-21). Blumenthal et al., (1986b) indicate that biology and biochemistry faculty who receive research funds from industry are four times more likely to report that their choice of research topics was influenced by the likelihood of commercial implications of the results.

As Bruchbinder and Newson point out, differences in industrial and academic orientations can be to some extent seen as culturally-based:

> Existing barriers to a greater degree of cooperation and collaboration between universities and the corporate world are identified as 'cultural differences.' To a large extent, these differences relate to the process of work itself. There is the academics' self-paced nature of working, the discretion of faculty members over the organization and management of their research, the rules and understandings concerning freedom of communication and publication. Contrasted to these aspects of the academic environment are the orientation toward profit and commercialization, the need to meet deadlines, proprietary rights, and the maintenance of a competitive edge in the marketplace, all of which are seen to be characteristic of the corporate environment (Buchbinder and Newson, 1985:45).

Differences in values, breadth of focus, nature of rewards, standards of success, and lifestyles may explain some of the difficulties of academic-entrepreneur interaction (Bird and Allen, 1989:593). For example, industry grants to universities tend to be much shorter term than federal grants (Blumenthal et al., 1987), which suggests a focus on narrow research questions. The matter of time frame reflects not only cultural differences but ·o different perspectives on the purpose of research. Blevins and Ewer caution: "The one difference that threatens a lasting relationship between industry and higher education is industry's propensity to work toward short

term profit maximization while the university maintains a philosophy of long term considerations. All other differences between the two institutions pale in comparison. It is of dire necessity that universities not lose their long term perspectives" (Blevins and Ewer, 1988:654). The danger that they will is, of course, very real given the rewards which university researchers may be able to obtain by adjusting their research agendas to accommodate short term industrial interests.

Another value difference introduced by industrial funding concerns openness of communication. Academic research culture is based on this value, while industrial profit motives require some secrecy to protect competitive advantage. One quarter of faculty with industrial research support in biotechnology report that they are restricted from circulating research results by the terms of their funding, a rate that is five times higher than for those without funding (Blumenthal et al., 1986b). In response, most research universities (74 percent) have developed guidelines that indicate how long such restrictions may apply -- usually no more than 90 days (Louis et al., 1988).

Other concerns on the university side are conflict of commitment and conflict of interest. Most faculty members have teaching and other responsibilities beyond their research. To the extent that work with industrial organizations impinges on these other duties and compromises the value of the non-research services which the university provides, universities may charge their faculty members with conflict of commitment (Blevins and Ewer, 1988:651). Giamatti writes, "I doubt that a faculty member can ordinarily devote the time and energy the university requires and also pursue a substantial involvement in any such outside company. Such involvement necessarily

demands great concentration and commitment..." (Giamatti, 1982:1279). Consulting appears to be the primary source of difficulties: high levels of research funding from industry do not appear to have a negative effect on research productivity, but exclusive or extensive consulting does result in lower publication rates (Blumenthal et al., 1987:25). Ninety-five percent of all research universities regulate faculty consulting (Louis et al., 1988); most universities require faculty members to report, if not obtain permission for, all consulting arrangements. They also generally limit faculty consulting to one day per week (Giamatti, 1982:1279; Boyer and Lewis, 1985). Perhaps of greater concern is the possible conflict of interest in the industrially funded professors' teaching and mentoring roles: doctoral students whose education is supported by industry funds report lower publication rates, more delays in publication and constraints in discussing their work (Gluck, Blumenthal and Stoto, 1987).

The potential for conflict of interest likewise leads universities to seek to regulate faculty behavior. A professor who has a substantial financial interest in a corporation which funds his research or who holds an executive office in a company which is pursuing commercial development of innovations stemming from his academic research is generally subject to accusations of conflict of interest. A recent survey of academic deans at research universities reports that 88 percent of these institutions have written policies concerning consulting, 52 percent have policies regarding faculty involvement in firms whose products are based on their own research, and 45 percent have policies relating to other sources of conflict of interest or commitment (Louis et al., 1988).

Thus, from the university's perspective, the major problems with university-industry interaction stem from the distinctive character of academic research and the responsibilities of academic researchers as members of the university community.

From industry's perspective, the greatest concern centers on its reasons for entering into collaboration with a university in the first place, namely, the possibility of benefiting from the outcomes of sponsored or collaborative research. In the competitive climate of U.S. industry, exclusive control of technology or information is critical. Intellectual property, the usual outcome of academic research, can be protected in one of two ways: through statutory grants (patents, trademarks, etc.) or through trade secrets (Buttel and Belsky, 1987:38). Increases in university-industry arrangements have focused a great deal of attention on the implications of both of these approaches to maximizing private industry's return to its research investment.

Trade secrets stemming from academic research pose the greater challenge: "Trade secrecy envelops not only scientists who work for private business but also many who are based in government and the universities. Companies in many fields eagerly invest large sums in the services of university researchers, asking for guarantees of secrecy in return.... At scientific meetings, disputes over secrecy are erupting, and in some organizations, actions are being considered which could censure or expel members who use their business obligations as shields to avoid participation in the usual sharing and discussion of new advances" (Bok, 1982:37). Secrecy contradicts the academic norms of openness and free exchange of information. It restricts communication with colleagues, some of whom may also be competitors in the

sense that they are linked with competing industrial interests. It greatly complicates the participation of graduate students in the research enterprise. Bok argues that trade secrecy should not play any part in the research of universities because of the faculty's responsibility to the public, colleagues, students, and the progress of learning (Bok, 1982:38).

Patenting of research results with subsequent licensing arrangements is an alternative way to protect industry's interests. The temporary monopoly afforded by a patent provides an incentive to innovate (Samuelson, 1987:7). The incidence of patent awards to university scientists or universities has been growing; many universities now contain patent offices or have stimulated independent foundations to deal with patents and royalties (Blumenthal et al., 1986b). In addition, many industries report that they have made patent application based on research that has occurred in universities (Blumenthal et al., 1986a).

Patents are not without complications, however. In some arrangements, sponsoring corporations have the option to review papers reporting research findings to check for patentable material (Coberly, 1985:322). This kind of review may delay publication of results. When patents are to be held by the university involved, industrial sponsors may expect exclusive licenses to the products of research. Even this arrangement meets with some opposition in industry: "Business wants fair value in return for its investment and therefore wants the ability to use the research results without having to pay a second time for the privilege. Moreover, many business people themselves have difficulty reconciling the role of a university as a public agent with its desire to take proprietary positions" (Bremer, 1985:52). It is not always easy, however,

to assign ownership of intellectual property, particularly when it has been built up over many years, through the contributions of many people. A single corporation can seldom take full credit for having funded a particular research innovation (Bremer, 1985:_ Lepkowski, 1984:10). Finally, procedures involved in securing a patent are not completely free from the problems associated with trade secrets.

Organized Publics

The last set of environmental actors we consider is somewhat loosely defined. "Organized publics" includes a wide variety of interest groups and constituencies which only relatively recently have come to affect the work of individual researchers.

Kenneth Prewitt notes the growing influence of what he calls "the attentive public for science --- that is, there is now a broadened constituency of non-scientists who attend to and often influence science and technological matters. Looked at from the point of view of the mass public, this attentive public is a tiny and highly selective constituency; but looked at from the point of view of practicing scientists, it appears as a large and unpredictable actor" (Dialogue: Ethical issues in the assessment of science, 1982:57). The demands of the attentive public relate to such far-ranging concerns as impacts of research on the environment and public health, responsible use of state funds, use of data on hypothermia victims in Nazi Germany, and lack of treatment for control groups in medical or psychiatric research.

The general motivation for most action on the part of organized public groups is the need for accountability. Dorothy Nelkin notes, "The reasons for such

emphasis on accountability include the high cost of research and the fact that more and more technologies appear to be intrusive. In addition, an increasing number of other public issues are being redefineed in terms of science and technology. In other words, problems of risk could be defined as problems of corporate power or responsibility, but instead they often are defined as problems inherent to technology itself" (Dialogue: Ethical issues in the assessment of science, 1982:59).

Two examples will serve to illustrate how public groups are able to influence academic research. In the mid-1970s, community concerns about recombinant DNA research slowed progress on a new facility constructed by Harvard University. While agreements which permitted the construction were finally reached, the facility had to meet standards stricter than those required by the National Institute of Health. The controversy led to the establishment of a Cambridge Biohazards Committee to oversee all recombinant DNA research in the city, thus resulting in even greater organization of concerned community citizens (Krimsky, 1986:15).

The other example of community pressure on university researchers involves the use of animals in research experiments. Animal rights groups continue to advocate more humane treatment of research animals or even the cessation of experiments on animals (Zola et al., 1984; Ritvo, 1984). Advocacy organizations charge researchers with causing suffering for animals while performing pointless or redundant experiments (Lopatto, 1986). Moss sees public pressure as having an effect on researchers:

> The shift [in scientific opinion] involves abandonment of the point of view that concern for laboratory animal welfare is a inor or eccentric sideshow in the overall progress of biomedical research. Instead it is

beginning to be seen as one of a few crucial interfaces between the operations of science and the concerns of the public as a whole. And because the laboratory animals issue is one among relatively few areas in which the public expresses concern about the procedures, ethics, and approaches of scientific research (human subject practices, recombinant DNA research, and industry-university relationships, among the others), many scientists now recognize that the scientific community must ensure that the issue is handled sensitively and credibly" (Moss, 1984:51).

DISCIPLINES WITHIN THE UNIVERSITY

Changes in institutional control of academic research can be differentiated not only by external agents but also by disciplines or fields of study within the university. In addition to being part of the general academic enterprise, faculty members are associated with specific fields of study. Boundaries of disciplines are roughly approximated by university departments but are in constant flux due to the emergence of interdisciplinary fields of study (Clark, 1983:186). A professor's education, training, and socialization in a particular field strongly affect his or her approach to research, both what is done and how it is done (Van Maanen, 1979). It is reasonable, then, to expect that disciplinary differences in faculty work lead to differences in institutional control of faculty behavior.

More importantly for this discussion, faculty in different disciplines face different external environments. Scholarly associations, funding patterns, and linkages with a wide variety of organizations are generally unique to particular fields: "Critically, the primary links to 'the environment' are specialty-based, with each disciplinary section of a university or college or institute possessing bridges of its own to groups outside the enterprise. The crucial linkage is to others in the same field, first within the academic system

itself and then secondarily, in the professional fields and some of the arts and sciences, to members of the field located outside the academy" (Clark, 1983:206). The university-environment interface exists in many different forms because boundary-spanning activity is widely dispersed throughout the university (Thompson, 1967:70).

Rather than addressing all the special features of institution-faculty relationships in individual fields, we choose to consider field differences using three contrasts derived from the Biglan typology. In an influential study, Anthony Biglan (1973a, 1973b) distinguished subject matter characteristics associated with eight categories of academic departments These categories are defined by all combinations of the following descriptives: pure versus applied, hard paradigm versus soft paradigm, and life versus non-life subject matter. We consider contrasts in control over faculty activity along each of these dimensions.

Pure versus applied. By their very nature, applied fields have been historically more closely linked to their environments. As Ashford points out, past ties with commercial organizations have made academics in engineering, medicine, and chemistry "kindly disposed towards industrial goals" (Ashford, 1983:17; see also Smith, 1984:24). Research centers funded either by government or by private corporations are far more likely to involve faculty in applied fields than in pure fields. Areas such as engineering not only have ready outlets for the results of their research, but in fact have developed in large part in response to problems posed by external constituents:

> At some institutions, in departments of engineering, physics, and biophysics, more than half the faculty are involved in some significant way in industry. And they do so not for financial gain, but because in

> these fields the cutting edge --- or some element of the cutting edge --- is, in fact, in industry. If they want to be at the cutting edge and if they want their students to be there, then they naturally work with industrial research groups. The faculty have set rules for what is appropriate conduct. For example, at some universities, faculty may consult for one day per week (Dialogue: Disclosure of conflicts of interest, 1985:38; see also Cherniavsky, 1985:103).

Blumenthal et al. (1987) support this assertion, reporting that more than 43 percent of chemists and engineers receive some research support from industry, as compared with 23 percent in biology-related fields (where the tradition of applied research is less developed). Thus, in applied fields, associations with external organizations are more common and also more likely to be subject to established procedures and protocols.

Even in fields with long-standing environmental ties, changes in relationships are evident. Government funding for applied research, particularly in defense-related areas, has grown (Ballantyne, 1986:12; Bortnick, 1986:240). As an example, computer science has always had strong support from external organizations, both governmental and industrial, and secrecy for the sake of industrial sponsors is common. Cryptography, however, has come under increasing scrutiny by the federal government because of its defense-related applications (Bok,1982:38). Cherniavsky chronicles a particular cryptology research group's interaction with the National Security Agency (Cherniavsky, 1985). In its efforts to maintain the secrecy of research results, NSA has several control mechanisms at its disposal, including the Invention Secrecy Act, the International Traffic in Arms Regulations, and the Export Administration Regulations. In this research group's case, NSA did not substantially alter either the funding or the direction of cryptology research projects; however Cherniavsky reports, "Members of the research group who were active during the 1975-1978

controversy recall that they were 'chilled' in their research efforts. They believed that actual imposition of controls would have forced them to give up research in cryptology at their university, although such research could have been done off campus" (Cherniavsky, 1985:101). With the advent of the Strategic Defense Initiative, the federal government has an even greater interest in applied research and in controls over the dissemination of research findings (Bortnick, 1986:240; Abrahamson, 1986; Ballantyne, 1986).

Thus, even in applied fields, where faculty have considerable experience managing relationships with external organizations, new developments bring more opportunities for control over faculty work. It is not surprising, then, that "pure research" fields which are establishing new linkages with outside groups confront critical issues in the management of cooperative ventures. Many pure areas maintain only modest, primarily academic relations with organizations in their environments. In other areas, however, faculty whose past work was motivated by curiosity and the drive for new knowledge suddenly find themselves courted by a variety of external constituencies whose interests are not purely intellectual. The most obvious case here is microbiology with its explosion of commercially valuable research: "And in the mid-1970s, just when public skepticism of the economic value of basic science was growing and the center of gravity of innovation in fields such as computers and microelectronics had clearly shifted to industry, biotechnology came along. This new field appeared as uniquely the product of a sustained national investment in the esoteric and seemingly 'useless' field of molecular biology, an investment made almost entirely in academic or government laboratories" (Brooks, 1988:50-51). Now, a field that formerly was marked by

"extreme openness" has become "the most secretive of all biological sciences today" (Alexander Faberge, quoted in Chubin, 1985:77).

Hard paradigm versus soft paradigm. Biglan's use of the term "paradigm" derives from Kuhn's analysis of the development of disciplinary fields (Biglan, 1973a, 1973b; Kuhn, 1962). He explains, "By 'paradigm' Kuhn refers to a body of theory which is subscribed to by all members of the field. The paradigm serves an important organizing function; it provides a consistent account of most of the phenomena of interest in the area and, at the same time, serves to define those problems which require further research. Thus, fields that have a single paradigm will be characterized by greater consensus about content and method than will fields lacking a paradigm" (Biglan, 1973a:201-202). Mathematics and agronomy are hard-paradigm fields; psychology and philosophy are soft-paradigm fields. Researchers in hard paradigm areas are more likely to have studied topics in a curricular canon, to share basic assumptions about their work, to collaborate, and to share common definitions of technical terms. Soft paradigm fields are more likely to be characterized by idiosyncratic methodologies and project-specific terminology.

Research in hard paradigm fields may be subject to the observation that what is more easily defined is more easily regulated. Staffs of agencies which fund or regulate research in the sciences are likely to "speak the same language" as academic researchers. Consequently, appropriate behavior and standards of research conduct are more easily codified in hard paradigm disciplines.

For the present discussion, the most interesting difference between hard and soft paradigm fields has to do with varying degrees of collaboration (Fox and

Faver, 1984:350). The enormous differences in background and training exhibited by researchers within a single soft-paradigm field such as art history often preclude collaboration. The solitary scholar doing research on Picasso's cubist period is not likely to be subject to extensive institutional control. By contrast, cooperative work is the norm in many hard-paradigm fields such as physics. In particular, student involvement in sponsored research projects is more likely in hard paradigm areas. In a study of graduate student participation in sponsored research projects in the social and natural sciences, Teague found that natural science students are more likely to be involved in projects related to their career interests, to use data from their projects for their own dissertation research, to author or co-author papers derived from these projects, and to present papers at professional conferences based on their research (Teague, 1982:139). Student participation can complicate arrangements with commercial firms in terms of both time constraints (Smith, 1984:25) and secrecy: "The burden of maintaining a teaching program and two separate research programs, where the results of one research program are to be widely disseminated and the results of the other may have to be kept secret in the pursuit of commercial success, is more than even the most responsible faculty member can be expected to shoulder" (Giamatti, 1982:1279). Collaboration can also create problems when the research is government-funded and possibly sensitive and when the students involved are foreign nationals (Park, 1986).

Life versus non-life. The clearest example of differences between life and non-life fields in issues of faculty-institution interaction is the development of human subjects regulations. Standards of appropriate conduct for research on humans are developed by individual institutions as well as by disciplinary

associations. In nursing and other health care disciplines, for example, ethical codes and guidelines evolved from the Nuremberg Code and the Declaration of Helsinki (Cassidy and Oddi, 1986:343). The American Psychological Association's code on ethical principles, first published in 1973 but revised since (Baumrind, 1985:165; Adair et al., 1985:61), is a frequently cited standard for research on human subjects. Such guidelines typically address a wide range of issues such as informed consent, coercion, permission to withdraw, deception, debriefing, confidentiality, and reporting of results (Adair et al. 1985; Baumrind, 1985; Cassidy and Oddi, 1986; Dutton, 1987; Garfield, 1987; Gordon, 1983; Robinson and Gross, 1986).

With regard to faculty conduct in research with human subjects, the primary control mechanism is the university's Institutional Review Board: "Every organization that does any research sponsored by the federal government must have an IRB. The IRB must approve almost all research using human participants in that university, not just research by faculty members under a federal grant. Research found to be unethical can be stopped" (Korn, 1988:76).

Another distinction between life and non-life fields is their susceptibility to influence by animal rights activists as discussed above. Faculty who study animals appear to be less likely to be affected than those who use animals to study other things.

Finally, research in biotechnology has been forever changed by the Supreme Court's decision in the case of Diamond v. Chakrabarty. The Court ruled:

> that human-made, genetically-engineered bacteria constituted patentable subject material. In fact, the Court ruled that patentable material includes "anything under the sun that is made by man."

> Following this logic, in September 1985 the U.S. Board of Patent Appeals and Interferences in its Ex parte Hibberd decision ruled that plants are patentable subject matter.... Parts of plants --- for example, roots, tubers, leaves, fruits, flowers, and seeds --- can be separately protected as can novel life forms, chemicals, and biotechnical processes of importance, and specific strains of microorganisms for conducting fermentation (Buttel and Belsky, 1987:39-40).

These developments opened the way for life disciplines to benefit financially from research in ways previously restricted to non-life fields.

It is interesting to note that, if the number of articles is of any real interest, that the greatest professional concerns about the need to regulate faculty behavior appear to be in the Biglan cell that is characterized as "pure"/"soft"/"life", e.g., basic theoretical psychology. Perhaps the reason for the level of controversy is the involvement of humans and animals in research where the connection between results and near term improvements in human welfare is difficult to assess. Thus, the concerns of both researchers and the general public about the ethics of informed consent and animal care are particularly salient.

THEORIES OF ORGANIZATION-ENVIRONMENT INTERACTION

We have examined change in the faculty-institution relationship across different kinds of external agents and across academic disciplines. We now turn to characteristics of the relationship between academic research and environmental actors. Two perspectives of organizations and their environments inform our discussion: resource-dependence theory and institutional theory.

Resource-Dependence Theory. Some aspects of change in institutions' influence on faculty research can be thought of in terms of resource-dependence theory as developed by Jeffrey Pfeffer and Gerald Salancik (1978). The basic premiss of the theory is that organizations are not self-sufficient but need to acquire resources from their environments to survive. The central problem for any organization and the key to its persistence is then the management of relations with critical actors in its environment. An external group is critical to the extent that it supplies resources which are both important to the organization and difficult or impossible to obtain from other sources. Interdependencies are problematic because they are subject to uncertainty and ambiguity. In consequence, interdependent organizations employ a variety of approaches to increase their control over elements in their environments, thereby reducing uncertainty as well as their dependence on external groups. As Pfeffer and Salancik put it, "The typical solution to problems of interdependence and uncertainty involves increasing coordination, which means increasing the mutual control over each others' activities, or, in other words, increasing the behavioral interdependence of the social actors" (Pfeffer and Salancik, 1978:43).

As an example, it is helpful to think of the relationships between industry and academic research in terms of interdependencies (Shenhav, 1986; Ruscio, 1984). Industry's primary interest in universities is their supply of an educated work force. This fact explains industry's traditional support of higher education through such mechanisms as philanthropic donations, internships for students, and participation in disciplinary advisory boards. In industries with research-intensive technologies, it behooves corporations to maintain good relationships with individual faculty members and departments in order

to ensure an adequate flow of highly-trained students. Increasingly in recent years, industry's funding of graduate study has supplemented more traditional forms of support. Moreover, the increase in commercial value of university research has broadened industry's interest in faculty work, potentially increasing both university-industry interaction and interdependence. On industry's side, one mechanism by which organizations seek to moderate their dependence is by obtaining ownership of research results. On the university's side, strategic mechanisms for tempering industry's influence include maintaining diversity in external funding sources and approaching university-industry linkages with enough caution that overall industry support remains a relatively small proportion of funding for academic research.

Virtually all of the mechanisms discussed by Pfeffer and Salancik through which organizations attempt to increase their own discretion and contain the influence of others (Pfeffer and Salancik, 1978:92-111), are in evidence in the changing faculty-institution relationship. We consider cooptation as an illustration. A funding agency of the federal government, whose initial role in relation to a research group or university may be that of critical assessor, may turn into a vocal advocate of the group or project. For example, in the cryptology case discussed above (Cherniavsky, 1985), the National Science Foundation provided strong and effective support for the researchers involved when their work became the object of National Security Agency scrutiny. Establishing good relations with people in high places, and in particular bringing them to the point of defending one's own position, can thus deflect interference from other groups. As a second example, the above-cited case of community concern about Harvard's recombinant DNA facility resulted in

community citizens' appointment to an oversight board (Krimsky, . 36). Such a strategy draws people into formal discussions in ways that encourage controlled opposition while at the same time setting the stage for developing friendships within an opposing group. Interestingly, the more traditional legal route taken in the other two cases presented by Krimsky failed to support the right to unmonitored scientific investigation.

Another aspect of resource-dependence theory which can inform the discussion of external influence is its perspective on organizational structure. Two characteristics are relevant here. First, organizations with relatively permeable boundaries are more likely to have critical interactions with external groups <u>without</u> proportional increases in control by those groups. Since universities interact with environmental elements at levels and in departments virtually throughout, there are many possibilities for "letting in" sources of influence. Boundary permeability works both ways, however. To the extent that university faculty are only "partially included" (Pfeffer and Salancik, 1978:29-32) in the institution, they do not represent their university in the same way that, for instance, a corporate executive represents the corporation. Through independent arrangements with external groups, faculty manage semi-autonomous research enterprises. Environmental groups are therefore often not able to influence academic research through well-defined bureaucratic mechanisms beyond those researchers with whom they have established links. The second aspect of university organization which diminishes the potential for external control is the loosely-coupled nature of the academic enterprise. To the extent that research in one department has essentially no relation to research in some other department, internal loose

coupling confines external influence to specific subgroups within the university.

A final illustration of the relevance of resource-dependency models to changing faculty-institution relations is the effect of research universities' customary approach to controlling their faculties' behavior. The focus of most university regulations relating to faculty is on detection and punishment, rather than prevention, of faculty misbehavior. As Sechrest has noted, universities tend to fall back on facets of faculty self-regulation such as peer review, reporting of inappropriate behavior, and socialization (Sechrest, 1987). They neither closely monitor the actual work of academic researchers (so as to prevent internal erosion of the academic ethic) nor offer significant opposition at the institutional level to external agents who would control faculty behavior (Steneck, 1984). In terms of resource dependency, there are two consequences of this rigidity of approach. First, standard responses in keeping with academic tradition release the university from the responsibility of responding to each challenge. As Rosenzweig puts it, "But I'm not sure how many universities want to make the effort to find out how individual faculty members are behaving. And on the whole I think they are right. If you go about the business of learning the way people behave you are under obligation to do something about it" (Robert Rosenzweig, quoted in Lepkowski, 1984:11). This approach may frustrate attempts by would-be influencers to change either faculty behavior or institutional response. Second, the approach may reduce universities' discretion in dealing with agencies or organizations which have legitimate interests in insuring compliance with specific regulations. Universities' reluctance to do more than they do at present or to adopt different kinds of procedures may, for example, encourage

funding agencies or corporations to initiate other kinds of controls in their contractual arrangements.

Institutional theories. While the resource-dependency perspective illuminates many aspects of the changing context of academic work, there are some aspects that can be better explained with reference to the set of organizational theories known collectively as institutional theories (Scott, 1987). We choose to focus on two particular aspects of the present discussion in light of institutional theories: the effects of the institutional environment and the development of buffering organizations.

Institutional theories often focus on the organization's interaction with its environment. The external environment is understood as a source of normative assumptions about and constraints on the organization's activities: "... the environment is conceptualized in terms of understandings and expectations of appropriate organizational form and behavior that are shared by members of society.... Such normative understandings constitute the institutional environment of organizations" (Tolbert, 1985). As resources are the currency of interest in the resource-dependency perspective, so legitimacy is the currency in institutional theories. Support necessary for organizational survival flows to organizations which are able to satisfy the demands of external actors. Successful organizations achieve legitimacy either by genuine adaptation or by establishing structures which both conform to external expectations and shield core technologies from external scrutiny (Meyer and Rowan, 1977).

Organizations vary in the degree of articulation of their institutional environments. Universities generally operate in highly institutionalized environments; that is, there are widely-held assumptions about what constitutes appropriate activity for a university. The cost of change is higher for an organization which must satisfy the members of diverse, external constituencies. That is, if support is to flow to a university in part because it maintains consonance with established expectations about its mission and appropriate activities, it is more difficult to accomplish change. A university may, for example, find it less "costly" in the currency of legitimacy to continue to portray itself to the state legislature as the educator of the young (with all the normative assumptions that role involves), even as its research activity leads it into the world of lucrative patents and commercial-like enterprises.

Thus it appears that most universities adopt strategies of symbolic responses in order to cope with increasingly heterogeneous environments. For example, only a handful of research universities have adopted policies that demand that faculty discuss potential conflicts of interest prior to entering into a research or consulting relationships with an outside agency, although most have a policy that covers such conflict of interest situations (Louis et al., 1988). As more and more actors enter the research context, normative pressures can become incompatible or even mutually contradictory, but the appearance of response may be more important than actual change, particularly if one constituency can be satisfied by a symbolic response without activating opposition from another source.

The university may also seek to maintain its legitimacy in the eyes of critical external constituencies by controlling the definition of work which is appropriate for it to do. It can do so either by demonstrating the essential compatibility of current research directions with traditional university activity or by attempting to expand generally held conceptions about what constitutes appropriate research at a university. Insofar as university administrators have issued major public statements about the changing institutional pressures on university faculty, and the need for university response, most have been of the first type --- for example, the Parejo Dunes Conference in 1984, at which several major university presidents articulated common concerns about the erosion of basic "norms of science" and academic ethic through increasing relationships with industry (Culliton, 1983). Nevertheless, what has been more notable is the lack of major institutional statements regarding the changing nature of academic research. If we compare universities to corporations, for example, we would expect much more public announcements of the way in which the institution expects to respond to its changing environment (Hearn, 1988). We are, therefore, drawn to the conclusion that the university, as an institution, is somewhat reluctant to confront these issues directly, but prefers to use more indirect mechanisms.

One indirect mechanism is the development of external "buffer institutions" (Fink, 1985). As noted above, one way an organization can preserve its sustaining relationship with external elem[illegible] is to develop structures which conform to the institutional environment while protecting its core activities from external interference (Meyer and Rowan, 1977). As an example, Fink (1985) describes one kind of buffer institution which provides a means for universities to participate in nontraditional forms of cooperation in research

or development activities. He argues that there are three institutional actors in the arena --- industry , government and the university --- and that it is important to establish independent agencies that can mediate the different interests of each. By helping to establish structures which distance innovative ventures from core academic activities, universities can moderate accusations that they are participating in inappropriate initiatives and states and industry can protect themselves from accusations that they are attempting to exert unwarranted influence on academe. At the same time, the work done in these buffer institutions is a potential basis for future "legitimacy enhancement", particularly if innovative outcomes come to have a substantial impact on regional economic development.

Another kind of buffer institution that has been established by many universities is the research foundation. Modeled after the Wisconsin Alumni Research Foundation, which was established to administer a lucrative patent acquired by the University of Wisconsin, the purpose of these buffering institutions is to take the "profit-making activities" associated with applied research out of the heart of the university, while retaining the potential financial benefits. While not uncontroversial, these buffering institutions have been much less criticized than other university strategies to invest in and profit from faculty research.

A final type of buffering agency that is becoming increasingly important is the national scientific board. The National Academy of Sciences, for example, was recently asked by the Biotechnology Science Coordinating Committee (a joint committee of agencies that review field tests of new organisms) to draw up guidelines for considering proposed field tests (Wheeler, 1989). In this

case, as in others using intermediary professional bodies, an independent agency acts as a mediator between federal government and university (and indirectly, the general public) to ensure that an appropriate balance is maintained between autonomy and accountability. Because of the high prestige of associations such as the National Institutes of Medicine of the National Academy of Sciences, this mediating role helps to create consensus while maintaining the legitimacy of the scholarly enterprise. It is also, notably, within the tradition of permitting scholars to govern their own conduct, since such boards are comprised largely of eminent academics.

CONCLUSION

Our review of the literature on current directions in academic research leads us to conclude that (1) significant changes in the faculty-institution relationship are occurring; (2) increasingly complex arrangements with external groups make control of faculty behavior more problematic; (3) as research relationships come to have the character of governmental or corporate contracts, the special norms of autonomy and self-regulation which have distinguished academic work in the past tend to have less certain status.

One implication of this review is that the academic appointment in years to come is likely to differ substantially from the traditional scholarly role (Hackett, 1988). In light of the projected need for replacements for a large proportion of the current professoriate, due to a large retirement-age cohort, changes in the academic environment raise questions about the attractiveness of academic careers (Brooks, 1988). One of the primary compensations for traditionally low wages in academia has been autonomy in research and

teaching. Should this autonomy be compromised by increased controls over faculty behavior, universities may be forced to find other ways to attract young scholars.

No matter what changes emerge in the nature of academic work, it is clear that university research will be increasingly related to elements in the environment. The ivory tower's doors are wide. open and its stairs are congested with the comings and goings of professors and their external constituents.

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