CHAPTER

Effective Knowledge Transfer: From Research Universities to Industry

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INTRODUCTION

The model for industrial research has changed. The era of large, independent industrial research laboratories, operating in isolation, has largely passed. This trend started a decade ago and continues apace. It is the consequence of several forces that continue to gain momentum. And even as industry looks increasingly outside its own laboratories for new technologies, changes within the universities make them more receptive to industry partnership.

In the U.S., the Bayh Dole Act in 1980 launched a fundamental change in the position of public universities concerning applied research, and the licensing of consequential intellectual property. In the European Union, Janez Potocnik, Commissioner for Science and Research, has spelled out a new direction for E.U.-sponsored research, emphasizing "simplification" in the Seventh Framework Programme for 2007 to 2013. One goal of this simplification is enhanced university-industry collaboration. The U.K.'s 2003 Lambert Review (H.M. Treasury, 2003) outlined new approaches needed for university–industry interactions in that country. Japan, through its Ministry of Education, has liberalized the terms on which its universities engage in work with industry, offering professors more freedom in undertaking compensated work outside their university appointments.

Thus, the largest economies of the world are driving changes in the way that their universities work with industry. Tighter budgets for government-sponsored research are another factor driving universities toward more industry-funded research.

Since the end of the Cold War, the U.S. national laboratories have explored new technologies and sought new missions. Federal legislation enacted in the late 1980s opened the door for technical transfer offices at the national laboratories. Collaboration with industry is now more attractive to government labs in the U.S. and elsewhere.

Another important trend for industry has been the development of a vibrant world of technology-driven start-up companies, funded by venture capital markets. This has created new options for researchers in industry and different risk/reward profiles for their careers. Ideas and technology generated in the start-up companies form another basis for collaboration. Thus, large-budget research companies look not just to universities and government labs, but also to the world of start-ups as sources of technologies and new businesses. Small cap companies have emerged across a broad range of industries and technologies, ranging from biotech to software to electronic materials. Frequently technologies of start-up companies have had their origins in universities or in larger companies, or even in government laboratories.

Within industry, pressures from cost competitiveness and global innovation intensify. Companies seek ways to improve R & D productivity, to reduce costs of R & D infrastructure and to bring products to market faster. External research partnerships have become the preferred means.

EVOLUTION FOR UNIVERSITY-INDUSTRY COLLABORATION

Structures have emerged in both universities and industry to deal with these trends. Research universities have established technology transfer offices, to facilitate their interactions with industry. Companies have formed groups to deal with in-licensing from universities. Companies have set up venturing organizations to tap technologies from start-up companies. Venture capitalists are looking for large cap companies as investors, or advisors, in part to develop some "built-in" exit options for their ventures. Everyone is forming and populating "advisory groups" to track and to learn from research approaches in the other sectors. All of this is a far cry from the past practices of university-industry relations.

During most of the last century, industrial financial support to universities had a large philanthropic component. Outright grants were provided by industry to endow chairs and to construct university buildings. Research sponsorship was often provided to obtain preferential access for recruiting purposes. The sponsored research was conducted in areas of general interests to companies, but with a focus on fundamentals, model systems or "precompetitive" technology.

Industrial researchers have always followed academic contributions to the scientific literature, and valued the development of fundamental knowledge, at the heart of academic research. However, the strongest historic link between universities and industry focused on knowledge transfer, not through the literature, but more directly, in the form of human capital. Universities were, and remain, the source of trained talent to populate industrial research laboratories. These incoming researchers normally maintained their contacts at their universities. University professors not only trained potential industrial researchers, but also had skills and insights that were useful in industrial research, and thus served as consultants.

Only very occasionally, in the old model, was there work in the academic labs of direct interest to industry. One of the early DuPont successes dates back to 1925 with the recognition of the work of Professor Nieuwland at the University of Notre Dame. Professor Nieuwland's chemistry became the basis for chloroprene monomer synthesis, practised commercially for nearly 40 years. Acquisition of Professor Nieuwland's technology occurred just two years before DuPont attracted, in 1927, a young instructor from Harvard University, Wallace Carothers, to join the DuPont Company. This was university-industry knowledge transfer of the other sort.

OPEN INNOVATION

The new industrial research model positions universities directly in industry's value creation strategy. University research no longer is used only to inform the research in industry; it can contribute directly to it. University-industry collaboration is only one option in an array of external research partnerships that industry is now pursuing.

Other options make use of web-based sources. A number of web-enabled marketplaces for technologies are now operating. All seek to bring together technology seekers and technology sources. Yet2, NineSigma and Innocentive are three leading examples. While they have nuanced differences in their business models, all of them seek to match technology providers with technology needs. All recognize that there is a global market for technology, with a myriad of providers and users. All recognize that potential sources of solutions are globally dispersed.

"Open Innovation" is a term that has been applied to this new model of research. Professor Henry Chesbrough's book (2003) by that title explains that technology development now relies on a combination of in-house capabilities, and accession of critical technologies from external sources. Speed and productivity are recognized as the principle drivers of open innovation.

Open innovation is a global pursuit. The development of science is more and more widespread. Newly industrial nations are training a larger and larger fraction of the world's scientists and engineers. Information technology allows us to access ideas instantly from around the world.

EXAMPLES FOR UNIVERSITY-INDUSTRY COLLABORATION

Leading industrial research companies may pursue dozens or even hundreds of university-sponsored research programmes. Certainly the pharmaceutical industry will partner with universities in a different way than the microelectronics or software industries. Nonetheless, virtually every industry is now intent on development of strong university-industry partnerships.

These partnerships can take on various forms: from very specific to very broad. Below, are a few current examples from the DuPont Company's experiences.

Hamburg University

Professor Detlef Geffken, Institute of Pharmacy of Hamburg University, developed a research lead for an agricultural chemical, a molecule with interesting fungicidal properties. Having come to the attention of DuPont in 1989, DuPont licensed Professor Geffken's lead compound and elaborated this lead through the synthesis of more than 700 related molecules. This work resulted in a highly successful commercial fungicide under the brand, Famoxate®. Collaboration with Professor Geffken's laboratory has continued, but this has not extended beyond this single laboratory.

University of North Carolina-North Carolina State University

Professor Joseph DeSimone holds joint appointments in chemistry and chemical engineering at the University of North Carolina and North Carolina State University. Professor DeSimone is also director of the National Science Foundation Science and Technology Center for Environmentally Responsible Solvents and Processes. DuPont has collaborated with Professor DeSimone since he received a DuPont Young Professor Award more than a decade ago. Among Professor DeSimone's research interests is the use of supercritical CO_2 as a medium for a number of reactions. This technology offers environmental advantages compared to conventional technologies, solvents or surfactants that are used to conduct certain types of chemistry. DuPont had a strong interest in this work, and struck a partnership to develop the technology for use of supercritical CO_2 to polymerize certain fluoropolymers products. Extensive licensing arrangements were concluded with Professor DeSimone. The supercritical CO_2 technology was further developed and scaled up in DuPont laboratories. With the support of the government of the State of North Carolina, we successfully commercialized that technology in North Carolina. Professor DeSimone's students have been hired by DuPont, and we continue to collaborate broadly with his Center.

In a separate collaboration at the University of North Carolina, Professor Maurice Brookhart had developed a family of late transition metal catalysts for single-site polymerization of polyolefins. DuPont entered into a licensing agreement for the initial patents, hired one of Professor Brookhart's group members, expanded the research in DuPont laboratories, and supported the continuing research in Professor Brookhart's labs.

DuPont-MIT Alliance

DuPont MIT Alliance (DMA), started in 2000, represents a new level of commitment in an industry-university partnership. The largest alliance of its kind, it has served as a model for other collaborations. The initial focus of DMA was industrial biotechnology, and the intent was to jumpstart DuPont's entry into this exciting new field. This initial scope allowed plenty of room for innovation in areas such as biopolymers, biosensors, bio-surfaces and biomedical materials. DMA did not target a single professor or a single department. Rather it involved the full scope of MIT. More than 15 MIT academic departments and centres have participated in dozens of research projects.

Initially, work was of a more fundamental nature. As the research teams have gained more experience in working together, the level of openness has increased. Projects are proposed by MIT or DuPont. More and more projects are jointly proposed.

Recognition of the education role of DMA is reflected in the fact that a significant portion of the funding has been set aside for education purposes. First-year graduate student funding was a key financial need for MIT. DuPont supports DuPont Presidential Scholars. More than 100 students have been supported so far.

Another educational dimension of DMA is the offering of tailored short courses by MIT faculty on subjects of DuPont's choosing. These courses have ranged from highly specialized presentation on narrow research subjects to an overview of biotechnology designed for DuPont corporate leaders.

Recently, the DMA has entered a new phase, and will be continued for a second five years. The scope has been expanded beyond the original focus on bio-based materials. New technology areas such as nanotechnology, flat-panel displays and microcircuit materials are now included.

Current university-industry collaborations tend to be focused in a company's home country, close to its internal research base. This pattern is just beginning to change, but globalization of university-industry is occurring. For example, U.S. research universities are engaging in collaborations with companies headquartered in other regions.

LEARNING FROM UNIVERSITY-INDUSTRY COLLABORATION

Obstacles to university-industry collaborations are numerous, but the above-outlined factors provide a potent driving force for even more collaborations in the future. The universities and companies that will be most successful in collaboration will be those who succeed in overcoming the historic and cultural barriers that exist on both sides.

Overcoming Barriers to University-Industry Collaboration

Knowledge transfer remains at the heart of university-industry collaborations. Individual faculty members, programmes or departments with expertise and accomplishments in a given field are a powerful magnet for industry seeking technologies. Nonetheless, more collaborations are problematic than successful, so that steps must be taken to improve the likelihood of success.

This begins with a clear understanding of the objectives of both parties for the collaboration: industry must recognize the research and education missions of the university, thus the needs for continuity of funding for students, for topics that are compatible with the university's research mission, and for the ability to publish results of the research. Universities must recognize that which is important to industry: the ability to exploit a technology in exclusivity and the imposition deadlines, milestones and redirects. Unrealistic expectations by either side can derail collaborations.

Universities must have a disposition that supports industry collaborations as appropriate to the university mission. Many universities lack adequate staffing or experience in technology transfer. This often slows the development of partnerships. Universities or professors can have unrealistic expectations in the valuation of technology and IP rights, or fail to consider the cost associated with launching a technology, post-discovery, and its impact on valuation. In the case of state-supported institutions, similar unrealistic expectation can arise from government–local/regional investment, or job-creation, or other constraints on exploitation are barriers that are sometimes imposed.

Industry, for its part, must be open to a collaborative approach. "Not-invented-here" attitudes defeat any attempt at open innovation. It is also important that industry recognize the mission of the university, and select or adapt the subject collaboration to that mission. Universities are not contract research operations, nor outsourcing vehicles.

The most significant barriers to effective university-industry collaboration are mutual, rather than originating on one side or the other. The key to successful collaborations is the commitment of effort, beyond the financial support. Below are some best practices in university-industry collaborations:

- Selection of appropriate projects of genuine interest and importance to both the university and the company.
- Realistic expectations.
- Clear understanding of intellectual property, or other rights associated with the work to be undertaken.

- Defined responsibilities and assigned accountable persons in both organizations.
- Frequent (ideally weekly) contact between researchers from both sides, using teleconferences, visits or co-location of the team.
- Regular assessment of project performance vs. expectations.
- Continuity of project staffing and predictability in financial support.
- Involvement and visible support from leadership in both the university and the company.

Benefits of University-Industry Collaboration

For the university, industry represents a development partner and a commercial outlet for early-stage university research. As a partner, and holder of intellectual property, the university stands to share in financial benefits of research.

Collaboration also offers to universities an access to industrial experience, resources and know-how to support research on such subjects as pilot facilities, scale-up, health and safety management, patent strategy and marketing. Collaboration is also helpful to the education mission of the university, offering students practical training in contact with the industrial research setting.

University partnerships bring industry an access to world-class expertise and access to students, who are potential future employees. Joint work with universities also represents a stimulus to an industrial research organization. The flow of new concepts and the intellectual rigor of academic research complements the need to "get to an answer" in industry. Universities may also present a cost-effective alternative to in-house research, for more speculative research projects. Universities are also sources of in-licensed technologies that cut time as well as cost on development of projects.

Finally, it must be recognized that today there is neither a shortage of top-flight research universities, nor a shortage of able industrial research partners. Both universities and companies must acknowledge that what they offer to the other is generally not in short supply. This realization should promote a spirit of reasonableness during the negotiation phase, and throughout the conduct of the collaboration. This is already understood by leading universities and companies, alike. Thus, one should expect to see continuing strong growth in university-industry collaborations, and these collaborations will be increasingly boundary-less and global in nature.

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