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The Relationship between Universities and Industry: The American University Perspective

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Dedicated to the memory of Professor Vera Johanides, Croatia's pioneering biotechnologist

Summary

The enactment of the Bayh-Dole Act in 1980 by the U.S. Congress allowed universities and small businesses to own patents on research which had been federally-sponsored. This has revolutionized the relationship between academia and industry. The legislation allowed universities to license their patents to industry, exclusively or non-exclusively. Royalties, received by the universities for such licensing, are used for further research and education as well as for rewarding the inventor(s). The intellectual property (the patent) is held by the university and licensed to new or existing companies. Intellectual property is also a key component in research collaborations between universities and companies. Although the interests of the academic and the industrial partner are very different, successful collaboration has been possible when both parties respect each other's interests and ease the tension around intellectual property considerations. The thorny issue of publication from such collaborations is resolved by allowing the company 30–60 days to examine the manuscript and determine whether patentable inventions are present. Within this period, the patent is filed and the academics are then able to submit the manuscript for publication. The industrial partner is offered the following alternatives: *(i)* a non-exclusive license to the technology at zero or nominal royalty; *(ii)* a royalty-bearing exclusive license; or *(iii)* a waiver of rights for a share of the university's licensing revenues (the last being offered by only a few universities). The university charges the company the same overhead rate that it charges the federal government on grants. Successful interactions between academia and industry rely on interpersonal (= interscientist) relations on both sides; frequent contact is recommended. The royalty income of leading universities represents, on the average, about 0.5 to 2 % of the annual research budget. In a few cases, some successful universities have obtained major revenues from one or two very successful licenses. University licensing has led to the establishment of an impressive number of new companies. M.I.T. is currently granting 80 to 100 licenses per year to its technology, and spinning off 10 to 20 new companies per year; since 1987, 202 new companies have been founded. Nationally, over 2000 new companies have been established around university technology licenses.

Introduction

Prior to 1980, commercialization of intellectual property from universities was rare and of little interest to most universities. However, the enactment of the Bayh-Dole Act by the U.S. Congress in that year had a remarkable effect on the relationship between academia and industry by allowing universities and small busi-

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nesses to own patents on research which had been federally-sponsored. The legislation allowed universities to license their patents to industry, exclusively or non-exclusively. Royalties, received by the universities for such licensing, were to be used for further research and education as well as for rewarding the inventor(s). From 1981 to 1987, the U.S. Executive Branch provided Executive Orders which loosened restrictions on the granting of exclusive licenses by universities to industry. As a result, many new companies have been formed in the US creating hundreds of thousands of jobs and many billions of dollars in business revenues. As a result, students become aware of the potential commercial value of their research and some are motivated toward applications of science and technology.

The Bayh-Dole Act was based on the need to protect university technology with intellectual property in order to provide an incentive for industry to invest in development of the technology. Since most university inventions are embryonic, commercialization requires substantial investment of time and money to reach the market. And the risk is high, since neither the technical practicality nor the market profitability has been established at the point at which the university transfers the technology to industry for development. Strong intellectual property protection provides an incentive for the developing company to take the risk, since if the product succeeds, the company will have a market monopoly through the exclusive license.

Benefits of Protection of Intellectual Property by Academia and Licensing It to Industry

Protection and licensing are of great value to the U.S. public since it leads to job creation and economic prosperity. These are the reasons that it is encouraged by the U.S. government. It also brings good publicity to the academic institution as one which is aware of the commercial potential of research over and above its basic knowledge value. Protection and licensing also attract industrial sponsorship of university research and motivates faculty. The latter comes about *via* the appreciation by professors that their research can be put to good use, that they can share in royalties, and enjoy increased opportunities for consulting and participation in industrial Scientific Advisory Boards. Closer ties between academia and industry are established, providing job opportunities for graduates and revenue generation for the university.

Contrast between the Two Cultures

There is no doubt that the interests of the academic and the industrial partner are very different. These differences are evident in the negotiations around university licenses, but even more so when companies and university collaborate in research projects. The university has a societal responsibility whereas the company has a proprietary responsibility to the company's stockholders and is therefore driven by profit and loss. The goals of the academic researcher are open-ended whereas the company development projects are guided by specific targets around company objectives. Academic research is unpredictable, cannot promise anything and must be free to change directions at any time. In contrast, the industrialist wants specific objectives and specific milestones for success of the project. Academic research has a long term view as opposed to the short term orientation of industry. Finally, the professor is an individualistic character, a type of Prima Donna, whereas the industrial contact is a member of an institutionally controlled hierarchy and is accustomed to team research. Despite these many differences, successful collaboration is possible if both parties respect each other's interests and goals, and try to ease the tension around intellectual property considerations, among others. Both parties must understand that the purpose of the collaboration must be to *(i)* support more discovery research, *(ii)* educate students (potential industrial researchers) about the concerns and approaches of industrial research, and *(iii)* improve the transfer of academic discoveries to the public *via* product development by the collaborating company. The compromises that universities and companies make in their negotiations of research collaborations are based on these fundamental principles of academic research but with the understanding of the needs of the collaborating company. Some of the major terms of these research agreements are discussed below.

Publication

It is an absolute requirement for university professors and their students to publish their results since dissemination of knowledge is the essence of academic research. This is the chief way by which professors are judged by their peers, achieve advancement and tenure, and obtain future grants and recognition. For students, publication is essential to obtaining post-doctoral positions and jobs. Since industrial partners fear that publication will endanger their intellectual property arising from the collaboration, some compromise has to be worked out. This is usually done by the granting a period of 30–60 days during which the company personnel examine the manuscript and determine whether it contains any patentable items and, if so, the writing of the patent begins. After the patent is filed, the academics are able to submit the manuscript for publication. All of this usually takes place in 60 days but, in certain cases where good reasons exist, the manuscript is submitted after 90 days.

The Intellectual Property Issue

Industry could take the view that they paid for the research and should own the intellectual property (the patent) especially since it may be vital to their business and competitive position. However, most universities insist on owning the patents arising from their research, since only through such ownership can it *(i)* assure that the technology will be developed; *(ii)* assure also that the university can retain the rights to practice under its own inventions to assure its freedom of action in the future; and *(iii)* maintain a consistent policy for its investigators, whether they are working on government-funded

research or on industrial collaborations. The university further justifies this ownership by the fact that the company has not paid for the development of background knowledge, training of students and staff, purchase and maintenance of much of the laboratory equipment, and acquisition of the up-to-date know how and special world-class expertise of the professor. The company has merely tapped into a limited portion of this fountain of knowledge, experience and facilities for a limited amount of time. The company's relationship with the university is temporary; the university intends to go on forever. Most companies do understand that the university cannot compromise on ownership of patent rights because of the need for consistency, assurance that its technology will get developed, and freedom of action for future research. They are therefore usually willing to reach a compromise in which the university owns the patent but gives the industrial partner license rights. Under MIT's standard polices, the industrial sponsor is given the option to elect one of three alternatives for patents arising from the sponsored research: *(i)* a non-exclusive license to the technology at zero or nominal royalty; *(ii)* a royalty-bearing exclusive license; or *(iii)* a waiver of rights for a share of the university's licensing revenues (the last being offered by only a few universities). This is one example of the manner in which creative compromises are made so that the company can maintain its competitive position and the university can preserve its mission.

Overhead Rates

Most universities charge the company the same overhead rate that the federal government allows on its grants. Although in theory this federal overhead rate covers the full indirect cost of the research, many types of charges are disallowed by the government, and the university is subsidizing the research to some extent at the »government rate«. Companies sometimes object to paying even that overhead rate, arguing that the university already has the laboratories, the library, the personnel department, heat, lights and technology transfer office, and that therefore the company should only pay for the direct costs of the research. However, this is not possible since the government will not allow a special discount to industry as compared to federally-funded projects. Any shortfall would have to be made up by private philanthropy and student tuition. Once this is explained to the companies, they usually have no objection to the rate, particularly since it is usually substantially lower than their own overhead rates.

Successful Collaboration

At the university, the principal investigator (P.I.) is key. The P.I. must understand and sympathize with the company's objectives for the project and see it as fully compatible with his/her research and personal objectives. At the company, there should be a project advocate who has influence in the company. It is extremely important that communication is personal and frequent. There must be ample funds in the budget for frequent visits of the academics to the company to report on progress and for company representative to visit the university often.

Patent and Licensing Revenues

Patents granted to universities, research hospitals, and research institutes rose from 400 in 1980 to 3200 per year in 1998. Table 1 shows the number of patents obtained by various U.S. universities in 1999. The University of California (UC) system is comprised of many universities such as UC Berkeley, UC Los Angeles (UCLA), UC Davis, UC Irvine, UC San Francisco, UC Riverside, *etc*. The same applies to the State University of New York. Thus, comparing individual universities in patent numbers with such large state systems is somewhat misleading. From 1995 to 2000, M.I.T. obtained over 100 patents per year (only U.S. patents are counted, though many foreign counterparts were obtained). The royalty income that the leading universities receive from licensing patents is generally quite small compared to their research budgets, usually representing no more than about 0.5 to 2 % of the annual research budget. In the long range, these institutions hope to reach a level of 5 % of their income from licensing. However, sponsorship of research by companies can represent a much larger income potential for research. In 1999, 20 % of M.I.T. research was funded by industry. In a few cases, some successful universities have obtained major revenues from one or two very successful

Table 1. Top 20 U.S. technology transfer institutions in 1999[a]

Institution	Patents Issued
University of California	468
Massachusetts Institute of Technology	151
University of Texas	115
Johns Hopkins University	108
California Institute of Technology	103
Stanford University	91
University of Wisconsin	87
Cornell University	69
University of Pennsylvania	64
Washington University	60
Columbia University	59
University of Massachusetts	59
University of North Carolina	58
University of Michigan	58
University of Minnesota	55
University of Florida	55
State University of New York	54
Michigan State University	54
University of Washington	53
Harvard University	49

[a] R. Zacks, The *TR* University Research Scorecard, *Technology Review, 103* (2000) 88–92.

licenses. These include the Cohen-Boyer patent on recombinant DNA (Stanford University, University of California San Francisco), the Axel patent on gene expression (Columbia University), the patents on Warfarin and vitamin D (University of Wisconsin), the patent on the *cis*-platinum antitumor agent (Michigan State University), the Hemophilus vaccine patent (University of Rochester) and the Taxol synthesis patent (Florida State University).

By 1998, new technology license and option agreements increased to 3400 per year nationwide. In 1995, exclusive licenses of M.I.T. had amounted to 205 with an average age of 4.6 years. The revenue received by M.I.T. was $38 million. These M.I.T. licenses induced an investment by industry of $922 million in product development expenditures on the development of MIT-derived technologies and employment of 2 300 people. Nationwide by 1998, the investment by companies in the development of university-derived technology amounted to $2.46 billion. Industrial revenue from product sales totaled $33 billion and the number of employees employed in either the development or manufacture and sale of university-derived technology was 280 000.

Start-up Companies

University licensing has led to the establishment of an impressive number of new companies. M.I.T. currently is setting up commercial licensing agreements at a rate of 80–100 per year with a total of about 600 active licenses. Of the new licenses granted by M.I.T each year, over 20 are new companies formed to develop the MIT-derived technology. Since 1987, more than 200 new companies have been founded. A sampling of some of these start-up companies is given in Table 2. Nationally, over 2000 new companies have been established around university technologies.

Start-up companies are most attractive in very early stages of high risk technology with multiple applications and no established companies in the same business. They are most successful when the inventors actively participate in the company, *e.g.* the professor acting on the Scientific Advisory Board; the students becoming employees and/or executives of the new company. In many cases, the new company with core technology will license its early products to various other companies with larger financial holdings. Ultimately, it will hopefully obtain enough funds to produce and market its own products.

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Table 2. A sampling of M.I.T. start-up companies

Company	Field
Acusphere	Contrast Imaging Agents
Akamai	Internet Server Technology
Alkermes	Drug Delivery
America Superconductor	Superconductors
Arris Pharmaceutical	Biotechnology (Rational Drug Design)
Cambridge Heart	Heart Monitoring
Curl	Web Language Software
EXA Software	Parallel Computing
Integrating Computing Engines	Supercomputers
Interneuron	Pharmaceutical (Neuroactive)
Kinematix	Physical Rehabilitation
Lab Connections	Chemical Laboratory Equipment
Matritech	Cancer Diagnostics
Metabolix	Biodegradable Polymers
Micrion	Equipment for Semiconductor Chip Repair
Neurometrix	Neural Diagnostics
Pharmaceutical Peptides	Pharmaceuticals
R.S.A. (merged with Security Dynamics)	Computer Security
Reprogenesis	Tissue Repair
Soligen	Machine Tools & Molds (3D Printing)
Somatix (Merged with Genzyme)	Biotechnology (Gene Therapy)
Sontra	Ultrasound-Based Drug Delivery
Therics	Drug Delivery-3D Printing

Further reading:

1. AUTM Licensing Survey: FY Association of University Technology Managers, Inc., Northbrook IL (1999).
2. L. Nelsen, *Science, 279* (5356) (1998) 1460–61.
3. L. Nelsen: Investing in technology-based university intellectual property, Chapter 8. In: *Hidden Value, Profiting from the Intellectual Property Economy*, Bruce Berman (Ed.), 21st Century Books (1999).
4. L. Pressman, S. K. Guterman, I. Abrams, D. E. Geist, L. L. Nelsen: Pre-Production Investment and Jobs Induced by M. I. T. Exclusive Patent Licenses, *Journal of the Association of University Technology Managers* (1995).