The Impacts of Owning Private Companies on University Faculty: The Experiences of Biotechnology Faculty and University Administrators in One University

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(ABSTRACT)

It has recently become rather common for life science faculty to own a private company related to university research, an extreme form of entrepreneurial activity. Yet our understanding of how this changes the experiences of the entrepreneurial scientists and administrators is limited. This thesis, based primarily on in-depth interviews with three entrepreneurial biotechnology faculty, their graduate students and employees, their department heads, and university-level administrators, reveals how scientists and administrators are responding to conflicts and others' perceptions of conflict arising from their entrepreneurial activity. The faculty and administrators organize these conflicts into five categories: issues which they consider to be genuine conflicts but do not act upon; issues which they consider to be genuine conflicts and do act upon; issues which they do not consider to pose genuine conflicts but which they act upon because others perceive those issues to be conflicts; issues which they consider to be conflicts but which none of the principals expect to be experienced at their particular university; and issues which they do not consider to raise genuine conflicts whether experienced at their university or elsewhere. This thesis also shows how entrepreneurial faculty are incorporating business into their teaching and are altering their interactions with academic peers and graduate students all due to their entrepreneurial activity.

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INTRODUCTION

A rapid shift occurred in the field of biology from 1971 to 1976. With the advent of recombinant DNA, biological research suddenly had immense commercial potential and was, therefore, of great interest to industry. Venture capitalists and investors were quick to embrace the opportunities presented by this emerging field of biology, christened biotechnology by Wall Street (Teitelman 1989).

Definitions of biotechnology vary, but all emphasize methods. Teitelman (1989, 4) defines it as "a set of techniques, or tools." Geiger (1993, 301) offers, "[b]iotechnology, most simply, is the applied science of molecular biology." One professor interviewed for this study defines biotechnology as molecular biology combined with business, for without business you don't have biotechnology (Gilmore 1997a). For my purposes, I shall define biotechnology as research and development which utilizes at least one of two methods: use of recombinant DNA or monoclonal antibodies.

In 1973, Herbert Boyer of the University of California, San Francisco and Stanley Cohen of Stanford University successfully transferred pieces of genetic material, DNA, from one species of bacteria to another. Within the transformed organism, the foreign DNA maintained its original function, the production of a protein foreign to the transformed organism. The foreign DNA was replicated and passed on to progeny during cell division. The DNA of the transformed organism was termed recombinant DNA, and the technique recombinant DNA technology.

The second technique which revolutionized molecular biology involves antibodies. In 1975, Georges Köhler and Cesar Milstein at the Medical Research Council Laboratory of Molecular Biology in Cambridge began studying mutations in genes for antibodies. However, at the time, it was incredibly difficult to purify large amounts of only one antibody. By taking cells which produce antibodies and fusing them with cancerous cells (forming a hybridoma), Köhler and Milstein successfully isolated large amounts of monoclonal antibodies. These monoclonal antibodies could now be used to develop diagnostic products as well as in further research.

The first company devoted entirely to this new field of biotechnology was Genentech, founded in 1976 by Robert Swanson, a venture capitalist, and Herbert Boyer. The biotechnology industry grew rapidly; 112 new companies were founded in 1987 alone (Lee and Burrill 1995, 43). As exemplified by Genentech, university faculty participated in the founding of all of the early biotechnology companies, and many of the more recent ones. Most frequently, the faculty entrepreneur remained a faculty member while simultaneously participating in running a company.

Faculty retaining their university position while owning a private company are much more common in biotechnology than in other fields (Krimsky *et al.* 1991). Many have

expressed concerns over the this closeness and the frequency of industry-university relationships, as a result of the commercial potential of biotechnology. A number of potential conflicts - for instance, between universities and companies or between "entrepreneurial" faculty and universities - have been cited in books, journal articles, newspapers, and magazines. However, there have been few in-depth studies of the nature of these conflicts, particularly conflicts in which the entrepreneurial faculty are caught, or of other impacts of entrepreneurial activity.

This thesis will explore the experiences of university administrators and entrepreneurial faculty (all located at one university) relating to academic researchers who have started private biotechnology companies while remaining in the university. I will examine the experiences of the entrepreneurial faculty and administrators and how these differ from each other and the "stereotypical" view. This stereotypical view presents the following issues as problems stemming from entrepreneurial activity: conflicts involving only financial interests; conflicts involving student interests; conflicts of commitment (reduced time spent teaching, mentoring, and conducting administrative duties); research interests being directed more towards applied topics; and obstruction of the open exchange of scientific information and materials. I shall analyze which issues the entrepreneurial faculty and administrators find to be genuine conflicts, which they find not to be conflicts, and which they must address because others believe them to be conflicts even if the faculty or administrators do not. I will argue that the stereotypical view, the views of the administrators, and those of the entrepreneurial faculty all differ. I will show that, at this institution, the administrators give virtually no official guidance. I will also explore how the entrepreneurial activity of three life science faculty, specifically owning a company, located at one university has impacted their experiences in their teaching and in their interactions with other academic researchers and graduate students.

The structure of the thesis is as follows. In Chapter One, I will provide a brief overview of the history of university-industry relationships in the United States showing how the nature and frequency of these relationships have changed, particularly in the life sciences. I will also detail the commonly presented view of the potential problems involved in entrepreneurial activity in the university. I will review the literature contributing to the theoretical framework of this thesis in Chapter Two. The literature emphasizes the impact of change in the social environment on institutional structure and individual experiences. In Chapter Three, I will analyze the view of administrators regarding conflicts. In Chapter Four, I will explore the experiences of the entrepreneurial faculty regarding conflicts and their resolution and the affects of entrepreneurship on their teaching and their interactions with peers and students. I will present my conclusions and suggestions for further research in Chapter Five. I believe the impacts of the entrepreneurial activities of faculty members who own private companies have been significant. Without detailed examination of the changes occurring at the level of individuals, we lack an understanding of how significant these impacts are.

CHAPTER ONE: UNIVERSITY-INDUSTRY RELATIONSHIPS: THE STEREOTYPICAL VIEW

Relationships between universities and industry are not new. Since the early 1900s, industrial firms in the US have supported education through fellowships and turned to university scientists to conduct research on specified subjects (Noble 1977; Servos 1980; Swann 1988). In Germany, university-industry interactions in the field of chemistry date back to the early nineteenth century (Etzkowitz 1983; Haber 1958). So why has all this fuss been raised over the recent university-industry interactions in the field of biology?

In this chapter, I will outline the history of university-industry relationships (focusing on the US).[1] Through an examination of this history, I will proffer an explanation for the great concern these topics are generating now. The major point is that these relationships between industries and universities have changed qualitatively and quantitatively, especially those involving the start-up of a firm by a faculty member.[2] As a consequence of these new forms of university-industry relationships, faculty who have founded a private company are experiencing a profound shift in their social environment. I will also present the stereotypical view of the conflicts presented by university-industry relationships.

1.1 The Nineteenth and Early Twentieth Centuries (1800-1915)

Higher education teaching institutions began in the US with Harvard College in 1636 and consisted entirely of instructional institutions until the 1850s (Geiger 1990). Furthermore, the education received at these colleges was classical training; very little emphasis was devoted to "practical subjects" (Geiger 1986, 4). Until universities engaged in research and in practical instruction, there could be no university-industry interactions in the US.

Students themselves pushed for instruction in practical subjects. Through the elective system in which students could choose their own courses, students began to emphasize subjects with "practical utility" such as engineering or agriculture (Geiger 1986). In 1862, Congress passed the Morrill Land Grant Act. This authorized that large tracts of federal land would be given to each state for a college in which agriculture and "mechanic arts" would be taught along with liberal subjects (Geiger 1990). The Morrill Act contributed greatly to the idea that American higher educational institutions should include education in practical, applied subjects, subjects of interest to industry.

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[1]For this early history of university-industry relationships (1880-1970), I will be drawing mainly on Geiger (1986, 1990, 1992, 1993) and Etzkowitz (1983).

[2]As stated in n.1, I am relying principally on secondary, not primary sources. Nor will this be a complete history by any means; several events will be skipped over in favor of concisely illustrating the differences between university-industry interactions in the biological sciences since the 1980s and university-industry interactions in the late nineteenth and the twentieth centuries.

However, it was not until the founding of Johns Hopkins University in 1876 that research was recognized as a significant role of American universities (Geiger 1986). Yet, even though Johns Hopkins awarded almost as many Ph.D.s as both Yale and Harvard by 1889, it remained small (Geiger 1990).

Nevertheless, other universities quickly followed in the research footsteps of Johns Hopkins University (Geiger 1990). For example, Clark University (1889) opened as a graduate institution, and Stanford University (1891) offered graduate education. The President of Harvard, Charles Eliot, also established a graduate department, though it did not offer separate graduate courses. Eventually, Harvard College and the Lawrence Scientific School merged. The merged entity, the Faculty of Arts and Sciences, took charge of the Graduate School in 1890. Now, courses specifically designed for graduate students were offered.

With the incorporation of research into American universities, industry began to draw on that research expertise. One of the first consulting firms formed by individuals associated with a university was the Arthur D. Little Company, founded in 1886 and located near the Massachusetts Institute of Technology (MIT). The Arthur D. Little Company hired numerous teachers from MIT, who retained their university positions, as consultants for the company.

The relationship between MIT and the Arthur D. Little Company was particularly strong (Etzkowitz and Peters 1991, 138-139). Little offered lectures at MIT from 1893 to 1916. William Walker worked for both the company and MIT from 1900 to 1905 later becoming a full-time faculty member at MIT and director of the applied chemistry laboratory in 1908. The company even changed location when MIT moved in order to remain close to the school and the numerous consultants there.

Similarly, a need for a close relationship with university researchers was established with the formation of industrial research laboratories, most notably General Electric in 1900, DuPont in 1902, AT&T in 1907, and American Cyanamid and Eastman Kodak in 1912 (Geiger 1986; 1992). Initially, the companies desired only well-trained employees establishing fellowships for graduate student support (Noble 1977; Geiger 1992). To this end, individuals associated with the engineering industry, both university professors and company managers, sought educational reforms to better train future employees (Noble 1977). However, within the next two decades, industry would also be seeking contract research from university scientists.

1.2 From World War I to World War II (1916-1945)

With the advent of World War I, the importance of research to industry was cemented. The National Research Council (NRC), founded in 1916, was mandated to "coordinate the scientific resources of the entire country and secure cooperation of all

agencies, governmental, educational, and industrial, in which research facilities are available" (quoted in Geiger 1986, 96-97). However, according to the NRC, the support of research was still not a responsibility of government. Thus, the NRC actively encouraged relationships between universities and industry, particularly relationships in which industry funded university research.

The huge private philanthropic institutions, particularly the Carnegie Corporation and the Rockefeller Foundation, also began to support scientific research directly in the university at this time through grants to the universities or university researchers. This was not the first time Andrew Carnegie and John D. Rockefeller had supported scientific research. Both had established research institutes, the Carnegie Institution of Washington (CIW) in 1902 and the Rockefeller Institute of Medical Research in 1901 (Geiger 1986). Further, the CIW had given grants to research institutes which were often affiliated with universities. The general philanthropic foundations which gave funds directly to universities, the Carnegie Corporation and the Rockefeller Foundation, were founded in 1911 and 1913, respectively. Soon, these private foundations directly funded much of American scientific research in the universities.[3]

Scientific research in the university was also supported by industry at this time. These relationships were largely one of two types: either individual consulting or work in university research laboratories (Geiger 1992). As seen earlier, corporations began to make use of faculty expertise with the Arthur D. Little Company in the late 1800s. These types of relationships increased in number in the 1920s and 1930s. Corporations realized the value of access to advanced research, research which was taking place in the university.

Special university research laboratories which performed contract research for industry served as the second form of university-industry interaction. MIT was one of the first to exploit this type of relationship: it established the Research Laboratory of Applied Chemistry in 1908 (Servos 1980). The Department of Engineering Research at the University of Michigan was one of the most prosperous, earning $300,000 for contract research in 1929-1930 (cited in Geiger 1992, 269). Generally, as industries expanded their in-house research laboratories, these early university research laboratories were no longer needed (Geiger 1992). Consulting relationships, however, continued to grow.

Geiger (1992, 270) argues that by World War II, the relationships between universities and industry had the following characteristics. First, university research had become essential to industry research. Second, university-industry relationships readily emerged in fields where there was overlap in the interests of universities and industry, particularly engineering, chemistry, medicine, and business. Third, universities capitalized on the potential of these relationships. Finally, "despite multiplying links, there existed a strong

[3]For a much more detailed history of the Rockefeller's funding of university research, particularly research in the physical sciences which had applications in the biological sciences, see Abir-Am (1982, 1984), Bartels (1984), Fuerst (1984), Kohler (1976, 1979), Olby (1984), Staley (1995), Yoxen (1984), and Zallen (1992). For more on the history of Carnegie's philanthropy, see Lester (1941).

sense of the appropriateness of keeping academic and commercial activities separate" (Geiger 1992, 270). Thus, university-industry relationships were plentiful and bountiful, but the line between the university and the company was rather sharply drawn.

1.3 The Rise of Federal Support for Academic Research (1945-1968)

Academic science demonstrated its importance to the federal government during World War II. Up until this time, apart from land-grant funds devoted to agricultural research stations, the federal government did not support research in the university. After World War II, the federal government dominated support of research in the university. Most of the research support for individual scientists came from the Office of Naval Research (ONR), the Public Health Service particularly through the National Institutes of Health, and the Atomic Energy Commission (Geiger 1993). Until the 1950s, most federally funded basic research was supported by the ONR which was established in 1946 (Dupree 1964). Eventually, ONR's contribution was surpassed by that of the National Science Foundation (NSF), the governmental institution for support of scientific research championed by Vannevar Bush in 1945 in *Science -- The Endless Frontier*. Although suggested shortly after the end of World War II, because of inaction by Congress the NSF was not legislatively authorized until 1950.

For the next two decades, federal funding was the dominant source of funding for scientific research. Industry funding did not disappear. However, in 1954 total federal funding of university research was $141.7 million (out of a total research budget of $205.5 million) while industry contributed only $18.6 million (Geiger 1990, 21).

The percentage of federal contribution to research increased through the height of the Cold War. Federal support of university research reached 53 percent in 1953 and then increased to 63 percent in 1960 to a high of 74 percent in 1966; meanwhile funding provided by industry and other private sources decreased to a low of 8.7 percent in 1967-1969 (Geiger 1990, 27). Funding was not just for research; the federal government also intensively supported the development of the research infrastructure. Federal funds were used for approximately one-third of all capital expenditures of universities by 1968 (Geiger 1990, 26). However, beginning in the 1970s, the percentage of funding from federal sources began to decrease while contributions from industry increased.

1.4 The End of Growth (1968-1977)

In constant dollars, university research expenditures remained stable in this decade. Universities thus underwent a decade of declining support.[4] The proportion of university research funded by federal sources decreased to 67 percent by 1976 (Geiger 1990, 27). Furthermore, although federal agencies increased the total amount of funds supporting research, support of activities which would enable the universities to expand research

[4]Geiger (1990) labels this the "Stagnant Decade."

capabilities, infrastructure support, was diminished. Universities, and university faculty who had relied extensively on federal funding for several decades, again began to change their attitudes concerning industry funding; because of the shifting of available federal support, more scientists were willing to accept industry support (Geiger 1992). In addition, federal policy began, once again, to champion university-industry relationships.

In the early 1970s, the federal government began investigating the issue of how university knowledge could contribute to economic development. In 1972, President Nixon asked the NSF and the National Bureau of Standards to examine ways of encouraging industrial support of research and development and collaborations between industry, universities, and government agencies (Reams 1986). A study conducted by the Carter administration stated that the results of federally funded university research could contribute much more to economic development (Reams 1986). By the beginning of the 1980s, legislation was passed which was designed to foster the above goals. The Stevenson-Wydler and The Uniform Federal Patent Policy Acts of 1980 mandated that patent rights resulting from federally funded research would be granted to the university. This would establish financial incentives for the university to transfer the technology to private industry. The Small Business Innovation Development Act of 1982 required that federal agencies which spend more than $100 million per year give 1.25 percent of their budget to research conducted by small businesses.

1.5 The Rise of Biotechnology (1976-Present)[5]

Within this milieu, biotechnology was born. Researchers in biology, for the most part, had always relied upon federal sources for support.[6] However, as Geiger (1993, 301) argues, with the advent of biotechnology,

> [n]ot only did expanded research activities in this field by chemical and pharmaceutical companies add greatly to the volume of industry-sponsored academic research, but scientific breakthroughs also led to a transformation in university attitudes toward these links.

In 1976, Genentech became the first company devoted exclusively to biotechnology. Researchers at Genentech successfully isolated the human insulin gene within two years of the company's formation, beating several academic research teams in the process. Genentech made its initial public offering on October 14, 1980. The initial price was $35 per share. The price rose to $89 shortly after trading began and ended the day at $70. This demonstrated the immense commercial potential of biotechnology companies to venture capitalists and investors and also to universities and academic scientists.

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[5]For this most recent history of the biological sciences, I will be drawing largely on Geiger (1993) and Teitelman (1989).

[6]There are exceptions to this but, for the most part, university-industry relationships were found only in the fields of medicine and agriculture. For instance, pharmaceutical companies had consulting arrangements as far back as 1920s (Geiger 1986). Also, beginning in the nineteenth century, there have been numerous close relationships in agriculture between the food producers and agricultural researchers (Kenney 1986).

The number of biotechnology companies grew like wildfire, with about 200 founded between 1980 and 1984 (Geiger 1993). And with this, the number of academic scientists with industry connections also grew. Krimsky *et al.* (1991) estimate that 37% of life science faculty have some involvement(for example, consulting, membership on the Scientific Advisory Board, grants, or founder) with at least one private company. Like other university-industry interactions, these relationships were encouraged by federal policy. However, for biotechnology, a court ruling also played a role in encouraging university-industry interactions. In 1980, the Supreme Court in the case Chakrabarty v. Diamond ruled that living organisms could be patented. This created the opportunity to commercialize transgenic animals, animals which, through recombinant DNA techniques, contained foreign DNA in some or all of their cells.

The numerous close relationships with industry which had formed quite rapidly sparked great concern over university-industry ties, a concern which continues for many. The most distinctive of these activities was the founding of private companies by university scientists based on university research (also the activity deemed by many to be "the least compatible with a traditional view of the university scientist's role" (Louis *et al.* 1989, 113)). Again, companies started by university researchers are not new phenomena. The computer industry in Northern California consists largely of companies founded by researchers from Stanford University (Etzkowitz and Peters 1991). However, these researchers generally left the university either prior to starting the company or shortly after founding it. This was not the case in biotechnology. Here, academic researchers who founded companies generally also retained their university positions. As Etzkowitz (1983, 202) states, "[w]hat is distinctive about these firms is that they have been initiated with the active participation of scientists who hold academic appointments while they are participating in them."

A second distinctive aspect about these new university-industry relationships in biotechnology is the desire by academic scientists to profit from their work, or more crudely put, greed. Scientists have generally avoided profiting, or have sought no to be perceived as profiting, from their research. This attitude is exemplified by Pasteur who said to Napoleon III, "who asked him why he did not turn his discoveries to legitimate profit: 'In France scientists would consider they lowered themselves doing so' " (quoted in Etzkowitz 1983, 204). In contrast, one scientist interviewed for this study said in response to the question why did you start your company, "[t]o make money" (Gilmore 1997a). Another scientist, although not interviewed for this study, said, "a Ph.D. is not a vow of poverty." This blatant desire for profit has, fairly or unfairly, generated additional concern about university scientists forming or participating in private companies.

Biotechnology differs from other industries and research areas with respect to several other variables. Biotechnology requires a large initial investment. Because the goal is frequently a pharmaceutical product, the return on that investment often takes at least ten years. Furthermore, biotechnology, with its long time lag before generating a product, has

been viewed by the big, established companies as posing an extremely high risk. This limits the traditional areas of funding for start-up company research. In the amount of risk, time to final product, and the large amount of money needed to develop that first product, biotechnology stands apart from other industries supported by academic research.

1.6 Studies of Conflicts Arising from University-Industry Interactions

Much of the previous work examining entrepreneurial activity by faculty has been based on the notion that certain conflicts are inherent in these arrangements due to a clash between the two cultures, with their differing norms, of the university and private industry. These works typically characterize business as dominated by a search for profit and research in the university as being governed by the norms of science.

A common formulation of the mission of the university is the generation and dissemination of knowledge accomplished through scientific research, public service, and education. Robert Merton (1942) put forward what is probably the most famous formulation of the norms underlying scientific research, thereby portraying the "ideal" of university scientific research. Merton recognized four major norms. First, only impersonal criteria are used to judge research. The personal traits of the scientist are to be considered wholly separate from the research, reflecting the norm of universalism. Second, research results and materials are freely shared with other scientists, reflecting the norm of communality. The third norm is disinterestedness; research is pursued simply for the sake of knowledge. According to the fourth norm, organized skepticism, scientific work shall be scrutinized by peers to guarantee the quality of the research approach and conclusions. The duties of a university faculty member, consistent with the mission of the university, are research, teaching, university administrative service, and professional service (Fairweather 1989; Geiger 1986).

Mitroff (1974) proposed that the conduct of science involves counter-norms, which are in constant tension with Merton's proposed norms. For instance, the norm of communality is in tension with the norm that science should be treated as property until the researcher has derived satisfactory career advantages. Thus, open communication is constantly at odds with secrecy. The remaining norms likewise are in opposition to counter-norms. Although many of the studies concerning university-industry relationships do not take into consideration opposition to the Mertonian framework, it is important to emphasize that even if a distinct set of norms for scientific activity is assumed, the story is not simply confined to normative behavior and deviant behavior.

In contrast to the university, the mission of business is to make a profit and return a profit to investors. This entails secrecy and research which is directed at profitable products. Business emphasizes property rights. The framework of property and commons illustrates this emphasis. The idea of the commons descends from an area containing a resource to which everyone is allowed access, e.g., afield where everyone can graze sheep and cows. The

tragedy of the commons, most famously described by Hardin (1968), occurs when the resource is eventually depleted due to overuse. According to Hardin (1968, 1244), "freedom in the commons brings ruin to all."

By converting the commons to private property or by strictly enforcing use rights (fencing),the tragedy of the commons may be avoided (Hardin 1968; Hardin and Baden 1977). Thus, fencing, by physical or legal methods or by common understanding, is an attempt to conserve resources. Because individuals no longer have access to certain resources, a system of market exchange develops. Resources now must be allocated, which generates the motives for production (profit) and mechanisms for distribution and consumption.

Hardin's (1968) tragedy of the commons provides an idealized picture.[7] Nonetheless, the theory of the tragedy of the commons effectively illustrates the framework under which business is assumed to be operating: resources must be fenced in order to yield profit.

Several analyses of scientific practice strongly disagree with the idea of distinct scientific norms.[8] In this study, I will not assume that there are clear, discrete norms of scientific activity, whether those proposed by Merton or by others. I am also not making any judgments of right or wrong, deviations from norms or alternate norms. In the long run, some of the problems associated with entrepreneurial activity in the university may in fact stem from inappropriate distinctions of norms. For instance, as Hackett (1990) argues, norms, rather than being discrete and fixed in time, may vary along a spectrum with different positions being emphasized by different circumstances.

Nevertheless, even though much of the analysis of scientific practice now objects to Merton's characterization, it is still fair to say that many scientists and many of those who study scientific practice still maintain that these norms, or something quite like them, guide and should guide scientific practice.[9] Furthermore, even for those studies of entrepreneurial activity in the university which do not explicitly utilize the Mertonian framework, the questions are initially motivated by a discussion of the prima facie conflicts resulting from an apparent contrast between the culture of industry and that of the university. Thus, I will give a summary of this perspective. For this study, though, the most important issue turns out to be the *perception* of conflicts resulting from a clash between the *assumed* norms of science and industry, rather than deviations from norms of science.

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[7]For criticism of this simplified view, see Feeny *et al*. (1990).
[8]Work which strongly departs from this viewpoint of distinctive norms of science includes: Bloor (1991), Callon (1986), Gilbert and Mulkay (1984), Latour (1987), Latour and Woolgar (1986), Longino (1990), Lynch (1985), and Pickering (1992).
[9]For example, Anderson and Louis (1991), Bauer (1995a, b), Braxton (1986,1989), Kenney (1986), Nelsen (1991), Polanyi (discussed in Bauer 1995b), and Ziman (1994) all use Mertonian norms of science as their framework.

Potential Conflicts

When interpreted as the meeting of two disparate cultures, science(conducted in the university) and business, profound prima facie conflicts appear, resulting from the presumed institutionally-based divergences in norms, structures, and aims. The most obvious, and commonly cited, conflicts are as follows: conflicts involving primarily financial interests; conflicts involving student interests; conflicts of commitment (reduced time spent teaching, mentoring, and conducting administrative duties); research interests being directed more towards applied topics; and obstruction of the open exchange of scientific information and materials. As will be seen, a type of conflict can often be classified into more than one category. Examinations of the scope of these conflicts have focused largely on academic-industry relationships in the life sciences (e.g., Etzkowitz 1983; Kenney 1986; Kelley and Randolph 1994).

The framework of these conflicts does not assume any particular viewpoint, such as that of faculty member, student, or lay person. Instead, the following characterization of potential conflicts is the "stereotypical" view in that it assumes the clash between the cultures of the university and business, and it does not consider the perspective of entrepreneurial faculty regarding potential conflicts. This is not to say that only the perspectives of entrepreneurial faculty should be considered. However, along with the perspectives of administrators, non-entrepreneurial faculty, students, and the general public, the perspectives of entrepreneurial faculty should be incorporated into the framework.

Conflicts involving financial interests comprise a very broad category between numerous pairs of agents and with numerous possibilities, all of which derive "from the fact that nearly all of the biotechnology researchers have university appointments and yet work for and sometimes own substantial interests in companies that are commercializing biotechnological research" (Kenney 1986, 113). One potential conflict between the financial interests of the university and those of a entrepreneurial researcher and the company is the use of university resources for company work. One example of this conflict is the obvious: defrauding the university. A second, related example, is the improper transfer of a patentable invention from the university to industry. The university has a legal claim to any inventions developed using university funds or equipment while the inventor is working for the university. However, when the inventor also has a considerable investment in a private corporation, the potential exists to claim that the invention was developed on company time using company facilities and, therefore, that the university has no right to it.

A second example of conflict involving financial interests is manifested in researcher bias, whether actual or simply perceived (Kelley and Randolph 1994). This conflict stems from a clash between the "ideal" of university scientific research, as delimited by the Mertonian norms of science, and the financial interests of the entrepreneurial researcher and the company. A researcher who has or receives interest in a company may be viewed as biased concerning any issue or debate which may affect the company's research, particularly

in proprietary interests. One area where this type of conflict is explicitly avoided by both researchers and companies is clinical trials, for "[s]uch conflicts, which could lead to loss of objectivity, are counterproductive for the company as well as the academic stature of the investigator" (Kelley and Randolph 1994, 213). However, where this type of conflict is thought to be less damaging to both the researcher and the company, efforts to avoid it may be unsuccessful.

A researcher who owns a substantial interest in a private company and acts as a consultant for that company and/or receives a research grant from that same company presents a third case of conflict involving financial interests, one which is becomingly increasingly prevalent. Here, the conflict can be viewed as being between the "ideal" of the university and the researcher as entrepreneur, for the entrepreneur must pursue profitable research, and the researcher's academic lab is certainly a source for innovations. Kenney (1986) provides several examples of this type. For instance, Herbert Boyer, the University of California, San Francisco professor who co-founded Genentech, also was awarded a directed research grant of $200,000 from Genentech. A University of California, Berkeley professor received $10,000 for consulting and a grant for $82,302 from Advanced Genetic Sciences while serving on that company's scientific board. Raymond Valentine, then a professor of agronomy and range science at University of California, Davis (UCD), assisted in forming a contract between UCD and the company Allied Chemical as well as forming his own private company, Calgene (Fox 1981a). Along with the extensive research contract with UCD, Allied Chemical also purchased 20% of Calgene. According to Valentine, a UCD Dean " 'felt this closed the circle between the university, Calgene, and Allied to the point where the research could be directed too much by the private side' " (quoted in Fox 1981a, 42). Unfortunately, Valentine also served a two-month appointment at UCD's agricultural experiment station as part of his university job. Any work at this station is to be open to the public, and researchers there are to provide free advice to local farmers as part of UCD's land-grant mission of assisting the local community. With his close ties to Allied Chemical and Calgene, Valentine was viewed as potentially not being able to discuss some of his work. In the end, Valentine resigned from the experiment station and took no part in any of the research contract with Allied Chemical.

Interpretations of conflict resulting from the differing norms and structures are also manifested in conflicts with student interests. The potential exists for faculty with substantial interests in a company to exploit students by using them as inexpensive labor or by using their ideas without proper credit, both conflicts between the career (and financial) interests of the student and the financial interests of the entrepreneur and company. Potential conflicts also exist in the form of delaying student publications due to proprietary interests or conflicting commercial relationships between faculty members on an advisory committee. Delaying student publications can be viewed as a conflict between the interests of the student and the financial interests of the university, as well as between the interests of the student and the financial interests of the company and entrepreneur. Conflicting commercial relationships impeding work on an advisory committee can be perceived as a

conflict between the interests of the student and the financial interests of the company and entrepreneur and can also be understood as a conflict between the interests of the researcher as entrepreneur and those of the researcher as faculty, for the entrepreneur needs to keep proprietary information secure yet must also continue to have students complete their studies.

The misuse of graduate students has been extensively examined at both UCD and Stanford (Kenney 1986). The Stanford Graduate Student Association discussed one case of a post-doctoral student (post-doc) at Stanford whose advisor discussed her project and the approaches she was taking with a company for which he was consulting. The company promptly devoted intensive attention and work to the problem and quickly solved it. The post-doc was consequently forced to abandon months of work and begin a new project (quoted in Kenney 1986, 118). This example also illustrates the potential drawbacks to the Mertonian scientific norm of open communication.

The case of Valentine at UCD illustrates conflicts with student interests as well (Kenney 1986). Students and post-docs argued vehemently that Valentine's company, Calgene, was allowed first access to all their ideas. Eventually, the graduate chairman recommended that Valentine not be allowed to advise any more graduate students until the issue had been satisfactorily resolved.

Fox (1981b, 40-41) describes a situation in which several post-docs expressed concern when a professor called for an "informal lab bull session," yet neglected to inform the post-docs that he had ties to a private company. The conflict need not be so blatant. Professors may find it difficult to separate ideas developed at the private lab from ideas developed at the university lab; "[i]nformation and ideas created by graduate students could thus flow to a professor's company, purposefully or inadvertently" (Kenney 1986, 120).

More subtle potential conflicts with student interests also exist. The position of a post-doc or a student is inherently transient. In order to move on successfully, particularly in an academic position, a demonstrated publication record is a necessity. A delay of publication, even of six months to one year, due to the proprietary interests of a company may affect the chances of post-docs or students in obtaining their next position. Faculty who may have conflicting commercial relationships may impede the sharing of knowledge required to conduct dissertation research and may even be unable to serve on the same dissertation committee (Kenney 1986). Obviously, this has the potential to conflict with a student's need to create the most useful committee for the student's research.

Attempting to satisfy university obligations while also devoting substantial time to competing industrial interests generates conflicts of commitment (Kelley and Randolph 1994). Conflicts of commitment involve conflicts between the interests of the researcher as entrepreneur and the researcher as faculty, between the interests of the university and those of the entrepreneur, and between the interests of the entrepreneur and those of the students.

University policy generally is to allow 20% of a faculty member's time to be devoted to outside consulting. However, the distinction between university time and personal time for a researcher is becomingly increasingly difficult to draw (Slaughter and Rhoades 1993). The majority of faculty members are not required to account for a certain number of hours devoted to work for the university. Rather, they are required to achieve certain teaching, research, and service goals in order to attain promotion and tenure. Thus, this conflict becomes quite subtle and complicated: when exactly does a faculty member cease working for the university?

Conflicts of commitment can also be categorized as conflicts with student interests. As faculty spend more time devoted to industrial ties, they may begin to devote less time to students. Fox's (1981b, 41) interviews with post-docs revealed the following sentiment: " 'It's definitely, absolutely happening; people are neglecting their labs because they're spending time for their companies,' said one postdoc surrounded by several others who nodded in vigorous agreement." Potentially, as a result of competing time demands, students may be neglected.

Another often described potential conflict is the steering of research towards more applied concerns (Noble 1982; Kenney 1986), a conflict between the "ideal" of the university and the interests of the entrepreneur and the company and a conflict between the "ideal" of the university and the interests of the faculty member who must maintain a level of external support. Kenney (1986, 112) argued that this "process by which research is increasingly being skewed to targets of greater commercial interest" occurs in several ways. First, a professor, often with equity in a company, may begin to steer research towards products which have commercial potential. Commonly, these research interests will be a smooth progression from the researcher's prior work. Second, with the decreasing amount of federal funding available, a researcher may steer the research towards topics which would be of more interest to, and therefore have more potential for funding from, private industry. Third, a scientist may be awarded a grant with a specified research topic, or outcome, by industry. In all these instances, researchers are still choosing their research topics. Nonetheless, the end result is that much research is directed towards topics of interest to industry. This conflict may manifest itself through changes in publication practices of faculty, such as publishing in journals with more applied focus following involvement with industry.

The last common criticism of interactions between the university and industry is that these interactions obstruct the free exchange of information and materials. This conflict may be perceived as a conflict between the "ideal" of the university and the interests of the entrepreneur and company. As discussed earlier, this free exchange has been identified as a principal norm of scientific activity, according to a Mertonian framework. Corporations, because of proprietary needs, often require at least a delay of open publication. Thus, researchers who work with corporations or have an interest in their own proprietary rights recognize strong impediments to this free exchange. One lawyer even advised, much to the

surprise of many in the audience, that if a researcher believes the work to have any commercial potential, the researcher should not discuss it even in an informal setting such as a local departmental seminar as this would jeopardize potential patents (Peet 1996). Kenney (1986, 123) also cites Albert Halluin, chief patent attorney for Cetus, in an address to the American Society for Microbiology as stating: " 'In the future when you come to scientific meetings and you are going to give a presentation, consider going to a notary public to have notarized [the material] you are going to [present, giving] the date when you wrote it down and the colleges you are going to visit ...consider not telling them certain things ...' " As mentioned earlier, restrictions on publication may also serve as conflicts with student interests.

A similar situation exists for the exchange of materials (Kenney 1986). Prior to the rapid shift in biology, materials generally were freely given to any researcher who requested them. Once the commercial potential of biological materials was realized, several universities began requiring researchers to sign forms stipulating restrictions on the exchange of materials and the arrangement of rights should the materials become commercially valuable. Companies have also developed transfer contracts. Genentech's form requires the researcher to agree that the researcher may not publish any results obtained with materials without the consent of Genentech.

Thus, several apparent categories of conflicts have been identified (see Table 1.1 for a summary). These prima facie conflicts arise from the interpretations of a clash that occurs when the profoundly different presumed norms and structures of the university and industry meet as a faculty member attempts to work within both cultures.

Empirical Studies of Conflicts

Still, the question remains: how prevalent are these potential conflicts? At least two studies have attempted to quantify the extent of university-industry interactions in biotechnology: Blumenthal *et al.* (1986a) and Krimsky *et al.* (1991). Blumenthal *et al.* (1986a) conducted a survey of biotechnology firms in order to determine how many were supporting university research. They also used the results of this survey to describe the possible benefits and risks of university-industry research relationships to the firms involved. The results showed that approximately one-half of biotechnology companies provide funds for university research. Blumenthal *et al.* (1986a) claim that this indicates that industry may support almost one-quarter of all biotechnology research conducted at universities. Further, they found that, per dollar invested, university research is actually yielding more patent applications than research conducted within companies. The risks, such as obstruction of free communication, to scholars appeared to be greater with interactions with small companies than with large (Fortune 500) companies.

Krimsky *et al.* (1991) also conducted a broad survey of life science faculty in order to quantify the extent of faculty involvement with industry. From this survey, a pattern of

extensive involvement with industry emerged for approximately 37% of faculty. Faculty from larger, more prestigious universities were more often involved in development of new firms. Krimsky *et al.* (1991) argue that these extensive ties could lead to serious conflicts of interest in academic arenas such as peer review where academic researchers with commercial connections may "pilfer" ideas for company work.

Thus, academic-industry relationships are quite prevalent in biotechnology. However, are the resulting conflicts also prevalent? Three empirical studies have examined the question of how widespread the potential conflicts are. Blumenthal *et al.* (1986b) conducted a survey, similar to that of Blumenthal *et al.* (1986a), of life science and engineering faculty at 40 major research universities in the United States in order to analyze the benefits and risks of university-industry research relationships to the traditional roles of faculty. The results of the survey indicated that faculty with industrial ties published more, earned more, and did not devote less time to teaching and administrative duties than faculty without industrial ties. Furthermore, faculty perceived numerous benefits to university-industry research relationships including patents, less bureaucracy, and increased resources and career opportunities for students. However, faculty with industrial support were four times more likely to indicate that considerations of commercial applications had impacted research choice. Both faculty with and without industrial support expressed concern over industrial support leading to too much devotion to applied research.

Gluck *et al.* (1987) conducted a survey of graduate students and post-doctoral fellows at six research universities. They found that 19% of the respondents received direct industrial support for their work and 15% of the respondents worked with faculty advisors who received industrial support. Support from industry was associated with some conditions placed upon the research -- fewer or delayed publications and limiting communication with others. Further, they found that students supported by industry were more likely than those without industry support to apply for patents developed from their research. Overall, the students and post-doctoral fellows believed that the benefits of industrial support greatly exceed the risks.

Another large survey of faculty was conducted by Allen and Norling (1991). They queried faculty at higher education institutions in Pennsylvania regarding whether client based research, consulting, and founding start-up companies had influenced institutional priorities (such as publishing research results, conducting academic research, and educating graduate students), teaching, or the desire to leave the university. They concluded that these industrial ties did not affect institutional priorities, time devoted to teaching, time devoted to academic research, or time devoted to university service, but did contribute to a strong incentive to leave the university.

One potential explanation for these empirical results is that the descriptions of scientific norms are faulty, leading to inaccurate descriptions. These empirical studies also

Table 1.1. Summary of the Stereotypical View of Conflicts Due to University-Industry Interactions

Conflicts involving financial interests

Misuse of university resources

conflict between the financial interests of the university and those of the entrepreneurial researcher and the company

Researcher bias

conflict between the "ideal" of university scientific research and the financial interests of the entrepreneurial researcher and the company

Receiving grant from own company

conflict between the "ideal" of the university and the interests of the researcher as entrepreneur

Conflicts involving student interests

Use as inexpensive labor

conflict between the career (and financial) interests of the student and the financial interests of the entrepreneur and company

Use of ideas without proper credit

conflict between the career (and financial) interests of the student and the financial interests of the entrepreneur and company

Delaying publication

conflict between the interests of the student and the financial interests of the university

conflict between the interests of the student and the financial interests of the company and entrepreneur

Impede sharing of knowledge in advisory committee

conflict between the interests of the student and the financial interests of the company and entrepreneur

conflict between the interests of the researcher as entrepreneur and the interests of the researcher as faculty

Conflict of commitment (time)

conflict between the interests of the university and those of the entrepreneur

conflict between the interests of the researcher as entrepreneur and the researcher as faculty

conflict between the interests of the entrepreneur and those of the students

Steering of research to more applied topics

conflict between the "ideal" of the university and the interests of the entrepreneur and the company

conflict between the "ideal" of the university and the interests of the faculty member

Obstruction of the exchange of information and/or materials

conflict between the "ideal" of the university and the interests of the entrepreneur and company

support other interpretations: that several of the potential conflicts are not particularly prevalent, several of the potential conflicts are not perceived as conflicts by faculty or students, or several of the potential conflicts have been avoided because faculty have adjusted their roles and duties so as to eliminate or otherwise resolve these conflicts. For instance, according to these studies, academic-corporate interactions do not result in reduction of the amount of time faculty spend on teaching, research, and administrative duties. Thus, the conflicts of commitment seem to be successfully avoided, or perhaps even wholly absent, as perceived by faculty with industry ties. Further, although obstruction of open communication, consideration of commercial potential impacting research, and conflicts with student interests in the form of delayed publishing are sometimes experienced, these risks are believed to be far surpassed by all the benefits provided by university-industry relationships.

1.7 Conclusions

University-industry interactions are nothing new. However, the number and type of university-industry relationships are new, particularly in the field of biotechnology, representing a significant change in the social environment of the university. These relationships go beyond consulting and conducting clinical trials which had been present in the US since the 1920s. University scientists and industry in the life sciences, encouraged by federal policy and by the commercial potential of university research, have linked up in droves. Further, when university scientists start companies, the ties become closer rather than more distant. From the 1980s on, many university scientists in the broad field of molecular biology have recognized the commercial potential of university research and have pursued that potential while remaining a university researcher. Consequently, many university researchers have experienced a shift in their social environment. Concordant with this shift, many scientists and non-scientists alike have expressed strong concerns over the potential conflicts arising from university-industry relationships.

CHAPTER TWO: LITERATURE REVIEW

Changes in the social environment are frequently accompanied by changes in institutional structures and in individual experiences, norms, or values. Recent studies of higher education have strongly argued that changes in funding patterns have wrought changes in the structure of the university and changes in the behavior of individuals within the university. Of particular concern have been the changes resulting from increased interactions with industry, the most untraditional of which occurs when a faculty member founds a private company while retaining his or her faculty position. While it is important to understand what, both institutional and individual, is changing, it is also important to understand how the experiences of the institutions and individuals are changing.

The literature reviewed in this chapter unanimously contends that, as a result of the commercial potential of academic science and a corresponding increase in the number and extent of university-industry relations, the university is changing. This is not a biased sample. I have found no literature which dissents from this view; there are no arguments either that increased entrepreneurial activity is not responsible for changes within the university or that increased entrepreneurial activity is not occurring.

The literature which guides the theoretical framework for this project can be roughly divided into three categories: policy studies, educational studies, and science studies. Although extensive work exists which analyzes changes in social structures or individual behavior due to some change in the local environment,[10] I have concentrated on analyses of change occurring in the universities and academic research. It is important to remember that all the literature discussed concerns the same general subject of university-industry relations. Furthermore, this literature has a unifying theme of reorganization (most at the institutional level) accompanying changes in the social environment. Thus, although I have classified each study in either one of those three categories, several could easily be placed in more than one of the categories.

Much of the literature reviewed in this chapter focuses on changes occurring at the institutional rather than individual level. An analysis of what the entrepreneurial faculty consider to be genuine conflicts resulting from their industry work and which are issues they must address but which they do not consider genuine is absent. Furthermore, of the works which support the argument that change is occurring at the individual level, the analyses fail to present, beyond the broadest terms, exactly what changes the individuals within the university are undergoing. This thesis attempts to fill some of that gap.

[10]For instance, Thornton and Fricke (1987) and Fricke *et al*. (1990) argue that socioeconomic change greatly impacts the structure of the family. Another example is Erikson (1976) who analyzed the loss of communality between the individuals of a small town as a result of a devastating flood in West Virginia.

2.1 Policy Studies

The works I have included in this category present analyses of the reorganization of the university as a result of increasing commercialization of scientific research produced in the university. This reorganization, which includes the generation of new structures and various means of fostering the development of university-owned intellectual properties, allows the university to assume its new responsibility of fostering economic development and growth in a formal way. The studies argue that the interactions between the university, industry, and government shape each individual institution and the boundaries between the institutions are beginning to blur as new structures, which span two or more of these institutions, emerge. The university is assuming roles and duties previously restricted to industry, and industry is likewise assuming roles and functions previously limited to the university.

Etzkowitz and Peters (1991) analyze the reorganization of the university in response to its new role of economic development and the increasing commercial potential of faculty research. They contend that the university has adopted a structure increasingly similar to that of industry:

> [i]n accepting an economic role, the university moves a little to being like a business corporation, with entrepreneurial and marketing activities, in addition to traditional research and teaching functions (Etzkowitz and Peters 1991, 133).

They examined these trends of reorganization in four fields - biology, chemistry, materials science, and computer science - at eight universities. They found that the universities had incorporated several "organisational innovations" (Etzkowitz and Peters 1991, 133) in the quest to interact with industry. They discuss in detail the following emergent structures arising from the additional economic role, and concomitant duties, adopted by universities: entrepreneurial faculty; university research centers; and administrative changes, including contracts and grants offices, industrial relations offices, legal counsel, and committees to arbitrate university-industry interactions. Etzkowitz and Peters (1991, 166) conclude that, given the limitations on funding for scientific research, "academic scientists and university administrators are increasingly willing to reconsider their traditional ideas."

Etzkowitz (1994) argues that organizational innovations by government, industry, and universities play an important part in inducing technological change.[11] As scientific research becomes interpreted as being crucial to economic development, science policy has become integrated with technology policy and both are used to contribute to economic development. Thus, governmental science and technology policies have increasingly encouraged university-industry interactions in order, presumably, to stimulate economic development.

[11]This is a brief description of what Etzkowitz (1994) calls a "spiral model" of university-industry interactions. This model is not well-developed in this particular paper. However, Etzkowitz expands this spiral model into the "Triple Helix Model" which I examine in greater detail in the following discussion.

Furthermore, over time, new patterns of organization can elicit transformations in purpose. Etzkowitz contends that the university is experiencing such a transformation in purpose, or what he calls a second academic revolution. The first academic revolution occurred with the introduction of a research mission of the university. Before this, the university was wholly a teaching institution. This new mission of research produced dual roles for professors, that of teachers and of disciplinary specialists. Because of this duality, conflicts arose over how to balance teaching and research duties. The second academic revolution, now in progress, involves the introduction of economic development as a mission of the university, and, as in the first academic revolution, "[t]o the extent that universities become more entrepreneurial, there will be even more than the traditional tension between research and teaching" (Etzkowitz 1994, 151). Thus, the university must alter its structure in order to keep its diverse functions in harmony. Etzkowitz (1994) concludes that, although this new mission may endanger the other missions of the university (such as the university as a source of disinterested expert knowledge), the university may also metamorphose just as universities which incorporated a research mission in the late nineteenth century were fundamentally transformed.

Leydesdorff and Etzkowitz (1996a, b) propose a model for understanding and mapping the institutional changes taking place within the university, the triple helix model. The triple helix is formed through the interactions of governmental, private, and academic institutions. This model contains four dimensions (Leydesdorff and Etzkowitz, 1996a). The first is the internal change within each helix. The second is the mutual impacts between helices. The third is the creation of new organizations which span the three helices. The fourth is the reflexive influences of the helices on the institutions from which they arose and on society as a whole. The triple helix model, drawing upon an evolutionary framework, argues that agents are continually reshaping the institutions. As the institutions are reconfigured the interactions between the institutions are altered. As the interactions are altered, the institutions are reconfigured. With the resulting reconfiguration of institutions, the agents must readjust their position within the new boundaries and constraints of the institution. This model can be used to investigate questions concerning where new research will be situated. Most importantly, for this thesis project, this model, "leads us to view the institutional actors on an equal level in the network" (Leydesdorff and Etzkowitz 1996b, 284). Thus, the changes instituted by individuals are equally important, no matter whether the individual occupies the position of legislator, university administrator, or faculty member.

2.2 Educational Studies

In contrast to the literature characterized as policy studies, the analyses placed in this category focus on factors which are effecting changes in the perceptions, of both members of the university and the state government, in the duties and roles of faculty, and in the behavior of faculty. These educational studies do not dwell much on how perceptions are changing in the state government, and do not consider at all how expectations beyond these two arenas

are changing. This literature suggests that faculty behavior shifts to meet changing perceptions and expectations.

Slaughter and Rhoades (1993) examine how the views of commercialization of science produced by a public university have altered and how this shift has shaped the perceptions of faculty, particularly as employees. They analyzed the patent policies of the University of Arizona, the Arizona Board of Regents, and Arizona state statutes concerning patents from 1969, 1977, and 1988 for changes in "ownership and rewards, ideology, and administrative control" (Slaughter and Rhoades 1993, 291). They argue, that over this time period, the view of faculty changed from one in which they had their own time to one where faculty in effect were always at work for the university; the definition of the best serving of the public interest changed from maintaining a distance from private enterprise to actively transferring technology to industry; administrative control shifted from the university to the state; and administrators acquired greater discretion over whether to pursue commercialization of faculty work. These changes reflect a reorganization of the institutional structure of the university in order to maintain faculty autonomy and give "special treatment" to faculty involved in commercialization of their scientific research while simultaneously increasing a proprietary claim on that scientific research (Slaughter and Rhoades 1993, 290). This analysis reveals institutional reorganization and shifting perceptions of faculty boundaries accompanying the increasing commercialization of research produced in the university.

Slaughter (1985) also emphasizes the theme of shifting expectations of faculty members. However, she pushes this analysis one step further and asks if faculty are modifying their behavior in order to satisfy these expectations. Slaughter (1985) analyzes planning documents produced by the Regents of the State University of New York (SUNY), Buffalo and the SUNY system over a period of approximately ten years, 1970-1980. She argues that university administrators' expectations of faculty underwent a profound shift during this time. Slaughter contends that, at the start of the interval she examined, university administrators emphasized the faculty roles of supporting the university system and teaching students. In contrast, the faculty role of supporting the state economy was given prominence in planning documents written around 1980. Slaughter (1985, 50) outlines three ways in which the university administrators expected faculty to change their behavior in order to meet these new expectations:

> to teach students more efficiently and effectively, to increase their sponsored research dollar support and research output, [and] to regenerate the economy through service to the wider society, most particularly the business sector.

Slaughter also asks whether faculty are in fact altering their behavior in order to meet these new expectations. Quantitative data indicate that faculty were teaching students slightly more efficiently in 1980 than in 1970. For instance, they were producing more master's and doctoral students with fewer resources. Faculty attempted to obtain more research support as indicated by the increase in the number of grant applications in 1980 compared to that of 1970 even though the number of faculty decreased. However, there was

no increase in the number of federal grants actually awarded to SUNY, Buffalo faculty.[12] Based upon a comparison of number of publications of professors being considered for tenure in 1967-1968 to the number of publications of professors being considered for tenure in 1977-1978, publication rates appear to have increased for the faculty being considered in 1977-1978. Furthermore, faculty being considered in 1977-1978 are slightly more likely to have published a book. Slaughter did not arrive at a suitable indicator for whether faculty had increased service to the economy. She argues that SUNY, Buffalo administrators had not delineated a distinct strategy for support of the local economy. However, SUNY was developing a number of new institutional structures, such as a Technology Transfer Office and Industrial Liaison Program, by 1980. Slaughter (1985) concludes that, as a result of changing perceptions in the SUNY system of what faculty ought to be doing, faculty behavior, as measured by student and publication output, began to change in order to meet these new expectations.

However, there are some problems with this direct causal attribution; faculty may be altering their behavior for reasons other than changing expectations of academic managers. For instance, faculty may be applying for more grants because the competition for grants has become more keen. This is a question Slaughter (1985) cannot address, for she only examined quantitative data. She did not take into account the faculty's opinions regarding why they were becoming more productive. Nonetheless, Slaughter (1985) does show that faculty were modifying their behavior.

These studies of the higher education system indicate that there are changes in the perceptions of what faculty should be doing and how they should be performing and behaving. Further, these studies provide evidence that faculty are altering their behavior, possibly in order to fulfill these new expectations.

2.3 Science Studies

Like the educational studies, the literature I have characterized as science studies concentrates on analyses of shifts of university responses and subsequent shifts in professional behavior. These studies argue that science faculty modify their activity, and even their views, due to changes in their social environment, such as funding availability.[13] The relationship between faculty and their environment is seen as reflexive as in Rabinow (1996): even as faculty play an important part in shaping the milieu, they are in turn shaped by it.

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[12]Interestingly, Slaughter (1985) makes no mention of whether industrial support increased while federal support remained constant. Federal support comprised approximately 75 percent of sponsored research at SUNY, Buffalo (Slaughter 1985, 51). However, again, it is unclear if this percentage refers to number of grants or amount of money. Consequently, Slaughter (1985) may be missing an aspect of increased productivity of SUNY, Buffalo faculty, namely applying for and possibly receiving more money from industrial sources.

[13]Some of these works utilize something of a Mertonian framework of norms (such as Etzkowitz 1983 and 1989). However, as stated in Chapter One, the framework for this research project makes no use of assumptions about previously existing, distinct scientific norms.

Etzkowitz (1983) contends that, recently, academic scientists' views concerning commercialization of their scientific research have altered. Previously, in accordance with the "traditional ethos" of science, scientific research remained separate from commercial uses; many scientists no longer hold this boundary to be desirable. Etzkowitz (1983) argues that this acceptance of entrepreneurial behavior by faculty evolved from academic team research, which necessitated characteristics of an industrial firm. Although this is the only structure which was readily converted to a function useful for university-industry relationships mentioned by Etzkowitz (1983), other structures can also be seen as "pre-adaptations." For instance, tenure may have a role in university-industry relationships by providing faculty members with the freedom to pursue new entrepreneurial interests. Thus, in addition to the argument of Etzkowitz and Peters (1991) which stated that emergent structures were arising due to university-industry relationships, Etzkowitz (1983) points out the importance of previously existing structures to the feasibility of university-industry interactions.

Still, several potential conflicts exist. This is because academic scientists, "have not conceived of themselves, or been conceived, as performing a role distinct from traditional academic scientists" (Etzkowitz 1983, 199). These conflicts stem from issues regarding secrecy, time allocation, and use of graduate students.

Etzkowitz (1989) analyzes commercialization of science in the university through a framework of normative change encouraged by alterations in the university structure. Scientists' views concerning industrial interactions are changing due to external pressures (such as funding) and internal perceptions. The changing behavior of academic scientists should be viewed not as deviation from norms but as transformation of norms. Scientists and administrators are reinterpreting behavior -- what was once thought to be in conflict with scientific activity in the university is now perceived to be consistent.

An analysis of how scientists alter their behavior in response to a specific environmental factor, funding, is provided by Hackett (1987). Hackett examines "how the changes in the funding environment, particularly changes that increase competition for resources, might influence scientists' careers, work patterns, and the science they produce" (Hackett 1987, 135). Hackett categorizes the consequences of funding pressures into five themes: marginal scientists, relationships between the principal investigating scientist and their research teams, organizational implications for the university, modifications to scientific change, and effects on the quality of science.

Hackett contends that marginal positions (for academic scientists, particularly, non-tenure track positions) have increased. Although these positions are filled by scientists making valuable contributions and provide these scientists with further opportunities for training, the uncertainty and insecurity of these positions inflict substantial damage to the

individual as well as to the system of research.[14] With regard to the relationships between principal investigators and their staff, Hackett argues that conflicts between the interests of the faculty and the interests of their staff are now more prevalent as senior investigators need low-paid, skilled labor to rapidly complete projects while post-doctoral fellows and graduate students need substantial work which will advance their careers. Changes in the funding environments has led to increased appreciation for the value of tenure, along with the behavioral freedom it allows, while the status and freedom of marginal positions has decreased.

Funding pressures seem to lead to organizational changes such as estrangement of marginal scientists, anomie ("a weakening of norms and rules that guide behavior" (Hackett 1987, 140)), and modifications in the structure of the university. Scientists are more pressured to alter research directions and accept certain theories, methods, or results and incorporate these new findings into their research. Finally, all researchers, in both marginal and tenured or tenure-track positions, find decreasing opportunities to generate preliminary results or to replicate results. They are also less able to undertake a "risky" research project which may not yield tangible, useful results. Thus, Hackett (1987) concludes that changes in funding, particularly increases in the competition for funding, greatly impact individual scientists' behavior and views.

In "Science as a Vocation in the 1990s: The Changing Organizational Culture of Academic Science," Hackett continues and expands this framework. Here he presents culture, specifically the culture of academic science, as a set of axes with extreme values and norms at each end. He argues that, as a result of social and organizational forces, the exact position of academic scientists along these cultural axes shifts. Thus, "the norms of science are historically situated accommodations to a particular set of circumstances, not universal principles that transcend time and locale" (Hackett 1990, 244). Accordingly, as academic science begins to adapt behaviors similar to those found in private industry, not only does its structure change, but also its values and norms. These changes affect individual scientists' behavior in their careers and research.

Behavior of scientists includes teaching methods and class content. Does the content of what the faculty teach change as they engage in entrepreneurial activity? Noble (1977) argues that as a result of the increasing influence of corporate capitalism in the discipline of engineering, scientists and professional engineers transformed what was taught and how it was taught in engineering schools in the early twentieth century. Through education, engineers sought to train their future successors and subordinates for what they viewed as necessary for success in business. Consequently, "[i]n their reform efforts ... they sought to bring both the form and the content of that education into line with what they perceived to be the immediate manpower needs of industry and the long-range requirements of continued

[14] An examination of how this may be impacting the system of research is an interesting, but separate question, one which this study shall not attempt to answer.

corporate development" (Noble 1977, 169). Several programs were initiated at universities by corporations such as General Electric, AT&T, and Westinghouse.

Reforms of higher education in engineering and development of new programs were not exclusively executed by industry. Several professors, such as C. F. Burgess at the University of Wisconsin and Frederick L. Bishop at the University of Pittsburgh, also expressed the need to modify the educational content in order to create college graduates who would be better able to "link the laboratory with the industrial plant" (Noble 1977, 193). Thus, as a result of the commercialization of engineering research, the content and form of engineering education was transformed. This raises the question of whether parallel changes are occurring in the classes of professors who have established biotechnology companies, a question which remains unanswered by any previous studies.

2.4 Literature Review: Conclusions

The science studies literature indicates that there are changes occurring in the behavior and views of individual research scientists as a result of social change. Several of these studies (such as Etzkowitz (1983, 1989) and Noble (1977)) argue that these shifts occur as a result of the increasing commercial potential of academic research and entrepreneurial activity of academic scientists.

These science studies analyses build upon the arguments found in the literature categorized as policy and educational studies. The policy studies point out the reorganization of the institutional structure of the university resulting from increasing commercial activity within the university. The analyses characterized as science studies then argue that this reorganization in turn leads to modification of individual behavior and values. The educational studies argue that, concomitant with increasing commercialization of academic research, perceptions of faculty are shifting. Further, as Slaughter (1985) argues, faculty appear to be altering their behavior in order to meet these changing expectations. However, no one has put forward a detailed examination of how the behavior of faculty is being modified.

Previous studies that have examined conflicts arising from increased entrepreneurial activity in the university have posited several potential conflicts. However, even though the framework of these conflicts is derived from several viewpoints, it fails to take into account the perceptions of the entrepreneurial faculty themselves. In order to analyze how faculty are altering their behavior in order to resolve these conflicts, I must first examine which conflicts the faculty have determined require some sort of resolution.

I shall use these frameworks of social change in the environment leading to structural or individual behavioral changes to answer questions concerning the impacts that participating in the founding of a private biotechnology company has upon an individual faculty member. I am not assuming that institutional change directly causes changes in individuals. Rather, I

am operating within the framework that changes in the social environment lead to changes at both the level of institutions and individuals, and I will focus on change at the level of individuals. Specifically, I shall address both the differences in the perceptions of conflicts arising from faculty entrepreneurial activity on the part of administrators and of entrepreneurial faculty and the changes in the experiences, teaching, and interactions with colleagues of biotechnology faculty as they approach these conflicts.

2.5 Methodology

The bulk of this thesis is based on personal, taped interviews, 18 in total. All of the interviews were transcribed either by me or by a professional transcribing service. The respondents were three life science faculty at a single research university who had started private firms, some of their graduate students, employees of the scientists' companies, the heads of the faculty members' departments, administrators in the graduate school, and a faculty member who taught a biotechnology class incorporating business topics. The three faculty are in different Colleges within the university, with different deans and different tenure and promotion procedures. These biotechnology faculty are part of a larger pool of life science faculty who have started private companies, but not much larger. There are currently only a handful of researchers who have begun biotechnology companies at this university. In the analysis of this thesis, the research university shall be referred to as "Major Research University" or MRU. In the interest of preserving confidentiality, the names of all the participants and all identifying factors have been changed. A summary of the pseudonyms and brief descriptions of the individuals are presented in Table 2.1.

The university is a state-supported institution which currently ranks in the top fifty research institutions. At MRU, faculty not only can start a private company, but are frequently encouraged to patent and license their research. Faculty receive 50% of the royalties on all inventions, with the other 50% being divided between the university and the institution set up to handle patenting of university inventions.

The interviews were open-ended. Specific topics were covered in every interview, but questions were not uniformly worded in all of the interviews. This allowed for exploration of each individual's unique circumstances and experiences. The interviews lasted from 30 minutes to two-and-a-half hours, with most interviews running for approximately 45 minutes.

The faculty respondents were chosen because of their presence at MRU, their willingness to participate in this project, and because each had continuing involvement in a private company which s/he helped establish. Students were chosen so that I could obtain a strong sampling of individuals' experiences with each research scientist. The employees of the companies were chosen for interviewing because of special circumstances concerning their employment, for instance, being a part-time graduate student as well as a part-time employee.

Table 2.1 Summary of Individuals Interviewed. All names are pseudonyms.

University-Level Administrators				
David Hunter				
Richard Baxter			James Renwick (Former Administrator)	
Department Heads				
Robert Anderson			Douglas Johnson	Erwin McClung
Entrepreneurial Faculty Members				
Patrick Gilmore			John Davey	George Street
Simon North (Vice-President of Gilmore's Company)	Gregory King (Graduate Student)	Paul Walden (Part-time Employee at Gilmore's Company)	Rose Thorpe (Graduate Student)	Paul Walden (Part-time Graduate Student)

Beyond questions in the personal, in-depth interviews, I gathered data on the publishing record of the entrepreneurial faculty through a review of their published articles from approximately 1982 to the present. I obtained the article citations through two sources. First, I requested a complete curriculum vitae from each scientist. I further performed a database literature search. I examined each scientist's publishing record for changes in the journals in which they published which may correspond with their entrepreneurial activity.

I also conducted participant observation of a biochemistry class offered at MRU which covers both business and science aspects of biotechnology. For the majority of the semester, I sat in on the class observing how and what the professor was teaching. I also interviewed the professor concerning the design of the class and the reasoning behind the structure of the class.

The research for this thesis consisted largely of asking and listening. I have drawn extensively from the research methodologies of Paul Rabinow in *Making PCR: A Story of Biotechnology* and Edward Hackett in "Funding and Academic Research in the Life Sciences: Results of an Exploratory Study." Both construct striking narratives of how individuals are, in Rabinow's words, "shaped" by external factors through extensive interviewing of the people involved. Through a tremendous amount of questioning and listening, Rabinow and Hackett piece together the terrain populated by individuals in different positions and the experiences of those individuals involved. In developing my account of the experiences of faculty who have established a company, I have tried to map out the unique positions while also looking for unifying themes and patterns.

This analysis may be missing certain positions or viewpoints. For instance, all of the entrepreneurial research scientists are approximately the same age. Thus, there may be generational differences in these issues which this analysis does not reveal. Similarly, all the faculty respondents are male and have tenure. These factors may affect the picture captured by this study. Furthermore, this analysis provides a description of the issues encountered at only one university. However, I am confident that I have captured a wide picture of entrepreneurial faculty through the cross-section of respondents and the searching interview process. I believe the description which emerges from this research provides valuable insights into how entrepreneurial faculty have modified their behavior in certain aspects of their academic careers.

CHAPTER THREE: ADMINISTRATORS' EXPERIENCES

Life science faculty are now engaging in entrepreneurial activity, including participating in the formation of private biotechnology companies. This is a major change in the social environment with resulting changes in the experiences of individuals, specifically faculty members. Changes in faculty experiences are reflected in their individual actions as they attempt to reconcile conflicts resulting from maintaining their faculty position while running a company, in their teaching, and in their interactions with peers and graduate students.

In order to pursue the question of how faculty are responding to these conflicts, a detailed understanding of the perceptions of conflicts by the entrepreneurial faculty is necessary. However, faculty are not the sole judges of what counts as a conflict stemming from entrepreneurial activity. University administrators (among many others) also have formed opinions on this subject. Furthermore, administrators may mandate certain actions to prevent or counteract certain conflicts. In exploring how faculty respond to the perceptions of others, I first will delineate what messages, if any, the faculty receive from the university-level administration (especially individuals in sponsored programs, research administration, and the graduate school) and the department heads of the researchers' departments, regarding which actions produce conflicts and how the resulting issues should be resolved. In the following chapter, I will then examine the viewpoints of the entrepreneurial faculty regarding conflicts. The views of the administrators and faculty regarding conflicts which arise due to faculty entrepreneurial activity will also be contrasted with the stereotypical view summarized in Table 1.1. I will argue that significant differences exist between the views of the administrators and the views of the faculty.

Significant differences also exist between the stereotypical view and the views of administrators and faculty. When examined from the viewpoints of administrators and entrepreneurial faculty, the stereotypical view has several omissions. One prominent omission of the stereotypical view is the role that it itself plays in generating the category of conflicts that do not directly impact on the entrepreneurial faculty or administrators, but to which they must respond because of others' perceptions. The stereotypical view delimits the issues which appear as conflicts to others. Entrepreneurial faculty and administrators must then react to others' belief that there is a conflict and the actions taken because of that belief.

A second prominent omission of the stereotypical view concerns the use of university research by faculty entrepreneurs in their companies. The stereotypical view is in some ways motivated by this concern, but does not express it as a separate conflict. However, the university-level administrators, department heads, and entrepreneurial faculty all find this issue to present a conflict, which they characterize as a conflict between the "ideal" of the university and the financial interests of the entrepreneurial researcher.

A third salient oversight of the stereotypical view concerns differences in the categorizations of conflicts. This limitation seems to result from the limited viewpoints considered in the stereotypical view. In the stereotypical view, all conflicts are considered genuine and should be acted upon. As discussed above, however, some conflicts are not considered genuine by entrepreneurial faculty and/or administrators. Yet they act because others identify the issues as conflicts. The entrepreneurial faculty and/or administrators do not even consider some supposed conflicts to be real. These faculty and administrators divide the conflicts posited by the stereotypical view into five separate categories: issues which they consider to be genuine conflicts but do not act upon, issues which they consider to be genuine conflicts and do act upon, issues which they do not consider to pose genuine conflicts but are which they act upon because others perceive those issues to be conflicts, issues which are considered to present real conflicts but which they do not expect to ever experience at MRU and, consequently, they have not acted upon, and issues which none of the principals consider to raise genuine conflicts. Hereafter, I will abbreviate these categories as GC/NA, GC/A, NGC/A, GC/NE, and NGC, respectively. I should emphasize that I did not impose this categorization upon the data. The respondents themselves divide these issues into these categories using similar terms. It may not be the best scheme, and it certainly is not the most clear description. However, it is the most accurate description of the experiences of administrators and faculty.

Distinctions can also be drawn for the actions taken concerning the NCG/A issues. In these situations, the administrator or faculty can direct the action toward the individual who perceives the conflict or toward the situation perceived to be a conflict.

Thus, instead of the stereotypical view of conflicts presented in Chapter One, the experiences of the administrators and entrepreneurial faculty reveal a schema more like that presented in Table 3.1. There are also differences between the views of the university-level administrators, department heads, and entrepreneurial faculty. Along with detailed discussion of these differences, these three distinct schemes are separately summarized in Tables 3.2, 3.3, and 4.1.

I have defined action regarding a conflict as a procedure specifically undertaken in order to resolve the conflict. Consequently, I have not considered general recommendations as actions. Also, issues which the faculty and/or administration consider to pose real conflicts and which they believe may be experienced at MRU, but they have not yet experienced or acted on, are categorized as GC/NA. As will be shown, these distinctions are particularly relevant to comparisons of the views of the administrators and the faculty. I will explore these distinctions in greater detail in discussing the individual experiences of the administrators and entrepreneurial faculty.

Table 3.1. Conflicts Due to University-Industry Interactions According to the Experiences of University Administrators and Entrepreneurial Faculty at MRU. Issues differing from those perceived as conflicts in the stereotypical view are marked with an asterisk (*). 1=CG/NA issue, 2= CG/A issue, 3=NCG/A, 4=CG/NE, and 5=NCG.

	Category of Conflict				
	1*	2*	3*	4*	5*
Conflicts involving financial interests					
Misuse of university resources					
conflict between the financial interests of the university and the financial interests of the entrepreneurial researcher and company					
*Misuse of graduate students**					
conflict between the financial interests of the university and the financial interests of the entrepreneurial researcher and company					
Researcher bias					
conflict between the "ideal" of university scientific research and the financial interests of the entrepreneurial researcher and company					
Receiving grant from own company					
conflict between the "ideal" of the university and financial interests of the entrepreneurial researcher and company					
*Capitalizing on university research**					
conflict between the "ideal" of the university and the financial interests of the entrepreneurial researcher and company					
Conflicts involving student interests					
Use as inexpensive labor					
conflict between the career (and financial) interests of the student and the financial interests of the entrepreneurial researcher and company					
Use of ideas without proper credit					
conflict between the career (and financial) interests of the student and the financial interests of the entrepreneurial researcher					
Delaying publication					
conflict between the interests of the student and the financial interests of the university					
conflict between the interests of the student and the financial interests of the entrepreneurial researcher and company					
Impede sharing of knowledge in advisory committee					
conflict between the interests of the student and the financial interests of the entrepreneurial researcher and company					
conflict between the interests of the researcher as entrepreneur and the interests of the researcher as faculty					

Table 3.1 (cont.)

	Category of Conflict				
	1*	2*	3*	4*	5*
Conflicts involving student interests (cont.) *Dual role of mentor and employer** conflict between the interests of the student and the dual role of faculty/entrepreneur					
Conflict of Commitment *Time* conflict between the interests of the university and those of the entrepreneur conflict between the interests of the researcher as entrepreneur and the researcher as faculty conflict between the interests of the entrepreneur and those of the students *Energy and enthusiasm** conflict between the interests of the university and those of the entrepreneur conflict between the interests of the researcher as entrepreneur and the researcher as faculty conflict between the interests of the entrepreneur and those of the students					
Steering of research to more applied topics conflict between the "ideal" of the university and the interests of the entrepreneur and the company conflict between the "ideal" of the university and the interests of the faculty member					
Obstruction of the exchange of information and/or materials conflict between the "ideal" of the university and the interests of the entrepreneur and company					

3.1 University-Level Administrators

Issues Considered to be Genuine Conflicts but Not Acted Upon (GC/NA)

When university-level administrators deal with the issues raised by the entrepreneurial faculty who have started private companies, their greatest concerns regarding conflicts deal with misuse of university resources, conflicts between the financial interests of the university and those of the entrepreneur, and conflicts of commitment. These administrators view graduate students as a university resource. Consequently, from the administrative viewpoint, misuse of university resources encompasses conflicts which arise when the entrepreneurial faculty member appropriates a graduate student for company work and the university does not receive adequate compensation. Furthermore, as will be discussed later, these university-level administrators perceive only the use of graduate students as inexpensive labor as a genuine conflict. Yet, even though the university administrators all consider these to be serious conflicts, they have made no recommendations for how faculty should manage them.

The use of university resources for private gain was, for administrator Dr. David Hunter, the "most troubling." Public funds or public resources should not, and by law cannot, be used for private business without appropriate compensation determined by the university.

> We can't assist them with public funds so that wall between what they're doing inside the university and what they're doing outside is the most troubling aspect. Some things are black and white; there's a lot of gray. Allow me to give you just a couple of examples. One example is graduate students. A graduate student who is supported on a research stipend and the objectives of what he/she is doing on that side can be fairly clear. What is the legitimacy if that major professor also wants to hire that graduate student to help the graduate student make a few extra bucks outside, where does that end? Another example, in some cases we have unique resources inside the university that the person is not going to reproduce in their start up. ... Those are the biggest problems where the person has the potential for abuse (most times unintentional) in utilizing those resources in their business (Hunter 1997).

Dr. James Renwick, a former administrator, and Richard Baxter also find that the "use of university facilities" and graduate students (as employees) for company business is worrisome. These issues are particularly arduous to resolve because it is frequently difficult to discern the difference between a professor's university research and his company research (Baxter 1997; Renwick 1997).

Conflict with graduate student interests is viewed as involving the use of graduate students as inexpensive labor, "[i]f the faculty member is paying the graduate students through the company or as a part of a sponsored program at the university, there is a fear of

being used for company exploit, becoming well-trained technicians" (Renwick 1997). Still, as Renwick has seen no evidence of this problem at MRU, he has offered no response.

A third issue of concern is conflict of commitment. The administrators hold this to be a conflict between the interests of the university and the interests of the entrepreneurial faculty member. In contrast to the stereotypical view, they perceive conflict of commitment to involve more than just the time of the faculty member, but also enthusiasm and effort:

> Sure he/she comes in and teaches his or her class ... but is he/she eager to work with a citizen, are they there to pick up the slack for various things, holding office hours, are graduate students making good progress? ... So this whole area of commitment of a faculty member to his/her university position as opposed to time, energy, and effort to the company is one that I think is a difficult one. I think that's the hardest one (Renwick 1997).

One of the university-level administrators has acted upon conflicts of commitment involving faculty members' time. This will be discussed in the following section.

These administrators, although perceiving these issues as some of the "hardest" to manage, have not taken action or even made recommendations to faculty regarding these conflicts.

Issues Considered to be Genuine Conflicts and Acted Upon (GC/A)

In contrast to Baxter and Renwick, Hunter has made an initial attempt to address conflict of commitment involving time. Again, Hunter views this conflict as being between the interests of the university and the interests of the entrepreneurial faculty member. Hunter considers this type of conflict of commitment to be an unsolved problem. He has formed a committee to scrutinize this issue. However, he is not terribly optimistic about achieving an adequate policy regarding this potential conflict:

> What is a full-time effort? Is it forty hours a week, or is it eighty hours a week, or is it twenty hours a week? That's a question we aren't going to answer. ... It's very, very difficult because trying to define what are acceptable duties and acceptable responsibilities is not always easy to do (Hunter 1997).

Still, this is only an initial step. The only direct guideline for faculty or department heads is the regulation, now almost standard among universities, that faculty may devote up to 20% of their time to consulting activities, which could include work for the researcher's own company. However this regulation, as indicated by Hunter, is still vague; 20% of what?

Administrators also have taken action regarding two other types of conflicts involving financial interests, faculty capitalizing on university research and faculty receiving grants from their own companies. Although the stereotypical view is motivated somewhat by this issue, capitalizing on university research does not appear as such as a conflict in the

stereotype. These university-level administrators find it to be a separate conflict between the "ideal" of the university and the financial interests of the entrepreneurial faculty.

In response to these conflicts, the administrators review faculty disclosures of conflict of interest. The guidelines regarding how to manage these conflicts are not strictly university guidelines. Rather, MRU abides by a state law requiring that researchers receiving funds from a company must declare any ownership of greater than 5% of the stock of that company or receipt of income of more than $10,000 per year in any company which may affect the research done. Further, MRU also complies with a requirement from federal agencies that researchers receiving federal funds must sign agreements stipulating that they are not intending to capitalize on their research through their companies. The state has laws stipulating that no government employee may profit from his governmental work. Thus, receiving research grants from a company in which that researcher has a large interest, when the company will receive a competitive advantage from the work performed under the grant, is a violation of the state conflict of interest law. However, MRU, like many other state universities, has an exception to that law. The faculty member must complete a disclosure form which must be approved by the department head and Dean, "so long as that fact (ownership of the company) is disclosed and everyone who's approved knows what's going on, that's OK" (Renwick 1997). If any of the administration finds a conflict of interest, the faculty member must construct a plan as to how that conflict of interest will be avoided, and that plan must be approved. However, beyond those general prescriptions, there are no specific guidelines. The administrators themselves have taken only one specific action regarding these conflicts: namely, the development of a procedure by which exceptions can be made for the conflict when researchers receive a grant from their own companies.

Issues Not Considered to be Genuine Conflicts, but Acted Upon because of the Perceptions of Others (NGC/A)

Only one administrator, Hunter, expressed concern over situations which, while he finds no conflict, others perceive as presenting conflicts. This issue is most prevalent in conflicts involving financial interests. Because administrators review declared conflicts of interest, administrators as well as faculty must act to resolve this conflict. Although there are no official guidelines, Hunter offers one broad policy. Because the simple appearance of a conflict is just as damaging as an actual conflict, faculty and administrators must strive to avoid the very appearance of conflict. In this respect, the appearance of a conflict can function as if it were an actual conflict. In doing this, Hunter suggests being more cautious than simply making sure that the activities are appropriate; make sure the activities *appear* appropriate.

> The appearance of conflict of interest is as bad as the actual conflict ... I would say in the majority of cases the issues are really appearances as opposed to reality. Once you get into a situation where there is the appearance of conflict of interest you're never going to prove to anybody that it doesn't exist, so

you have to err on the side of being more conservative in that particular regard (Hunter 1997).

Obviously, Hunter has directed his resolution towards the predicament itself rather than towards altering the viewpoint of those who perceive it as a conflict. This response of overcompensation, or exceeding expectations, will also be discussed in greater detail in the next chapter.

Issues Considered to be Genuine Conflicts but Expected Never to be Experienced at MRU (GC/NE)

The issues of use of graduate student ideas without proper credit and impeding the sharing of knowledge on advisory committees have not arisen at MRU, and the administrators believe that they will not. Similarly, the university administrators expect that the problem of researcher bias (as mentioned in Chapter One, another form of conflict involving financial interests) will not arise at MRU. Instead, the administrators steadfastly maintain that, "most faculty have enough pride in themselves and their profession to do what's right" (Renwick 1997). However, even though the administrators do not expect these conflicts to arise at MRU, they do consider these to be genuine conflicts which arise at other institutions.

Issues Not Considered to be Genuine Conflicts (NGC)

For these university-level administrators, no other issues which are part of the stereotypical view present problems at any university. For instance, conflicts with student interests, apart from use as inexpensive labor as discussed earlier, are not recognized. These university-level administrators perceive graduate students largely as a university resource. However, graduate students are viewed in two different ways by these administrators. Graduate students are a university resource, yet they are also autonomous. When graduate student support, such as fellowships and grants, stems from industry or when the industry-related work of a graduate student becomes incorporated into that student's thesis or dissertation, any conflict vanishes, "as long as there is a faculty advisor associated with that [the graduate student's work], there's nothing wrong with it" (Hunter 1997). Because the university is appropriately compensated and because in this case the student receives appropriate compensation in the form of his/her education and eventual graduation, there is no conflict of interest.

The university-level administrators also maintain that delaying publications, another conflict with student interests, does not present a genuine conflict. For publishing, the Graduate School has a formal policy which allows withholding of a dissertation or thesis from publication for at least a year, usually for purposes of applying for a patent. Further, as Renwick maintains, "I have never seen any evidence of this problem because in many cases I can name off the top of my head, the graduate students are part of the company as well" (Renwick 1997). So long as the work is in some manner contributing to a degree and the

student is not simply being used as a highly-skilled technician, the university-level administrators do not conceive of the interests of the graduate student of as being at all opposed to those of a professor involved in a private company.

With regard to entrepreneurial activity obstructing the exchange of information or materials, Hunter and Renwick both argue that although it would be inappropriate to "embargo" information indefinitely, withholding information for a limited time is suitable, particularly in order to "reward an individual" for her efforts. Furthermore, most faculty, being in such competitive fields, are compelled to publish as quickly as possible lest they be surpassed by rivals. Renwick also believes that steering of research to industry-related topics is not a problem, no matter where it may arise. Any move toward more "applied" research is "just the natural course of events" (Renwick 1997).

University-Level Administrators: Brief Conclusions

Table 3.2 summarizes the university-level administrators' image of conflicts. The university-level administration has developed very few guidelines concerning how conflicts are to be resolved. These guidelines are vague, and, except for the implementation of the regulation directing that a maximum of 20% of time is allowed for consulting, the university has not designed the guidelines. Predominantly, the administration relies on the faculty member's integrity and the oversight of the department head to monitor these conflicts. They trust the faculty to know where the line between appropriate and inappropriate behavior lies. The department heads are to monitor the researchers' activities and judge when the faculty have crossed that line. For example, Renwick states,

> [o]nly the department head is in a position to judge that [the enthusiasm and effort of a faculty member]. I guess that's why there are very few university rules or regulations or policies because who's to say that the faculty is continuing to meet his or her normal obligations? It comes down to the department head (Renwick 1997).

But "first of all it's up to the faculty member; it's his or her job. ... I think it's pretty much left up to the integrity of the faculty..." (Renwick 1997) with the supervision of the department head as a fail-safe.

3.2 Department Heads

The individual department heads -- in this instance, Dr. Robert Anderson, Dr. Douglas Johnson, and Dr. Erwin McClung -- are assigned the task by university-level administrators of monitoring the possible problems. They also have views regarding which issues are most troubling and how these issues should be resolved. Their views and experiences differ somewhat from those of the university-level administrators and also from those of the entrepreneurial faculty. Which issues then do the individual department heads consider to present actual conflicts, and how do their views differ from those of the

Table 3.2. Conflicts Due to University-Industry Interactions According to the Experiences of the University-Level Administrators at MRU. Issues differing from those perceived as conflicts in the stereotypical view are marked with an asterisk (*). 1=CG/NA, 2=CG/A, 3=NCG/A, 4=CG/NE, and 5=NCG.

	Category of Conflict				
	1*	2*	3*	4*	5*
Conflicts involving financial interests					
Misuse of university resources	X				
conflict between the financial interests of the university and the financial interests of the entrepreneurial researcher and company					
*Misuse of graduate students**	X				
conflict between the financial interests of the university and the financial interests of the entrepreneurial researcher and company					
Researcher bias				X	
conflict between the "ideal" of university scientific research and the financial interests of the entrepreneurial researcher and company					
Receiving grant from own company		X			
conflict between the "ideal" of the university and financial interests of the entrepreneurial researcher and company					
*Capitalizing on university research**		X			
conflict between the "ideal" of the university and the financial interests of the entrepreneurial researcher and company					
Conflicts involving student interests					
Use as inexpensive labor	X				
conflict between the career (and financial) interests of the student and the financial interests of the entrepreneurial researcher and company					
Use of ideas without proper credit				X	
conflict between the career (and financial) interests of the student and the financial interests of the entrepreneurial researcher					
Delaying publication					X
conflict between the interests of the student and the financial interests of the university					
conflict between the interests of the student and the financial interests of the entrepreneurial researcher and company					
Impede sharing of knowledge in advisory committee				X	
conflict between the interests of the student and the financial interests of the entrepreneurial researcher and company					
conflict between the interests of the researcher as entrepreneur and the interests of the researcher as faculty					

Table 3.2 (cont.)

	Category of Conflict				
	1*	2*	3*	4*	5*
Conflict of Commitment *Time* conflict between the interests of the university and those of the entrepreneur *Energy and enthusiasm** conflict between the interests of the university and those of the entrepreneur	X	X			
Steering of research to more applied topics conflict between the "ideal" of the university and the interests of the entrepreneur and the company conflict between the "ideal" of the university and the interests of the faculty member					X
Obstruction of the exchange of information and/or materials conflict between the "ideal" of the university and the interests of the entrepreneur and company					X

university-level administrators? How do the department heads execute their assignment of oversight? How do the department heads believe these conflicts should be handled? To what extent are these expectations relayed to entrepreneurial faculty?

Issues Considered to be Genuine Conflicts but Not Acted Upon (CG/NA)

Similar to the university-level administrators, the department heads find the misuse of university resources, a conflict between the financial interests of the university and those of the entrepreneur and company, to present the greatest concern. For whom is the researcher working? Johnson states,

> there are going to be, obviously, real conflicts that you have to look out for, conflicts of interest. Who does a person work for? When they're doing something, whatever activity it is that they're engaged in, are they doing it for themselves? Are they doing it for the company, and therefore for themselves? Are they doing it for the institution? Or are they doing it as part of their role as a faculty member (Johnson 1997)?

Anderson also expressed this concern over who benefits from the researcher's academic work -- is it the students, the researcher, the researcher's company, the university, or the external grant sponsor?

Only one department head, Johnson, recognizes that some issues could constitute conflicts and could arise at MRU but which he has not had any experience managing as a department head. The first concerns the use of a graduate student for company work, where a graduate student is considered a resource of the university. For instance, Johnson argues that, although funding from a faculty member's private company for a graduate student may be financially beneficial, "you still have to be conscious, especially in those cases [of funding from a faculty member's company], of conflict of interest. Are you exploiting graduate students, where graduate students are a resource of the university, for private gain" (Johnson 1997)? Johnson, who only has one company associated with faculty in his department, has simply never had experience with graduate students working for that company. Johnson maintains that as long a someone is looking for and examining those issues periodically things are "probably all right..." Beyond that, Johnson has no suggestions about how to resolve this conflict.

Johnson also approached a second issue which he considers to be a significant conflict which may arise at MRU, but has not yet experienced -- the appearance of conflict. However, he does have recommendations regarding how to manage this conflict should the perception arise. He argues that there is probably little difference in the impact of a conflict and the appearance of a conflict. Further, he maintains that it is important to avoid even the appearance of a conflict, specifically a conflict of interest, because, "if one faculty member is tarred with that brush, then we all are" (Johnson 1997). The appearance of conflict is difficult to resolve, according to Johnson. He has only two suggestions. First, attempt to distance the faculty member further, an approach directed toward the situation. Second,

maintain an open dialog with the general public in an attempt to, "come to a new perception that avoids people thinking that people are ripping the university or ripping the state off" (Johnson 1997). In contrast to his first approach and the approach of Hunter, this second strategy is directed toward altering others' perceptions of the situation.

Issues Considered to be Genuine Conflicts and Acted Upon (CG/A)

The department heads have taken specific actions regarding researchers capitalizing on university research, researchers receiving grants from their own companies, conflicts of commitment (with the exception of Johnson who does not perceive this as a conflict), and conflicts with graduate student interests. Like the university-level administration, the department heads have adopted the actions mandated by state law and federal agency policy regarding capitalizing on university research, a conflict between the "ideal" of the university and the financial interests of the entrepreneurial faculty. Anderson and McClung have developed strategies regarding conflicts of commitment in fulfillment of their role as monitors. Unlike the university-level administration, McClung also recognizes conflicts with student interests and has developed a procedure to catch this conflict.

As at the university level, these departments generally have not developed any guidelines, "hard and fast rules" (Johnson 1997), regarding researchers capitalizing on university research and researchers receiving grants from their own companies, both conflicts between the financial interests of the university and those of the entrepreneur. Each department head reviews the disclosure forms for any grants, either from private companies in which the faculty member has a large stake or from federal agencies when the faculty member owns a large part of a company. Generally, they find these reviews fairly easy.

> Only twice have I had to sit and really think about whether this application for a grant from the NIH [National Institutes of Health] is really a conflict of interest, whether or not that really is work that would promote the company rather than promote the academic growth of this department or the students or whatever (Anderson 1997).

McClung and Anderson express concerns about conflict of commitment, perceived as a conflict between the interests of the university and those of the entrepreneurial faculty member. Anderson, however, seems to find this a minor worry. For McClung, problems with energy and excitement are more likely than problems with time. How does an individual avoid a conflict of commitment when one job, namely running the new company, tends to be so much more "exciting" than the other job, university research and teaching? Faculty devote much of their "emotional energy" to the company, possibly at the expense of the university, "it's hard to serve two masters with equal enthusiasm..." (McClung 1997). However, McClung also views the participation in a small company as potentially returning an indirect benefit to the university in the form of "regeneration." By seeing and capitalizing on their research, faculty members may become encouraged which "in itself raises the energy level and that can also fall over into research and teaching..." (McClung 1997).

Still, their departments do not have any specific guidelines delineating resolutions to conflicts of commitment. Instead, the department heads scrutinize each case against the standards of performance built into evaluations of research and teaching. McClung attempts to address the topic of potential problems informally. He does not conduct an extensive conversation covering what actions are acceptable with the faculty; rather, he approaches these issues through "five-minute conversations" where he might say "I hope your teaching evaluations continue to stay as high as they have ... as a subtle way of saying ... don't neglect that part that is working for you here in the department..." (McClung 1997). If he were to see any change in a faculty member's performance (to this date he has not), he would call that individual in for a discussion of that change. For Anderson, as long as the faculty member continues to contribute to the goals of the department as evidenced by the faculty's evaluation, he does not worry about any conflicts. The faculty member and he have a "clear understanding" of what the department expects from the faculty member over the next year. Then, "[a]s long as the department meets those goals that we have set for ourselves then I don't monitor anything else" (Anderson 1997). Again, so far, Anderson has not experienced any problems with faculty member performance declining because of ownership of a company.

A third conflict which Anderson and McClung perceive and have developed methods to detect is that between the interests of the graduate student and the interests of the researcher who has a company. McClung recognizes the most general type of this conflict, simply damage to the advisor-student relationship. McClung is worried that the relationship between the major advisor (faculty member) and the graduate student could become quite "strained" in many instances. Anderson's department does have "an unwritten sort of set of rules ... that state that it is inappropriate to use graduate students to do anything but proceed towards their degree..." (Anderson 1997). However, if work on a company project is deemed to make a sufficient contribution to a dissertation or thesis, Anderson considers that work appropriate.

In the experiences of the department heads, "very, very infrequently does that [a graduate student involved with a faculty member's company] ever come up" (McClung 1997). Thus, they have no definitive guidelines about how to resolve this conflict. Again, as in conflicts of commitment, their solution lies in the monitoring and review of progress. Detection of any problems involving graduate students should occur through the semi-annual monitoring of the department's graduate committee. Each student is expected to pass certain "milestones" at certain times. The graduate committee reviews each student's progress towards these milestones. Anderson believes this is "sufficient to ensure that people don't get shunted off to the side and do a two or three year side project to solve some manufacturing problem rather than to continue progress towards the degree on the topic that is being agreed upon" (Anderson 1997). Thus, the department heads depend on this monitoring to prevent and catch any conflicts involving graduate student interests.

Issues Not Considered to be Genuine Conflicts, but Acted Upon because of the Perceptions of Others (NCG/A)

The department heads have not encountered issues in which they believe there is no conflict of interests but which they have acted upon because others perceive them as conflicts. As discussed in the section examining issues which are considered to be genuine conflicts but not acted upon, Johnson is concerned with the appearance of conflict. However, he has not yet experienced this problem.

Issues Considered to be Genuine Conflicts but Expected Never to be Experienced at MRU (GC/NE)

The department heads have found only one issue which they categorize as a GC/NE issue -- researcher bias. They certainly maintain that this is a real conflict if it arises within a university. However, they believe that the "integrity" of the faculty at MRU, and indeed at most universities, prevents this issue from arising.

Issues Not Considered to be Genuine Conflicts (NCG)

Johnson, as already mentioned, does not recognize any conflict of commitment. For instance when queried about the possibility of a conflict of commitment in the form of time spent working on university matters, Johnson replied, "[a]s a matter of fact, I hadn't even thought about it until just now. Because, looking at what those folks do, it's never occurred to me that they are working for their company exclusive of working for the university" (Johnson 1997). To Johnson, often advancement of the company coincides with advancement of the university. Because of that, along with the university policy of a maximum of 20% of faculty members' time allowed for consulting, Johnson does not anticipate that this conflict will ever occur.

Other issues of obstruction of the exchange of information and materials and steering of research, although certainly possible consequences of entrepreneurial activity, simply do not pose conflicts according to all three department heads.

Department Heads: Brief Conclusions

Thus, the department heads and the university-level administration have a very similar understanding regarding which issues are recognized as conflicts (see Table 3.3 for a summary). For the department heads, as long as the faculty succeed in maintaining their performance and meeting department expectations and graduate students continue progressing towards their degree, the conflicts have been successfully averted. Thus far, these department heads have not experienced any problems with faculty owning companies.

Table 3.3. Conflicts Due to University-Industry Interactions According to the Experiences of the Department Heads at MRU. Issues differing from those perceived as conflicts in the stereotypical view are marked with an asterisk (*). 1=CG/NA, 2=CG/A, 3=NCG/A, 4=CG/NE, and 5=NCG.

	Category of Conflict				
	1*	2*	3*	4*	5*
Conflicts involving financial interests					
Misuse of university resources	X				
conflict between the financial interests of the university and the financial interests of the entrepreneurial researcher and company					
*Misuse of graduate students**	X				
conflict between the financial interests of the university and the financial interests of the entrepreneurial researcher and company					
Researcher bias				X	
conflict between the "ideal" of university scientific research and the financial interests of the entrepreneurial researcher and company					
Receiving grant from own company		X			
conflict between the "ideal" of the university and financial interests of the entrepreneurial researcher and company					
*Capitalizing on university research**		X			
conflict between the "ideal" of the university and the financial interests of the entrepreneurial researcher and company					
Conflicts involving student interests					
Use as inexpensive labor		X			
conflict between the career (and financial) interests of the student and the financial interests of the entrepreneurial researcher and company					
Use of ideas without proper credit				X	
conflict between the career (and financial) interests of the student and the financial interests of the entrepreneurial researcher					
Delaying publication					X
conflict between the interests of the student and the financial interests of the university					
conflict between the interests of the student and the financial interests of the entrepreneurial researcher and company					
Impede sharing of knowledge in advisory committee				X	
conflict between the interests of the student and the financial interests of the entrepreneurial researcher and company					
conflict between the interests of the researcher as entrepreneur and the interests of the researcher as faculty					

Table 3.3 (cont.)

	Category of Conflict				
	1*	2*	3*	4*	5*
Conflict of Commitment *Time* conflict between the interests of the university and those of the entrepreneur *Energy and enthusiasm** conflict between the interests of the university and those of the entrepreneur		X X			
Steering of research to more applied topics conflict between the "ideal" of the university and the interests of the entrepreneur and the company conflict between the "ideal" of the university and the interests of the faculty member					X
Obstruction of the exchange of information and/or materials conflict between the "ideal" of the university and the interests of the entrepreneur and company					X

Further, all three mentioned that owning a company possibly provides an indirect benefit to the department in the form of adding "a little extra spark to some faculty member's life" (Johnson 1997), or regenerating enthusiasm for one's academic research.

3.3 Conclusions

This examination of the experiences of faculty and administrators has revealed some significant differences between their views and the stereotypical view and has shown many similarities and a few differences between the views of the university-level administrators and the department heads. Some differences in the viewpoints of university-level administrators, department heads, and entrepreneurial faculty may be expected due to their differing roles. For instance, the university-level administrators have a duty to protect the interests of the university. The department heads are responsible for protecting the interests of their departments. Thus, the administrators tend to be more concerned with issues which threaten the interests of the university than those which have no direct impact on the university. Similarly, the department heads are more concerned with the issues which directly impact their interests. These differences in viewpoint seem to stem, at least in part, from differing roles of the individuals involved.

University-level administrators have experience with a wide variety of companies, from engineering to information technology and, only recently, biotechnology. However, the department heads largely only have experience with chemical or biological companies. Thus, the views of university-level administrators will differ somewhat from those of both the department heads due to this extrinsic variable. Furthermore, university-level administrators and department administrators are located differently relative to the conflicts. The rates of change of individual perceptions, institutional expectations, and institutional structures are different. Again, this may account for some of the divergences between the views of individuals with different institutional roles.

Regardless of the similarities between the viewpoints of the administrators and faculty, the faculty receive very little direct guidance from the administrators regarding what the conflicts are, how important they are, and how to resolve them. The strategies the faculty use (discussed in detail in the following chapter) for managing these conflicts have been developed by the faculty themselves.

CHAPTER FOUR - ENTREPRENEURIAL BIOTECHNOLOGY FACULTY EXPERIENCES

Thus, as evidenced in the discussion of administrators' views, the faculty receive virtually no formal guidance regarding how to resolve conflicts resulting from their entrepreneurial activity. The administration reviews grant proposals for conflicts of interest, but if a conflict is found, it is left to the faculty to resolve. Beyond that, the faculty are informally told simply to maintain satisfactory performance. The administrators expect the faculty to know what is appropriate and what is not, to "[m]ake sure that what you do is on the up-and-up, and that you know what the rules of conflict of interest are. Make sure you don't go over the line" (Johnson 1997).

Obviously, the faculty are not in a vacuum regarding how to resolve these conflicts. They have a body of practice from which to draw; they are not the first life science faculty to start a company while retaining their faculty position. However, the faculty do not receive any formal guidelines directly from the administrators. Consequently, based upon their own individual experiences, these three faculty, Dr. John Davey, Dr. Patrick Gilmore, and Dr. George Street, have had to reach their own determination regarding which issues raise conflicts and how to resolve them, which issues are perceived as conflicts by others, and which issues do not present conflicts.

4.1 Conflicts

In analyzing what these faculty regard as conflicts, it is important to take into account first how they regard the role of entrepreneur versus that of faculty member. The meaning of the role of entrepreneur to these researchers strongly shapes their perceptions of conflict. Each faculty member considers his role as a faculty member quite traditionally. They should be engaged in teaching, research, mentoring of graduate students, and service to the university and the scientific communities. In fulfilling those duties, each faculty member supports and serves as a major advisor to graduate students; teaches at least one class a year (two of the faculty members teach more); maintains an active research lab in the university which obtains grants from federal, state, and private sources; and participates in other activities such as undergraduate organizations, journal editorial boards, and grant review panels.

All three faculty members see owning a company as an "extension" of their academic jobs. They view running a company not as a "second job," but rather as an aspect that "merges" into the work performed at the university (Gilmore 1997b). The boundary of the university encompasses the company (Street 1996). Davey (1997) is more specific in his views. To him, the company is another way to fulfill the academic duty of service to the university. The reasoning follows this line: the company's product was developed at the university through academic research; the university owns the patent to that product; my company licensed the patent from the university; by commercializing that product, I am returning revenue to the university; if other individuals attempt to market the product and

were not successful because they did not know the product as well as I, the inventor, do, the university might not receive this revenue.

This view of their entrepreneurial activities as a continuation of their academic job strongly affects these faculty members' conceptions of conflict, particularly conflicts involving financial interests. However, this view seems to be contradicted by the same individuals' views of conflicts of commitment and conflict with graduate student interests, where the faculty perceive the two roles of entrepreneur and faculty member as separate. Thus, for these faculty members, their own perceptions of their entrepreneurial activities are not entirely consistent.

Issues Considered to be Genuine Conflicts, but Not Acted Upon (CG/NA)

By far the most striking difference between the experiences of the administrators and that of the faculty involves the category of issues which they consider to be genuine conflicts but do not act upon. In the experiences of the faculty, this category is empty. There are no issues which the faculty consider to present real conflicts and no cases in which others' perceive issues as posing conflicts which the faculty have not developed strategies for resolving.

Issues Considered to be Genuine Conflicts and Acted Upon (CG/A)

The faculty find that conflict of commitment poses the primary concern, and the problem they most frequently experience. For two of the faculty, Street and Davey, it is, in fact, their greatest concern. In contrast to the administrators, however, the faculty perceive this issue as a conflict between the interests of the entrepreneurial faculty and those of the students or as a conflict between the interests of the researcher as an entrepreneur and those of the researcher as a faculty member. Street has experienced conflicts involving his time due to intensive business travel and business meetings. He worries about the impact of his frequent physical absence on the training of graduate students because, to a certain degree, the "journeyman-apprentice" aspect is lost (Street 1996). He misses a certain number of opportunities to "just kind of hang out and watch them [graduate students] work and talk about their work..." (Street 1996). Travel also presents the possibility that Street will miss some of his classes. In order to avoid this, he often schedules his business travel in order to leave immediately after one class and return before another. Although he tries to meet the ideal of "never missing a class," he does not succeed all the time. Street's attempts at reconciling these contrary demands of business and teaching/mentoring and these competing needs to physically be in different places elicit the most stress for him.

Street also believes that differing demands on his attention, another conflict of commitment, presents his second largest concern. Because his company is relatively new it often seems more exciting. He struggles so that he does not

> recognize one group as first class because they are in the company and the other group that are working on research in the laboratories and are funded by NSF or NIH grants ... as second class citizens because they are just not as exciting as the company (Street 1997).

He maintains that because there are other individuals involved in running the company he can "protect himself" from this conflict. Because he does not have to do everything associated with the company he can reserve some of his attention and enthusiasm exclusively for academic teaching and research.

Currently, Davey and Gilmore believe they have effectively avoided any conflict of commitment through a judicious balancing act, always putting first priority on their faculty duties. However, it is Davey's "biggest worry [that] the company [may] start taking a lot of time. Suppose somebody sues the company. Or suppose some development happens which is extremely important for the company that will need a lot of my time. That worries me" (Davey 1997). If he simply devotes more time to the company, because he only has a limited amount of time, some other commitment will get short-changed. This would present a clear and unacceptable conflict for him. Instead, he thinks that should this problem ever present itself, he would hire somebody for the company instead of committing more time to the company.

Gilmore, like Davey, maintains that he has managed to balance the competing demands on his time. But what that means for him is that he never stops working. He intersperses work at the company with his work at the university, in the early morning, on his lunch hour, and at night.

Thus, these faculty employ three strategies specifically to address conflict of commitment. The first strategy is delegation. None of them are the sole owners of a company. In order to avoid becoming overwhelmed with work for the company, they rely on others to assist in running the company and to conduct company work. The second tactic is to schedule work for the company at hours different from work for the university. Thus, these faculty lessen the conflict of commitment in their perception by strictly separating time spent on company work and time spent on company work. Although it may first appear as if they perceive company work as a second job, that appearance is deceiving. The faculty are only attempting to maintain a definite separation between the company and the university.

Each faculty member also utilizes as a third strategy the approach of exceeding expectations. This strategy could be interpreted more as a defensive mechanism rather than a mechanism to solve or avoid any real conflict. The faculty see this strategy as guarding them against any appearance or accusation of conflict, for if the researcher is performing beyond expectations in his professorial role, how can there be any conflict? Street argues that he is "twice as productive" as he was prior to starting the company (Street 1997). He has maintained the level of his university activity while, at the same time, participating in running a company, thus prohibiting any insinuation of conflict. Davey states that, "you cannot tell

me my job is suffering because my evaluation has not changed. As a matter of fact, it has been going up..." (Davey 1997). Gilmore states this position the most frankly of the three: "I make damn sure that people think I do a good job ... and fulfill my obligations. I have NIH grant support. ... I have graduate students. I teach. I have an undergraduate class. Very hard to throw bricks at me" (Gilmore 1997a). They are not just fulfilling their obligations; they are exceeding them. In their opinion, this is proof positive that they are managing any conflicts of commitment they experience as a result of running a company while maintaining a faculty position.

A second conflict recognized by Gilmore and Davey is misuse of university resources, a conflict between the financial interests of the university and the interests of the entrepreneur and company. They characterize this conflict strictly as lack of separation between the company and the university. However, Street, whose company operates by giving grants to university faculty to support their research and then licensing any patents which result, does not even perceive this issue as a conflict.

Gilmore views this conflict as his greatest concern; how do you draw the line between the company and the university? He discussed one case at another university which he thought was clearly improper. In this example, the individuals were running the company in the university with university equipment which they leased for specified amounts of time. He also noted that they were quite "antagonistic" towards the university because these individuals felt that the university was impeding them. Gilmore's opinion is "that the university *should* put impediments in their way" (Gilmore 1997a).

Another example he discussed which was not so clear cut is one with which he is currently dealing. He has a post-doctoral fellow who is working half-time in his university lab and half-time in the company. Again, he maintains that it is crucial to keep a strict separation between the company and the university. The potential for not spending 50% of the time on the university work or for conducting company work at the university arises. The solution? "[T]hey and the professor that are doing it must have a moral ethics about what they're doing" (Gilmore 1997a).

Davey also focused on the possibility of conducting company work with university facilities or on university time, "if you originate an idea, where did you originate it at? The company during your weekend or did you originate it while you were using the computer here to check references? That is a tough one" (Davey 1997). According to Davey, this is a conflict that will never be resolved completely. There will be those individuals who will say everything was developed on their own time, and there will be those who distinguish the inventions that occurred in the company from those that were initiated in the university. However, he also emphasizes a positive aspect which may overwhelm this potential conflict: if the company with the new patent contracts a grant back to the university for further work and then a second invention arises from that work. For the second invention, the university would clearly be the co-inventor, a possible financial benefit to the university. Overall, he

believes this to be an inherent conflict. All that can be done is to try to "reduce it [the conflict of interest] to the minimum" and if "you have an individual who is relatively honest, [in the long run] the benefits outweigh the cost" (Davey 1997).

As discussed earlier, for these researchers (with the exception of Street) conflicts involving financial interests are strictly characterized in terms of lack of adequate separation between the company and the university. Consequently, the obvious solution is to maintain separation. For Davey and Gilmore, this entails actual physical separation of the company from the university lab. In this way, they are better able to guarantee that university resources are not being used for company work. There is some interaction between the company and the university in both cases: Gilmore and Davey are willing to let the company give a grant back to the university lab, and Gilmore currently has a post-doctoral fellow working part-time for the company and part-time for the university. However, these faculty insist on maintaining a "line" between the company and the university, and they consider only strictly limited crossover to be acceptable.

Another strategy used to resolve conflicts involving financial interests is avoidance. (As will be discussed, this is also a strategy used to resolve conflicts with student interests.) This strategy is evidenced in the following statement by Gilmore: "[s]ometimes I won't do something in the university lab because I think it might be too close [to company work]" (Gilmore 1997a). Avoiding the conflict of financial interest resolves the problem before it even begins.

The third and final conflict these scientists perceive is the clash between the interests of a graduate student and those of the company and its owner, the researcher-professor. Unlike the administration at MRU, these faculty members do not conceive of the graduate students as a university resource at all. Instead, all three seem to view graduate students as colleagues-in-training. As such, graduate students should engage in original research instead of research designated solely to "[attain] a company goal" (Street 1996).

Furthermore, these faculty are uncomfortable with the dual role of employer and mentor, a duality which they cannot resolve. This is not a type of conflict with student interests taken into account by the stereotypical view, the university-level administrators, or the department heads. Here the faculty cannot view the company as an extension of their academic job. The inability to separate these roles completely would lead to situations where the student would not know whether she was interacting with her employer or with her academic mentor. This duality does not arise when these faculty serve as academic mentors to graduate students conducting research sponsored by a company which the faculty member does not own. Then the researcher is responsible only for the quality of the science, not the financial value of it, and the researcher operates only as a mentor, not as an employer as well. Combining the disparate roles generates conflict.

Another aspect of this conflict involves secrecy stemming from the need to protect patentable information. These faculty consider this to be in direct opposition to a graduate student's interest to publish.

Gilmore and Davey also believe a graduate student working on proprietary research for their companies creates too much of a "messy" situation. The difficulties arise in trying to determine exactly how to divide the intellectual property between the company, the graduate student, and the university. This is quite similar to the example of inappropriately transferring a patent from the university to the company discussed in Chapter One, an example of misuse of university resources. However, in this case, the resource is not the graduate student, but the university materials. This last aspect is considered a problem even though, as discussed earlier, MRU has several provisions in place for graduate students to delay distribution of a thesis or dissertation for patent purposes and to be named the inventor or co-inventor on a patent.

In the words of the individual faculty members:

- We wouldn't put him on something that's like that [patentable]. ... If we did, we'd have to work it out with the university. OK, we're supporting this, we're doing this, and figure out how to handle the intellectual property. It's always a mess (Gilmore 1997a)

- I think it would be very difficult for me to have a graduate student working on a company project. ... Because there, I think we would get into a conflict between a student actually generating some new and very interesting knowledge of particularly, or maybe their own, initiative, versus attaining a company goal (Street 1996)

- The other reason I think it becomes awkward in a company to have a graduate student is that if there are some intellectual property rights on something that is tied to the research, then you've got issues of secrecy ... And where, for a student, publication of her first paper is the most important thing in the world ... that puts us in a real awkward situation ... by having faculty who are involved in companies, you now have new conflicts that would never have happened before. Because now the conflict revolves around the faculty member as both a mentor as well as an employer ... (Street 1997).

- Number one, the student wonders if he is being exploited and I agree with that ... and you have the problem of conflict of intellectual property. So who in the heck owns the invention, the university or the company? ... It is going to be a mess (Davey 1997).

Each entrepreneurial researcher has reached the same solution to conflicts between the interests of graduate students and the interests of the entrepreneur. They simply do not allow their graduate student to do graduate work for their company, and, also, they do not allow any graduate student to conduct graduate research on a subject for their company which obviously has patentable results. There is one interesting case of a graduate student, Paul Walden, who is conducting research for the company owned by Gilmore and working toward a graduate degree under the supervision of Street.[15] In this case, the criteria listed above have been strictly followed. Walden is not working on a project which will lead towards a patentable product for the company, and Gilmore, although a member of the advisory committee, is not his major advisor. With this arrangement, the conflicts with the student interests have been avoided. Walden will be able to publish his research with no delays or problems involving ownership of a patent. Further, as Street argues, "[Gilmore] is not both the student's boss in the company and his research advisor. I am serving to guide the research of that individual and in that way I am going to keep the focus on the research, and Gilmore can worry about the company" (Street 1997).

Issues Not Considered to be Genuine Conflicts, but Acted Upon because of the Perceptions of Others (NCG/A)

For certain issues these academic researchers do not discern any conflict. Yet they must approach these issues as they would those they consider to be genuine conflicts because other individuals perceive these issues as conflicts. These "other individuals" include legislators, other academic researchers, university officials, and the public -- generally anyone apart from the entrepreneurial faculty member. Resolution of these conflicts perceived by others attempts to stave off two situations. First, the treatment of entrepreneurial faculty that would follow from others' belief that a conflict exists. Second, a person, or group, using that apparent conflict to accuse an entrepreneurial researcher of inappropriate behavior. In particular, this latter situation is important to avoid because it may impact all entrepreneurial faculty as well as the accused researcher: "we're all going to get painted with the same tar brush" (Gilmore 1997a).

There are two sorts of cases that these entrepreneurial faculty do not consider to present real conflicts but to which they respond nonetheless because of the perceptions of others: capitalizing on university research and receiving grants from their own companies. In contrast, recall that both university-level administration and department heads considered

[15]Although I will not discuss this case in great detail, several interesting similarities do exist between the experiences of Walden and the experiences of the faculty (Walden 1997). For instance, Walden received no formal guidelines from the university, beyond those given to all graduate students and those concerning potential conflicts with his interests received from Gilmore, regarding how to manage his situation. A second example involves the strategies devised by Walden to resolve some of the conflicts he experienced being both a graduate student and an employee. The strategies, openness and exceeding expectations, are also employed by the faculty members. Although he may have picked up on these strategies from Gilmore, Walden never directly asked Gilmore and Gilmore never directly told him how to use these methods to resolve conflicts stemming from his situation. Apparently, in this case, a graduate student engaging in a peripheral form of entrepreneurial activity also has experienced some behavioral changes.

these situations to present genuine conflicts, albeit conflicts to which exceptions could be made. These faculty, although maintaining that intentionally appropriating profits from research developed with university resources is a conflict, do not perceive developing products based on university research or receiving grants from their companies as real conflicts. Their views on these issues rest on their understanding of their company as a continuation of their academic jobs.

Again, as discussed earlier, federal agency policy and state law have dictated resolutions for these types of conflicts of interest. In both cases, the department head and college deans have the obligation to review the disclosure and the right to deny the funding if it is deemed there is too great of a conflict of interest. Street approaches these conflicts by following these mandates. However, he acknowledges that, although in the eyes of the state and federal agencies this removes the conflict, some people may not consider the conflict eliminated,

> that piece of paper is filed as disclosing that I have a conflict of interest. That seems to satisfy the law ... Now, does that mean that everybody would agree with that? Maybe not. I've been in too many [situations] where something is obvious to me is not obvious to other people, and I try to point out why they're wrong, but they keep disagreeing with me (Street 1997).

According to Street, this appearance of a conflict of interest can never be fully banished, but he has satisfied the law through the filing of a statement of disclosure.

Street is satisfied that he has attempted to accommodate external perceptions. However, he sees no conflict. Seeing his company as an extension of his duties and responsibilities as an academic researcher has shaped his perceptions of this issue. For instance, when discussing his "[responsibility] for encouraging the economy of the area," he contended that, for him, "there's no perceived clash. I'm quite sure there are people who see clashes between us as faculty and as business owners, as us engaging in economic development kind of issues" (Street 1996). For him, profiting from his research through his company is not a conflict, but another way of fulfilling his university duty of economic development.

Gilmore also denies that there is a conflict of interest in either receiving a grant from his company or receiving federal funds for research in the university when his company is conducting related research. In addition, Gilmore similarly discusses this appearance of conflict of interest in terms of his responsibilities as an academic researcher, although not to the same degree as Street. Gilmore accuses NIH and other federal agencies of "[speaking] out of both sides of their mouth...." (Gilmore 1997a) because, even though they have a mandate to devote a certain percentage (3%) to small business research grants and technology transfer, when researchers apply for grants solely from the university they must sign the statement indicating no intention to capitalize on the research. Thus, Gilmore is not satisfied with this solution to the appearance of conflict of interest. Although he is not setting out to capitalize on any of his academic research, "I might well make a discovery, and, if I did, it would be patented through the university and it might or might not be licensed to my company"

(Gilmore 1997a). Thus, this solution seems a bit contradictory to him. He is being encouraged to capitalize on his research and told not to capitalize on his research at the same time. This solution of disclosure may relieve the appearance of conflict of interest, but Gilmore finds it somewhat hypocritical.

In Gilmore's opinion, the largest problem with appearance of conflict of interest occurs in the grant review process. But interestingly, Gilmore is concerned with an inverse conflict of interest: funneling money from the company to the university lab. In one instance he was initially denied a grant because one reviewer believed that because Gilmore had a company which was "obviously" contributing funds to his university lab and, therefore, Gilmore did not deserve a grant for his university lab. According to Gilmore,

> that's the way a lot of university researchers look at it. They think that's the only reason you'd have a company: to sneak some more money out of NIH because it's easier to get grants out of the SBIR program than to get it as a regular investigator on research grants out of NIH (Gilmore 1997a).

Gilmore does not recognize any conflict of interest in these situations. He does not find himself worrying about how to avoid transferring money from his company to his university lab; that is simply not a consideration. However, he does experience the impact of others' actions because they perceive a conflict. Unfortunately, in this kind of situation, Gilmore has no solution but to "challenge" the reviewer. In the above example, Gilmore did eventually receive the grant, but not in the full amount he requested.

For Davey, the predicament of appearance of conflict of interest is much simpler: "[t]he moment you say I have a company which works in an area very related to what I do could already appear as a conflict of interest" (Davey 1997). Davey does try to "minimize" this appearance through a strict separation of university and company business. Moreover, Davey feels that this appearance of conflict of interest is somewhat alleviated because the company is benefiting the university by bringing in additional revenue and by allowing him to teach students about the business world. Thus, Davey finds a slightly different solution to the appearance of conflict of interest than Street and Gilmore. Instead of relying upon the strength of law and agency policy to alleviate this conflict, Davey believes that the benefits gained by the university from the company should minimize this appearance of conflict. Davey's resolution to the appearance of conflict of interest seems to result from his interpretation of his company as an extension of his university job. Because the company is an extension of his academic work, there is no true conflict for him. Furthermore, although he recognizes that it may appear there is a conflict of interest, this appearance should be minimized because of the benefits the university reaps from his company.

Thus, all three entrepreneurial faculty members use approaches which are directed toward the situation. Only Gilmore, regarding the appearance of conflict in the grant review process, utilizes a strategy which endeavors to change the perceptions of those who consider the conflict to be genuine.

The strategies used by Gilmore and Davey to combat GC/A issues are the same used to resolve NGC/A issues. These faculty members attempt to maintain separation between the company and the university lab. The specific approaches do differ, however. Gilmore allows for certain interchange between the academic lab and the company. For instance, Simon North, frequently attends meetings of the academic lab and contributes to the discussions of the academic research projects (Gilmore 1997a). On the other hand, Davey maintains a stricter separation to the point where he does not talk about his company at the university.

General Strategies for Resolving Conflicts

The entrepreneurial faculty, in contrast to the administrators, have devised strategies intended to address all types of conflicts to which they feel they must respond. These general strategies are openness about the nature of their activities and discussion with peers.

Openness is crucial to all three faculty members, although all three execute this approach in different ways. Nonetheless, the essential sentiment remains constant: let others know the situation. Gilmore is the most vehement advocate of this strategy. He argues that the strongest way to ensure that no lines get crossed and no conflicts are found when it is too late is,

> to keep sunlight on it. I tell everybody, "I have a company. ... Please remember that." ... Everybody working at it and reminding everybody there is a potential conflict. "Please inform me if you see something. If somebody's upset, let me know. Let's figure it out. Don't try to hide anything" (Gilmore 1997a).

Street also encourages open discussion, particularly between those working on the company grant and those working on other grants in his university lab. The lab has weekly group meetings where anything can be discussed "freely." Davey also uses openness to diffuse conflicts. However, his use of this strategy differs from the others. For Davey, keeping the company separate takes precedence over openness. Thus, he does not inform others that he has a company, particularly his students. One of his graduate students, Rose Thorpe, actually learned that he had a company from someone else (Thorpe 1996). However, should anyone ask, it is Davey's policy to be completely open concerning his company interests, "I do not tell my students very much about what we do in the company. ... [but] if they ask me a question, I will answer the question." (Davey 1997).

The second strategy the entrepreneurial faculty use in managing all types and categories of conflicts is discussion with peers. All these discussions are informal. Talking over potential conflicts and how to manage the conflicts serves two purposes for these researchers. First, it provides an opportunity to learn how others have handled conflicts and, consequently, to prevent conflicts from occurring. Second, it allows these faculty to monitor others involved in entrepreneurial activity to ensure that one individual does not taint all the others through getting caught in a conflict. Davey has only consulted his peers when "things

get really rough" (Davey 1997). At these times, he appreciates the opportunity to talk with others in similar situations about how to manage times of strain. Street finds discussion about conflicts with others to be very "worthwhile ... that we keep talking about all of these issues all of the time ... I would hope that we could be more self-policing and anticipate circumstances before they happen..." (Street 1997). Gilmore emphasizes the monitoring aspect of this strategy, "we talk out the ethical issues and say where we think the lines are, and that way, when we think somebody's starting to go over the line, we can sort of bring it back by peer pressure." (Gilmore 1997a).

Thus, the faculty members have taken on the role of monitoring themselves and their peers for conflicts. Through the use of all these strategies, all three faculty members are quite confident that they have each successfully avoided or resolved all real and apparent conflicts, and they have done so themselves.

Issues Considered to be Genuine Conflicts but Expected Never to be Experienced at MRU (GC/NE)

None of the three faculty members have ever experienced bias concerning research results because of their company work. They have never felt as if they were not being "objective" (Davey 1997; Street 1997). Consequently, they do not perceive researcher bias as a conflict for them. However, they do acknowledge that this is a potential problem which could arise. Davey claims, for example, "I believe I am objective as I can be. I have not found it to be a conflict for me, but I can see the potential of that being a problem" (Davey 1997). Using student ideas without giving proper credit and hindering the sharing of knowledge on advisory committees are also essentially non-issues in these faculty's experiences, for they would simply never engage in such behavior. *Again, however, they do consider this to be a conflict if it were to arise at an institution. They firmly believe it would not arise here.*

Issues Not Considered to be Genuine Conflicts (NGC)

The remaining issues posited as conflicts in the literature and discussed in detail in Chapter One -- obstructing exchange of information and materials and directing research interests more toward applied topics accompanied by changes in publishing behavior -- are simply not found to be conflicts in any form by these faculty members. This exactly mirrors the experiences of the administrators.

These faculty members do not experience blocking of the exchange of information and materials due to their entrepreneurial interests. Directing research interests towards more applied topics occurs, but rather indirectly, and is not considered by the faculty to be a conflict either for themselves or for others. Further, none of these faculty members have experienced any apparent alterations in publishing practices as a result of their entrepreneurial activity.

All three of these researchers work in highly competitive fields. Because of this degree of competitiveness, they often keep results and materials from their academic research secret until publication. However, they see no difference between this practice and keeping results secret due to company proprietary interests, particularly because the company work does not remain a secret; company work, just like academic work, is published. This view is emphasized by Gilmore:

> Anything I did in the university was just published. ... Almost everything we have has been published one way or another. We have very few secrets. ... Everyone thinks that about a company. Usually it's more being good at your business than having some inside information. If you have that, you're going to patent it and then you publish it. There's really not any reason to keep much of it secret (Gilmore 1997a).

Furthermore, the faculty are reluctant to publish extensively concerning the work presently being conducted in their academic labs. Just as in industry, in the competitive arena of the academy, the faculty must guard the directions their labs will be pursuing over the next two or three years.

Steering research topics does seem to occur; however, any redirection of research interests is indirectly a result of the struggle to obtain funds instead of a direct result of owning a company. Also, these faculty members argue that steering also occurs for individuals who only conduct research in an academic setting. Thus, any slight directing of research interests as a result of entrepreneurial interests generates no conflict. This view is exemplified in the following comment of Davey.

> [W]hat are the factors that would drive your research prioritization? One is your personal interest ... The next way you look at where you are going to focus your research is where are the funds. ... So if there is an area where there are no funds, it would be nice to be interested in it but you better not work on that, but work on some other area where you have interest where there are funds. ... So coming back to your original question which was does having the company and the potential of making money with the company affect my research direction ... I would say no (Davey 1997).

These faculty members also have not found themselves to be modifying their publishing behavior due to their entrepreneurial activity. This has already been briefly mentioned in the discussion of obstruction of the exchange of information and materials: company information is published. Furthermore, these faculty members do not find themselves publishing company research in journals different from academic research. Davey contends, "[y]ou can see that my publications are coming out in the same array of journals they were ten years ago [before starting a company]" (Davey 1997), and Street maintains that he "will [not] have them [publications of company work] being separated in different journals..." (Street 1997). For Street, it is particularly important to aim for the same journals in publishing his work, whether it be company or university research, because those journals are the respected ones in his field and read by his professional peers.

The contentions of the faculty members that they have not changed the journals in which they publish are borne out through a rough examination of their publishing history (Figures 4.1, 4.2, and 4.3). As can be seen by tracking the number of their publications in types of journals over time, owning a company has, thus far, not significantly altered where they publish. For Gilmore and Street, there may be some shift toward publishing more frequently in journals with a more technical, methodological orientation, but the shift is very slight. Gilmore also did not publish nearly as many articles in 1992-1996 as in 1987-1991, the period in which his company was started, although his publishing record in that time is still comparable to that of the other two entrepreneurial faculty. Consequently, this drastic decrease in number of publications may not be due to his entrepreneurial activity. Other factors, such as increased responsibility in the university, may have contributed to this decrease. This is a crude examination at a time close to when at least two of the three faculty have founded their companies. Some change may still occur, or at least be more recognizable, in the future.

The only potential difference is that it is more likely that company publications will be delayed slightly until after the filing of a patent application. However, a delay of publication for patent purposes is also quite common in university labs of researchers who do not own companies. Because of the prevalence of this situation, as noted by MRU administration, MRU has specific policies for delaying publication of work as well as assisting faculty and students in the filing of patent applications. Thus, neither the faculty nor the administration find any conflicts due to delaying publication. In addition, the faculty have not experienced any altering of other publication practices. Consequently, the faculty dismiss the idea that publishing behavior has changed as a result of entrepreneurial activity.

Thus, the views of the faculty differ substantially from those of the administrators and the stereotype (see Table 4.1 for a summary), with the most striking difference being that, for these faculty, there are no conflicts which they recognize but have not developed means to address.

4.2 Teaching

These three faculty members have also found that their entrepreneurial activity has influenced the content of their teaching. All three discuss enthusiastically and positively how, based upon their own experiences, they now incorporate industry examples into their lectures. Davey, for example, argues that this is an "indirect benefit" to education because, "from time to time I will bring something up in a lecture which reflects some of my experiences out there in the real business world..." (Davey 1997). Similarly, Street contends that his company experience is a "benefit" because whereas before he could only speak knowledgeably to students concerning graduate school or medical/dental school (where he has

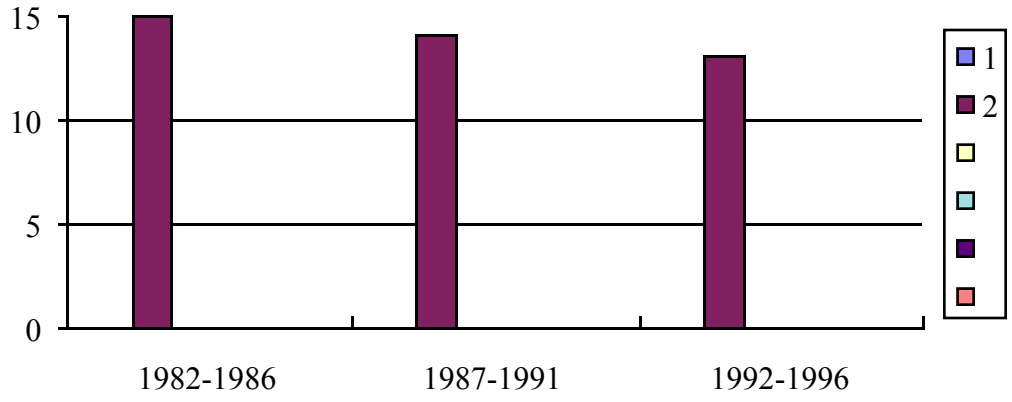

Figure 4.1 The Publication History of Dr. John Davey. His company was founded in the period 1992-1996. Key: 1 - Methodologically or applied research oriented journals; 2 - Basic research oriented journals.

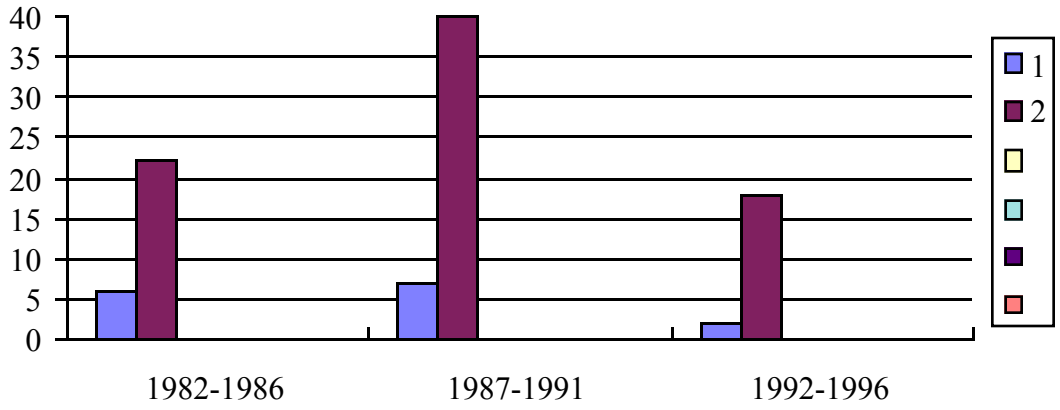

Figure 4.2 The Publication History of Dr. Patrick Gilmore. His company was founded in the period 1987-1991. Key: 1 - Methodologically or applied research oriented journals; 2 - Basic research oriented journals.

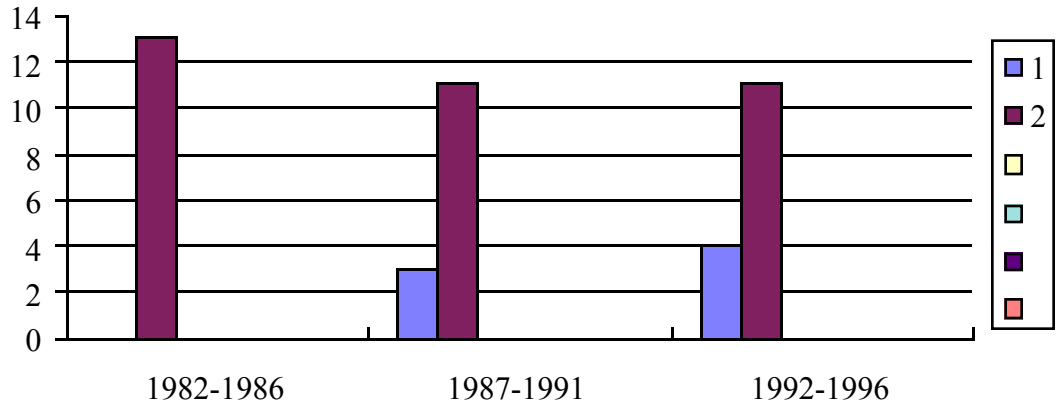

Figure 4.2 The Publication History of Dr. George Street. His company was founded in the period 1992-1996. Key: 1 - Methodologically or applied research oriented journals; 2 - Basic research oriented journals.

Table 4.1. Conflicts Due to University-Industry Interactions According to the Experiences of the Entrepreneurial Faculty at MRU. Issues differing from those perceived as conflicts in the stereotypical view are marked with an asterisk (*). 1=CG/NA, 2=CG/A, 3=NCG/A, 4=CG/NE and 5=NCG.

	Category of Conflict				
	1*	2*	3*	4*	5*
Conflicts involving financial interests					
Misuse of university resources		X			
conflict between the financial interests of the university and the financial interests of the entrepreneurial researcher and company					
Researcher bias				X	
conflict between the "ideal" of university scientific research and the financial interests of the entrepreneurial researcher and company					
Receiving grant from own company			X		
conflict between the "ideal" of the university and financial interests of the entrepreneurial researcher and company					
*Capitalizing on university research**			X		
conflict between the "ideal" of the university and the financial interests of the entrepreneurial researcher and company					
Conflicts involving student interests					
Use as inexpensive labor		X			
conflict between the career (and financial) interests of the student and the financial interests of the entrepreneurial researcher and company					
Use of ideas without proper credit				X	
conflict between the career (and financial) interests of the student and the financial interests of the entrepreneurial researcher					
Delaying publication		X			
conflict between the interests of the student and the financial interests of the entrepreneurial researcher and company					
Impede sharing of knowledge in advisory committee				X	
conflict between the interests of the student and the financial interests of the entrepreneurial researcher and company					
conflict between the interests of the researcher as entrepreneur and the interests of the researcher as faculty					
*Dual role of mentor and employer**		X			
conflict between the interests of the student and the dual role of faculty/entrepreneur					

Table 4.1 (cont.)

	Category of Conflict				
	1*	2*	3*	4*	5*
Conflict of Commitment *Time* conflict between the interests of the researcher as entrepreneur and the researcher as faculty conflict between the interests of the entrepreneur and those of the students *Energy and enthusiasm** conflict between the interests of the researcher as entrepreneur and the researcher as faculty conflict between the interests of the entrepreneur and those of the students		X X			
Steering of research to more applied topics conflict between the "ideal" of the university and the interests of the entrepreneur and the company conflict between the "ideal" of the university and the interests of the faculty member					X
Obstruction of the exchange of information and/or materials conflict between the "ideal" of the university and the interests of the entrepreneur and company					X

worked), he now can talk about industry. Consequently, he talks "continuously" in class about "the business of genetic engineering" using his experiences as examples (Street 1996).

In addition, both Street and Gilmore feel that it is important to teach students how science is conducted in industry because of their own experiences in hiring employees. Street emphasizes the need for students to become proficient in the technical skills, not just learning the science from a textbook, but participating in laboratory courses in which the students will learn methods crucial to industry work. His recognition of the importance of teaching methods is a direct result of his experience participating in a company: "[a]nd so because I am now in a company and I realize that when we hire somebody that they have to come in and perform right now..." (Street 1997). Gilmore also has modified his teaching because of the students he sees when he hires for his company. He, like Street, emphasizes not just industry examples, but also writing skills, lab skills, and cost-effective procedures for industry.

This newly realized importance of preparing students for jobs in industry has culminated in changing the structure of a senior-level biotechnology course. This course is deliberately organized so that business applications of biotechnology are taught as part of the course, not merely used as examples. The course goals are presented in the syllabus as follows:

> Science: Biotechnology is much more than just recombinant DNA, but you must have a reasonable background in this area before taking the course. Molecular Biology and Molecular Biology Laboratory or the [upper-level] Biochemistry course are mandatory preparation. We also will be spending a lot of time covering proteins since they are the most common product of biotechnology companies.
>
> The course will cover the recombinant DNA necessary to clone genes from prokaryotes and eukaryotes as well as how to produce the gene products and purify them. ...
>
> Business: Since biotechnology is the business of biology, the course will involve understanding the business side of biotechnology companies as well as the science on which they are based. The business lectures will be interspersed with the science and will constitute about 15% of the course. We also will cover the role of the Food and Drug Administration and the regulations that must be followed by the biotechnology industry (Syllabus 1997).

Students must learn about business as well as science. Consequently, beyond tests (which cover aspects of business and science), all students must make a presentation on a biotechnology company as if to a venture capitalist for "potential financial backing" (Syllabus 1997).

As mentioned in the syllabus, several lectures focused exclusively on business aspects. For instance, lectures were given by a patent attorney and a venture capitalist. However, these individuals did not just present the business of biotechnology; they discussed potential jobs and gave guidance on hiring and how to behave in a job. For instance, the patent attorney talked about the four characteristics he considers most important for hiring:

> Hiring: You will have to hire some very special people as consultants who will make or break you and your company. This is not a fraternity! Hiring must not be a friendship thing -- you get what you pay for. What do you look for?:
>
> Competence and Intelligence: it is hard to work and get along with stupid people or with people who act stupid.
>
> Experience: If you are hiring a lawyer to do a venture capital deal, hire one who has done lots of these deals before. Let him learn on someone else's money!
>
> Input Type Individual: You want someone who will use their judgment to help guide you from their experience. Experience which is not communicated well is useless.
>
> Character: Hire consultants who are interested in long term relationships -- it should be a win/win situation. Ask for references and call them! (Class Notes 1997).

Furthermore, this attorney gave the students examples regarding what he and other employers look for when hiring their own employees. For instance, he emphasized the importance of entry-level work experience and a error-free résumé. Similarly, the venture capitalist discussed the benefits and drawbacks to employees of employee stock options, as well as the financial vocabulary important to biotechnology companies.

Although the syllabus stated that 15% of the class would be devoted to business, the percentage was actually much higher. The professor who teaches this class, who also owns a company, frequently contributed business oriented comments regarding the science being presented. The following are only a few examples:

- When discussing the difficulty of cloning a gene and expressing the protein, called platelet factor, he mentioned a company which cloned that gene. It took them more than ten years, but, "platelet factor is worth about $500 million now."
- For the first writing assignment, the instructions included, "[m]ake it look like you would for business," i.e., graphically well-presented, clear language, and free of errors.
- Again, when lecturing on cloning, specifically on the use of a poly-thymidine segment as a primer for reverse transcriptase, "[t]hat turned out to be a problem for one of the biotech companies. Got all but a few amino acids of protein. Put it in, expressed it, got a patent. Making $100 million a year. Another company saw that that the amino acid sequence

didn't start with methionine. They went in and sequenced upstream. Took a patent on the new sequence. Now they split the market."
- When lecturing on protein purification, the professor emphasized the need to consider the FDA requirements for purification when designing a purification process in industry.

Thus, at the minimum, industrial examples are now being incorporated into lectures. At the maximum, students are now being tested on business aspects of science. These changes are a direct result of the faculty members' personal experiences in running a company.

The new structure of this course has encountered some resistance among other faculty members. Several faculty argue that attention to business aspects of science is not merited in a biological course. The disagreement is vehement enough in one life science department that the department does not grant its students credit toward the major for the course. Not all faculty opine that undergraduate life science majors should be taught the rudiments of the biotechnology business.

4.3 Interacting with Colleagues

Because of their entrepreneurial activities, these three faculty members also are experiencing changes in their relationships with colleagues, both other faculty and graduate students. Some of these changes are due to the responses of the entrepreneurial faculty to conflicts. Some of the changes in relationships with faculty are initiated by the other faculty while some are driven by the entrepreneurial faculty. The significant change in relationships with graduate students, however, is entirely of the faculty members' choosing. Furthermore, this change is hardly even noticed by the graduate students.

Other Academic Researchers

Because these faculty members own companies, they view their colleagues differently, and their colleagues view them differently. These modified perceptions are revealed in the grant reviewing process, the entrepreneurial faculty's interest in others' work, and the monitoring of the behavior of other entrepreneurial faculty.

As mentioned in the discussion of conflicts, many problems arise in the grant reviewing process for these entrepreneurial faculty. According to Gilmore, when reviewing grant applications from university labs, other researchers perceive faculty who own a company as using the company as a "front" in order to funnel money to the university (Gilmore 1997a). Consequently, these reviewers believe that researchers with a company do not need any more money for their university work. Furthermore, Gilmore believes that some of the problems may stem from jealousy and the opinion that "you should be totally clean and pure and keep away from [business]" (Gilmore 1997a). Thus, it is Gilmore's opinion and that of other entrepreneurial faculty that it is more difficult for those who own

companies to receive a fair review. These entrepreneurial faculty also find that they must remove themselves from committees. For instance, Davey is, "on several national committees ... and I have disqualified myself in some of them when this issue [related to his company work] came up" (Davey 1997). Due to their company work, they are occasionally unable to fulfill their duties effectively to their colleagues on these panels.

A second change in the interactions with other faculty members involves a change in the perceptions and roles of the entrepreneurial faculty. These three faculty now are not only looking for collaborative opportunities for research, but are also looking for research which could be commercialized for their company. Thus, they have begun to view their colleagues as potential business partners, "[w]e're always looking out for things. We always keep our little antennae open and our lid up to find people" (Street 1996). When Gilmore was collaborating with several of his academic colleagues he realized that they had a basis for starting a company (Gilmore 1997a). In this instance, the other faculty chose not to participate in forming a company. However, Gilmore was now looking at others' research with an eye for commercialization possibilities.

The third, and final, significant change in interactions with colleagues is also initiated by the entrepreneurial faculty. However, it is directed towards other entrepreneurial faculty rather than other faculty in general. As mentioned in the discussion of strategies to resolve conflicts resulting from their entrepreneurial activity, these faculty have begun to monitor the activity of other entrepreneurial faculty through informal discussions. This is not supervisors checking on subordinates, but peers checking up after each other. This is a new duty and responsibility of observing and attempting to regulate the behavior of other entrepreneurial faculty in order to prevent, "someone [doing] something stupid and it reaches the [newspapers] and we're all ... painted with the same tar brush" (Gilmore 1997a).

Graduate Students

Generally, the graduate students do not discern many advantages or disadvantages to their major advisor owning a private company. The one disadvantage they unanimously cited was the difficulty in the faculty member having enough time for meeting with the graduate student. Although the students usually did not directly link this to the company, there was the sense that the faculty member might have more time if he had no company. One student did find that there was a distinct, strong advantage of working with a faculty member who owned a company: the university lab is run "like a business" (King 1997). The research in the university lab is therefore directed towards a goal. In this graduate student's opinion, this business-like structure helps graduate students complete their research and add accomplishments to their curriculum vitae, such as publications.

On the whole, the graduate students of these faculty expressed indifference towards the company. With the exception of Paul Walden, they had no desire to participate in company research or to work for the company. However, what these graduate students fail

to recognize is that the entrepreneurial faculty exclude certain aspects of their research, namely anything having to do with the company, from them. The entrepreneurial faculty deny these graduate students the opportunity to conduct substantial company research, research which would lead to a product for the company. The limited exception is Walden who has been allowed to do research for the company, but only research which will not yield patentable results. For these graduate students, interesting and exciting company work, a significant part of their advisors' research, is simply not open for them to pursue. In other labs, faculty may not allow graduate students to work on certain projects due to, for instance, funding or manpower limitations. However, these projects are not explicitly denied to the students as in the case of entrepreneurial faculty.

As revealed in the discussion concerning conflicts with student interests, the entrepreneurial faculty are not denying these students opportunity to work on company projects for selfish reasons. The entrepreneurial faculty genuinely feel that company work is generally not adequate for graduate student research. Nonetheless, whatever the reason, profitable work for the company is not an option for graduate student research.

4.4 Conclusions

These three life science faculty are experiencing conflicts as a result of engaging in the management of a private biotechnology company while still maintaining their university position. Furthermore, university administrators provide almost no formal direction concerning which issues are conflicts and how to manage them. Consequently, the faculty have developed strategies to resolve both the GC/A and NCG/A issues. These strategies include delegation, scheduling company work around university work, exceeding others' expectations, maintaining separation between the university and the company, avoidance, disclosing financial interests, openness regarding their activities, and discussion with their entrepreneurial peers. These faculty have also begun to incorporate industrial examples and job skills into their classes, modifications in their teaching, as a direct result of their experiences with their companies. A third, and final, result of the entrepreneurial activity of these faculty has been the slight, but definite, modifications in interaction with their academic peers and graduate students. The entrepreneurial faculty have experienced peers reacting with suspicion, particularly in the grant review process, and they have had to remove themselves from some panel reviews due to their entrepreneurial interests. These researchers, with their new role of entrepreneur, now examine the research of their fellow academic peers for commercial potential. As a response to conflicts, they also examine the activity of their entrepreneurial academic peers for inappropriate behavior. Finally, graduate students are restricted from the research of the entrepreneurial faculty related to the company. These changes have all occurred as a result of the faculty members' entrepreneurial activity.

CHAPTER FIVE: CONCLUSIONS

In this thesis, I have explored the impact of the ownership of biotechnology companies on the experiences of three entrepreneurial faculty members and on relevant university administrators. It is important to recognize that these are three positions along the spectrum of experiences of entrepreneurial faculty. In different local situations and with different people, the picture which emerges may be strikingly distinct from this one. However, this examination of the experiences of faculty members owning companies provides a description of significant, particular individual locations. This thesis has shown how administrators are attempting to manage conflicts arising from this situation and how faculty members, due to their entrepreneurial activity, are experiencing changes in responding to conflicts, in their teaching, and in their interactions with colleagues.

5.1 Conflicts

This study has revealed some significant differences between the views of entrepreneurial faculty and administrators, and between both of these and the stereotypical view. In particular, the stereotypical view deals only with issues it takes to present genuine conflicts. However, the entrepreneurial faculty and the administrators categorize situations as either GC/NA, GC/A, NGC/A, GC/NE, or NGC issues and include some conflicts not recognized by the stereotypical view.

In particular, the faculty and/or administrators experience four issues as conflicts which are not encompassed within the traditional stereotype. They also offer a basis for considering for each issue as a conflict.

1) The administrators (but not the faculty) regard graduate students as a university resource. Consequently, they experience the inappropriate use of graduate students for company work as a conflict between the financial interests of the university and the interests of the entrepreneur.
2) The administrators find capitalizing on university research to present a conflict between the "ideal" of the university and the financial interests of the entrepreneur.
3) The faculty experience the dual role of mentor and employer as a conflict between the interests of graduate students and their dual roles of faculty member and entrepreneur.
4) Finally, the administrators view the differing demands on researchers' energy and enthusiasm as a conflict between the interests of the university and the interests of the entrepreneur, while the faculty view this issue as a conflict between the interests of the researcher as an entrepreneur and the interests of the researcher as a faculty member as well as between the interests of the entrepreneur and the interests of the graduate students.

The dissimilarities among the various positions I have examined reflect differences in viewpoint. The stereotypical view is constructed predominantly from an outsider's viewpoint. It takes into consideration issues which others consider to be significant problems

arising from entrepreneurial activity by university faculty. However, from the viewpoint of administrators and entrepreneurial life science faculty who must manage conflicts, certain issues in the stereotypical view do not pose any problems while others are found to pose problems only because of the influence of the stereotypical view on others' perceptions. In the case examined here, the stereotypical view does not fit very well.

This examination has also shown differences and similarities between the views of the university-level administrators, the department heads, and the three entrepreneurial faculty members. The differences between views are most prominent in the categories of conflicts -- whether an issue is considered to be a GC/NA, GC/A, NCG/A issue. A second contrast exists in how they conceive of conflict of commitment. The administrators view this issue only as a conflict between the interests of the university and those of the entrepreneur. However, the faculty also include conflicts between the interests of graduate students and the interests of the entrepreneur and conflicts between the interests of the researcher as a faculty member and the interests of the researcher as an entrepreneur. The entrepreneurial faculty, department heads, and university-level administration also differ greatly regarding action taken in resolving conflicts. The university-level administrators have very few strategies to resolve conflicts. Of those they use, two are mandated by outside agencies and one is a common strategy in universities. The department heads use strategies of monitoring to resolve and prevent conflicts. The entrepreneurial faculty use both monitoring and active strategies. The most prominent similarity between these three views is that all agree regarding which issues are not considered to be genuine conflicts.

The university-level administration hold that the following are the consequential problems: the use of university resources (including graduate students) for company work, which is a conflict between the financial interests of the university and the financial interests of the entrepreneur; the use of graduate students as highly skilled labor which is a conflict between graduate student and university interests and the financial interests of the entrepreneur; and conflict of commitment in the form of both time and enthusiasm which, to the university-level administrators, is a conflict between the interests of the university and the interests of the entrepreneur. However, the administrators, with only two exceptions, have made no effort to develop responses to these conflicts. The two exceptions are Hunter who has begun to respond to the conflict of competing time demands by forming a committee to investigate the matter, and the university regulation, mandated by state law, responding to the conflict of commitment which limits the amount of time a faculty member may devote to consulting. These administrators also see conflicts in two additional situations not included in the stereotypical view: researchers capitalizing on university research in their companies and researchers receiving grants from their own companies. In both cases, the result is perceived as a conflict between the "ideal" of university research and the interests of the entrepreneur. To resolve these conflicts, the administrators adhere to the guidelines of federal agencies and state law previously mentioned. However, a review by the university-level administration and department administration may find, and often does find, that the conflict of interest is not significant. One administrator, Hunter, finds that the appearance of conflict

of interest must be addressed by being excessively conservative, a strategy also employed by the entrepreneurial faculty. This strategy is directed at the appearance of conflict rather than at changing the belief. Beyond the one conflict with student interests, the administrators view no conflicts between graduate student interests and the interests of a faculty member who owns a company. They do believe that researcher bias is a real conflict, just not one which will ever arise at MRU. Consequently, at MRU, they have taken no action regarding this conflict. The university-level administrators do not recognize obstruction of the exchange of information and materials and steering of research as conflicts. For the most part, the university-level administrators rely on the integrity of the faculty and the monitoring of the department heads to manage (i.e., avoid) any conflicts.

The department heads consider misuse of university resources as a conflict between the financial interests of the university and those of the entrepreneur, capitalizing on university research as a conflict between the "ideal" of university research and the interests of the entrepreneur, and conflict of commitment (except for Johnson who does not consider this to be a genuine conflict) as a conflict between the interests of the university and the interests of the entrepreneur. They have taken no action regarding misuse of university resources. For the other two conflicts, they rely on faculty and graduate student evaluations as well as the disclosure policies mandated by state law and federal agencies as solutions. Johnson, like the university-level administration, considers the issues of the appearance of conflict and the misuse of graduate students (where graduate students are considered a university resource and the conflict is between the financial interests of the university and those of the entrepreneur) to be genuine conflicts. However, he has never experienced either, and, therefore has taken no direct action regarding them. His recommendations regarding how to approach the appearance of conflict of interest involve addressing both the situation and the individuals who perceive the conflict. Unlike the university administration, the other department heads do express a concern about conflicts between graduate student interests and entrepreneurial faculty interests, but only in the most general terms. For the department heads, in contrast to the university-level administration, none of the issues which they do not consider to be genuine conflicts but which are perceived as causing conflicts within the stereotype require action. As with the university-level administrators, the department heads hold that researcher bias and the misuse of graduate student ideas are genuine conflicts, but ones which MRU will never encounter. Lastly, the department heads do not consider steering of research or obstruction of the exchange of information and materials to be genuine conflicts.

The department heads view their job as one of distant monitoring, making sure that the faculty members who participate in running companies are continuing to contribute to the department and examining and approving any required financial disclosure. They depend liberally on the faculty to address any conflicts directly.

Consequently, the faculty members, with very little input from administration, must determine what the conflicts are and how to resolve any conflicts. The most immediate and noticeable difference between the experiences of the entrepreneurial faculty and those of the

administrators is that there are no CG/NA issues for the faculty. For these three faculty members, they found conflicts of commitment, both in time and enthusiasm, to be the most significant problem. In contrast to the administration, however, the faculty view conflicts of commitment as involving conflicts between the interests of the graduate students and the interests of the entrepreneur and between the interests of the researcher as a faculty member and the interests of the entrepreneur. They respond to this by delegating company work to other individuals involved with the company, scheduling company work around university work, and exceeding what is expected of them. Gilmore and Davey, though not Street (who finds this to be a non-issue), consider misuse of university resources to be a genuine conflict between the financial interests of the university and those of the entrepreneur and characterize it as a lack of separation between the company and the university. To address this conflict, these faculty maintain a "line" between the company and the university, though limited interaction is allowed. Faculty, unlike the university and departmental administration, do not consider graduate students as university resources at all. They do feel that there exists a very strong conflict between the interests of a graduate student and the interests of the company. Consequently, even though the university has mechanisms in place for students to conduct proprietary research, these faculty refuse to allow their students to conduct graduate research for a company where the results are likely to be patentable. Furthermore, they are uncomfortable with the dual role of major advisor and employer. The faculty members simply will not take on such distinct roles at one and the same time in relationship to one of their students.

These faculty do not consider capitalizing on university research and receiving grants from their companies to be real conflicts. However, they do recognize that others perceive these issues as conflicts between the "ideal" of the university and the interests of the entrepreneur. Consequently, they adhere to the disclosure policies and administrative review for conflicts of interest and, again, maintain a degree of separation between the university and the company. Both these strategies are designed to address the appearance of the conflict instead of the belief that there is a conflict.

These faculty, in contrast to the administrators, also have strategies designed to account for all types of conflicts, not just specific ones. These strategies are openness regarding the nature of their activities and discussion with peers. Discussion with peers allows the faculty more than opportunity to exchange successful strategies for resolving conflicts; it also gives entrepreneurial faculty an opportunity to monitor their peers for the occurrence of these conflicts.

The entrepreneurial faculty perceive researcher bias, use of graduate student ideas without proper credit, and impeding the communication on graduate student advisory committees as genuine conflicts. However, they steadfastly maintain that they are not conflicts which they personally will ever experience. They do not recognize as conflicts, and do not act upon, the issues of steering of research and obstruction of the exchange of information and materials.

5.2 Teaching

Along with experiences resolving conflicts, these three faculty members have also changed the content of their teaching as a result of their entrepreneurial activity. All three now incorporate examples from their business experiences into their lectures. Gilmore and Street are motivated to better prepare students because, similar to the field of engineering in the 1910s and 1920s as analyzed by Noble (1977), they have found that, as employers, they now have a better understanding of what employers expect. Consequently, they are shaping their classes to prepare students for industry jobs. This is an addition to their teaching content rather than an exclusion of other options. An extreme example of this sort is found in the biotechnology course discussed in the previous chapter which does not merely use industrial examples to illustrate the science, but actually covers the unique considerations of science conducted in an industrial setting.

5.3 Interacting with Colleagues

As a result of entrepreneurial activity, these faculty have experienced changes in their relationships with other faculty and graduate students. Other researchers, particularly in the grant review process, view these entrepreneurial faculty with suspicion. These three faculty also, on occasion, must remove themselves from review committees because of their entrepreneurial activity. They have found themselves monitoring other entrepreneurial faculty in an attempt to avoid anyone succumbing to conflicts, which would, in their opinion, taint all entrepreneurial faculty. All these changes are due to conflicts arising from faculty entrepreneurial activity. Finally, the entrepreneurial faculty look upon their colleagues as potential business collaborators as well as academic collaborators due to their new role as entrepreneur.

Graduate students, rather surprisingly, are largely indifferent to their mentor's ownership of a biotechnology company. They have very little interest in the company and the research of the company. However, although the graduate students seem not to recognize it, there has been a shift in the graduate student-mentor relationship, for now there is a certain part of the faculty member's research which is not accessible for the graduate student to work on. I must emphasize that this change is not a selfish one. Rather, the entrepreneurial faculty are attempting to look out for the students' best interests by guaranteeing that their graduate work will be original and without any direct influence from the advisor's company. Again, this change is due to the response of faculty to conflicts arising from their entrepreneurial activities.

5.4 Summary

The differences in view between university-level administrators, department heads, and entrepreneurial faculty regarding conflicts are largely due to position and role. The

administrators are more concerned with conflicts involving university interests, while entrepreneurial faculty are more concerned with conflicts involving their interests either as an entrepreneur or as a faculty member. Further, relative to the conflicts, the faculty and administrators are located differently. The faculty experience the conflicts immediately. There is a delay before any conflicts come to the attention of administrators. Thus, the rates of change differ: departments are slower than individual faculty and administrative procedures are generally even slower. Occasionally, the central administration may first set a structure in place to facilitate certain directions of individual change. However, thus far, this has not happened in these situations. Only one guideline has been put in place solely by the central administration: the restriction on the amount of time allowed for consulting work by faculty.

Although the central administration has not directly attempted to guide individual behavior regarding entrepreneurial activity, there are certain institutional structures or prior practices which are not directly intended to address changes associated with entrepreneurial activity, but which nonetheless may have impact on the behavior of entrepreneurial faculty. These may serve as pre-adaptations, particularly for resolutions to conflicts, similar to the argument of Etzkowitz (1983) that academic team research required characteristics of an industrial company, thus paving the way for faculty to participate more readily in industrial research. For instance, the entrepreneurial faculty in this case study all had tenure. Tenure may provide faculty with the necessary freedom to pursue entrepreneurial activity with minimal guidance from the administration. Tenure may provide these faculty with not only academic freedom, but entrepreneurial freedom as well. Similarly, there are already devices in place to assign credit appropriately among cooperative and competitive academic labs as well as among students and faculty. These devices may have influenced the strategies developed by the entrepreneurial faculty for resolving conflicts. Further investigation is needed to determine the extent of the impacts of these other factors.

I have explored the experiences of university administrators, department heads, and three entrepreneurial individuals. I have examined what they find to be genuine conflicts, what input the administration gives the faculty members concerning conflicts, what their strategies are for dealing with these conflicts, how the faculty teach their students to better prepare them for industry employment, and how the researchers' interactions with their peers and graduate students have changed because of their entrepreneurial activity. In many ways, the picture that emerges from this study stands in striking contrast to the pervious literature examining university-industry relationships. Prior work has argued either that faculty are changing their behavior in order to conform to mandates from administration or that the conflicts are not terribly prevalent or, simply, that some form of change is occurring. This analysis has revealed the specific ways in change is being experienced in the areas of managing conflicts, teaching, and professional relationships. This study has shown that the entrepreneurial faculty and administrators are experiencing conflicts as a result of faculty owning private companies (although not always the ones portrayed by the stereotypical view). However, the administration is not dictating specific actions to address these conflicts. The entrepreneurial faculty themselves have developed strategies to resolve

conflicts, both those they consider genuine and those considered genuine by others. This study has also shown that entrepreneurial faculty are incorporating business examples into their teaching and experiencing suspicion, the need to execute themselves from grant review panels, and the limitation of potential graduate student research in their interactions with colleagues. In conclusion, this study supports the argument that the effects of entrepreneurial activity are quite real and quite prevalent, although they are not always the effects espoused by the stereotypical view.

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