University Licensing in Change Mode

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Study shows methods of techology transfer now emphasize organization-level contact by in-house offices

Academic institutions have long been important initial sources of commercial goods. Many medical devices, pharmaceutical compounds, industrial instruments, computer programs, and pollution control devices, for example, first emerged as research ideas in university and medical school laboratories in North America, Europe, and Japan. Cancer-suppressing biotechnological drugs, industrial spectroscopic devices, artificial hearts, and Vitamin D are just a few such existing goods. AIDS vaccines and new energy sources may emerge in the future, drawing on current academic research. However, although academic research remains an important source of commercial goods, the methods by which academic advances are transferred to commercial producers are changing.

Traditionally, most ideas and designs have been transferred to corporate producers informally, either through hands-off methods such as academic publications or through individual contact methods such as hiring students and consulting with researchers. As recently as the late 1970s, Niels Reimers of Stanford University noted that "many universities [had] no ... mechanism for licensing of research results." Even universities with licensing mechanisms often did not operate an on-campus patent and licensing office, choosing instead to contract with external patent and license agents, which often filed for only a few patents each year at any one academic institution. In the past decade, however, universities throughout the world have attempted to capture an increased part of the revenue generated by academic research.

In the United States, several factors have led many universities and medical schools to change their transfer practices. Increasing research costs, plateauing public financial support in many research fields, increasing political and faculty demands for improved technology transfer, and changing laws governing the right to hold patents all came into play during the 1980s. Folowing the passage of PL 96-517 (the U.S. Patent and Trademark Amendments Act of 1980, Chapter 38, Patent rights in Inventions Made With Federal Assistance, enacted December 12, 1980), which granted universities the right to license patents generated through government-sponsored research, many universities established or expanded formal patent, copyright, and licensing offices. One reason to establish the formal offices is to generate income for the institutions and the individual researchers. At the same time, academic institutions hope to increase the likelihood that technology will be transferred to commercial practice, rather than gather dust on a laboratory shelf or mold in a filing cabinet drawer. Many university and commercial figures expected the 1980 law to improve the chances for better university-industry research relationships, but how effective the offices will be is still an open question.

In this article, I summarize results from a study of licensing incidence and technology transfer methods used since the mid 1950s in almost 200 cases of commercialization of academic medical diagnostic imaging equipment. The study shows that transfer methods are changing and that the likelihood of licensing has increased, especially when academic institutions have established formal in-house patent and license offices. I also discuss several general issues relating to the role of academic patent and license offices in effective technology transfer.

Academic research has played a particularly important role in generating commercial medical advances. Within the medical sector, diagnostic imaging instrumentation has been a particularly important application of academic design research. Identifying changes in medical diagnostic imaging equipment technology transfer methods and licensing incidence, therefore, clarifies our understanding of the changes that are occurring throughout the institutions of academic commercialization.

MEDICAL DIAGNOSTIC IMAGING EQUIPMENT

Diagnostic imaging equipment helps physicians and other health care workers obtain information about internal organs and physiological activity. Commercial x-ray imaging devices were introduced within a year of Roentgen's discovery of X rays in 1896, while electrodiagnostic devices, such as electrocardiographs and electroencephalographs, were introduced early in this century. Both classes of instrument quickly became key parts of medical practice.

The introduction of nuclear medical and ultrasonic imaging equipment in the 1950s and 1960s, followed by computed tomography (CT) scanners in the 1970s, and then magnetic resonance imaging (NMR

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or MRI) and digital radiographic equipment during the 1980s, expanded the field of diagnostic imaging and further assisted medical care. More recently, picture archiving and communications systems (PACS) devices have been introduced to store and transmit images produced by the imaging generating equipment.

Many commercial imaging devices introduced since the early 1950s began life as research prototypes in university and medical school laboratories. Some devices were designed by clinical practitioners who, as users of medical equipment, needed products that were not available commercially. Other devices were designed by university and medical school-based researchers aiming to improve medical practice, advance their careers, satisfy their curiosity, and/or gain financial rewards. Through formal and informal methods, the knowledge required to replicate and improve the devices was then transferred to commercial manufacturers, which introduced commercial prototypes. Some prototypes then became clinically-useful commercial instruments.

Information Sources

For this study, I identified corporate participants in the industry by searching business and government publications, attempting also to identify cases in which a firm had acquired key know-how from an academic source. I then contacted more than 100 individuals who had been associated with the companies to confirm the participation and know-how acquisition and to determine what methods of acquiring know-how had been used.

When the publications or interviews identified an American university or medical school as the source of some aspect of a firm's product, I contacted the university in order to obtain information about patenting and licensing of the know-how. When possible, I spoke with a person responsible for managing the institution's medical equipment licensing activities. I also spoke with personnel at organizations that have acted as external patent and license agents for academic institutions. I attempted to determine whether the academic institution or its agent had negotiated an agreement with the manufacturer specifying the terms by which rights to the product would be transferred from the institution to the manufacturer.

Determining whether a license existed was not always a clear-cut decision. In a few cases, a license was not negotiated before commercialization, but was obtained after the fact. I recorded such instances as cases of license. Because many of the institutions did not establish formal offices until long after the cases of diagnostic imaging technology transfer had occureed, some of the people could not be certain that a license had or had not been negotiated. Even in those instances, however, they usually were able to judge whether a license had been likely. In such a case of weak licensing confirmation, I used the person's judgment as the basis for my record, but also noted that the record was an estimate. In the statistical analysis, I then checked for bias created by including the estimates. After the interviews with academic licensing personnel, 191 cases of diagnostic imaging technology transfer from 46 institutions remained in the study, with 64 of the cases having been transferred via license between the academic research institution and the commercial manufacturer.

IMAGING RESEARCH TRANSFER METHODS AND LICENSING INCIDENCE

I classified methods by which corporate commercializers obtained access to academic medical diagnostic imaging equipment research into first- and second-generation technology transfers. First-generation transfers were those that occurred directly from the academic lab to the commercializing firm. Second-generation transfers involved corporate acquisition of know-how from firms that earlier had acquired academic technology. I identified 136 first-generation transfers and 55 second-generation exchanges. Within each generation, I classified functional transfer mechanisms as hands off, individual contact, and organizational contact methods. Organizational contact, whether by arms-length license or sponsored project, frequently also involved individual contact between the corporation and the key researchers.

Most first-generation cases involved people links, whether through individual contact or sponsored projects in the organizational contact category. Relatively few of the cases identified involved hands-off literature review, although this may be an underestimate owing to reluctance by corporate personnel to admit having done so. It is notable that the relative frequency of several first-generation transfer methods changed during the study period. The hands-off and individual contact methods declined in relative incidence, while the organizational contact methods of arms-length licenses and sponsored projects increased. By far the most common method of second-generation transfer identified was acquisition of another company or division or acquisition of an interest in another company.

Whether the transfer took place during the first or second generation of commercialization, licenses were negotiated in only a minority of cases. Of the 128 first-generation cases for which I was able to obtain licensing information, only 53 were licensed from the institution. With second-generation transfer, only 11 of 55 recorded cases of second-generation transfer included an academic license. However, incidence varied among the different transfer methods. Within the first generation, commercial products that emerged from academic research projects at least partly sponsored by a manufacturer usually involved formal licenses specifying post-commercialization payment to the institution. By contrast, licenses were relatively unusual in cases of transfer via researcher employment and startup firms established by researchers or their students usually did not license the technology from the research institution. Within the second generation categories, only in sublicensing cases was it common to find the academic institution included in the negotiated terms.

Logistic Regression

I also carried out logistic regression statistical analysis to investigate factors associated with license incidence. I found an increasing trend in licensing incidence during the 1954-1988 period of the study; the later the transfer took place, the more likely a license was negotiated. To capture the effects of Public Law 96-517 of 1980, a second time variable was specified for the 1981-1988 period, which produced a positive but statistically insignificant coefficient and so indicated that passage of the law alone did not lead to strongly increased licensing incidence. However, whether an institution had established a formal patent and license office when the technology transfer took place was significantly associated with positive licensing probability. Many universities established formal offices only after passage of PL 96-517 had increased their incentive to do so. Indirectly, then, PL 96-517 appears to have led to greater licensing incidence, but only at institutions that responded to the incentive and established in-house patent and licensing operations. Because many of the universities were still in the process of establishing formal offices by the late 1980s, and were still developing licensing policies and routines, the full effects of the law were not felt during the decade of the 1980s. It is likely that the incidence of licensing will continue to increase as more universities respond to the legal and other incentives by establishing in-house offices, and so gain experience with formal technology transfer.

Two secondary results of the regression analysis also were interesting. First, American firms were no more likely than their foreign competitors to license technology that they obtained from academic institutions. Second, start-up firms were much less likely than established manufacturers to license academic technology. It is possible that start up firms tend to commercialize technology that is not patentable, due to prior publication or general knowledge.

However, while it is difficult to determine the potential patentability of cases for which applications were not filed, many licensing personnel believe that much of the technology commercialized by start-up firms could have been patented and licensed, had there been a patent office to pursue patent applications and negotiate terms. Certainly, the number of patents applied for and granted has risen, as in-houses offices have been established. In addition, several universities have had formal or informal understandings that individual researchers who wished to commercialize technology themselves could do so without giving the university patent rights and negotiating a license.

DISCUSSION AND OPEN QUESTIONS

This study documented methods by which diagnostic imaging device know-how has been transferred from academic institutions to corporate manufacturers and the incidence of licensing during or after the transfer. Many methods have been used, but most involve people links, whether solely with a key researcher or in combination with organizational contact. Traditionally, relatively few licenses have been negotiated between the corporations and the academic institutions.

However, the methods chosen and the incidence of licensing are changing. Corporations now are more likely to undertake transfer via sponsored projects than they were during the 1950s and 1960s. At the same time, the incidence of licensing is increasing, especially with universities that have established formal patent and license offices.

Although these results apply specifically to the transfer and commercialization of medical diagnostic imaging equipment, they are broadly representative of academic research throughout the medical sector. Recent licensing incidence in biotechnology product commercialization, for instance, also is high. Other product sectors, such as computer software and hazardous waste management, also are seeing increases in licensing incidence. The results of this study, therefore, illustrate the closer organizational contact that is now developing between academic research and corporate commercialization. As markets become more competitive and technology more complex, many manufacturers are finding that they need to work more closely with basic researchers. At the same time, those universities that have established formal patent and licensing offices are able to negotiate licenses for the transfer of knowledge to the corporations.

Several key questions remain open. Has the incidence of technology transfer increased? Will academic institutions make money from their technology licensing operations? How can academic technology licensing operations increase the effectiveness of their technology transfer operations? The discussion in the following section is tentative, but I believe that it raises important issues for further study.

Has the Incidence of Technology Transfer Increased?

Although products that are transferred now are more likely to be licensed, a perhaps more important issue is whether products are more likely to be transferred.

If technology transfer offices simply capture part of the revenue stream of products that would have been commercialized anyway, diverting it into the pockets of the institutions and the researchers, they are doing part of their job. But it may be the smallest part. Indeed, in a closed economy with a well-functioning tax system and the political will to fund academic research, the revenue capture part of the academic technology transfer job would not be necessary.

A closed economy, or at least a balance in international technology acquisition, would ensure that the jobs and income resulting from commercialization of academic research accrue to the same economic entity that funded the research. A well-functioning tax system would ensure that the income resulting from the commercialization would return to the political system. The political will to fund academic research would ensure that the income is recycled into the institutions. (A nirvana in which all three

conditions are met, however, seems unlikely.) Of greater import is whether technology patent and license offices increase the likelihood that useful ideas and goods become used.

Languishing Research

The folklore of academic research contains many stories of potentially useful products that were never developed. A product may languish in the lab for many reasons. Once the joy of experimentation has worn off, the researcher may not be interested in the tedious refinement that is necessary for a commercial product. Academic researchers may fail to recognize the commercial potential. Necessary complementary products may not be available. No company may be willing to invest the funds necessary for refinement. Or a match between the product and a suitable company may never be found. Solving even part of these problems will increase the rate and effectiveness of technology transfer.

On-site technology patent and license offices cannot solve all the problems but they do have the potential to solve some of them. The offices can increase information flow out of the institution, so that potential commercializers are more likely to learn of the product. By ensuring that patent rights are obtained, they can increase the likelihood that some company will invest in further refinement. By acting as a liaison between the researcher and the manufacturer, they can increase the likelihood that a researcher will spend time working on refining the product.

These potential benefits of formal patenting and licensing offices should not be exaggerated. Established manufacturers usually know which researchers are doing research related to their products. The firms often follow their projects closely, sometimes partly funding them, sometimes hiring the researcher on consulting contracts, sometimes hiring his or her students. Patents often will not be an issue, because the firm can protect the value of the new product through its control of supporting products and systems. Because the information and patent protection issues are relatively unimportant in such cases, an academic patent and license office usually will not increase the incidence of such transfers, although it may garner part of the revenue stream.

Nonetheless, at least two significant opportunities to increase the incidence of technology transfer exist. First, a patent and license office may be able to link an established company with a new product that is outside its existing markets, and so may not be seen by the firm but which ties in well with an existing capability. An example would be introducing a biotechnology idea to a brewing company, because the brewing process is similar to the process required to produce biochemicals.

Second, a patent and license office may be able to help a startup venture get established through financial, organizational, or informational assistance. Thus, there are opportunities for technology transfer offices to increase the incidence of technology transfer as well as the incidence of licensing, but the opportunities usually lie outside the realm of bringing incrementally improved existing products to established manufacturers. Instead, the opportunities lie in finding major new goods or bringing new uses for existing goods to new manufacturers.

In the specific context of this study, has the formation of on-site patent and license offices increased the incidence of diagnostic imaging instrument transfer? The honest answer is fuzzy — probably, but not very much yet. Many of the transfers have been to established firms and most of those transfers would have occurred anyway. Some transfers, though, involve foreign firms with relatively minor presence in the U.S. It is possible that such firms would not have learned of the research, or would have lacked familiarity with American practices needed to acquire the know-how, if the academic licensing offices did not exist. In addition, a few cases involve startup firms that received significant organizational assistance from the licensing offices. It is unlikely that those manufacturers would now exist if the academic licensing offices did not operate.

Do Academic Patent and Licensing Offices Make Money?

If one goal for an academic patent and license office is to raise money for the institution and the researchers within it, how well is that goal being achieved? If the measure is licensing income, most offices do not make very much money. Although offices vary widely in how they calculate income and expenses, very few report annual income in excess of $2 million, which given current research support demands even at a small university, is small change. Although licensing revenues will rise as licensing offices become more experienced, the income will rarely support more than a small proportion of academic research. Most license agreements do little more than cover their costs. The elusive big hit is satisfying when it arrives, but will rarely be a line item in a university budget.

It is not clear, though, that licensing revenue is the appropriate measure of financial success for a university licensing office. A more useful measure would include all income that would not have been received by the university if the licensing office did not exist. Besides licensing fees and royalties, such income may include sponsored projects that require clear patent title, and federal research grants that require commercial technology transfer follow-up. In addition, if a patent and license office satisfies faculty demands for maintenance of a commercial conduit for their research, a university may find it easier to attract and retain high-profile researchers.

Those researchers may, in turn, attract public and corporate research support. Measuring such income accurately is difficult. Including all sponsored project and public research support income would greatly overstate the impact of a licensing office, but omitting all non-licensing income will understate the impact and perhaps reduce support for the licensing office. Therefore, the topic remains a fruitful area for further study.

How Can Licensing Offices Transfer Technology Effectively?

Occasionally, technology licensing requires only three simple steps: file for a patent on a commercializable product, negotiate a license with an available firm or firms, and then sit back to receive royalties. However, such cases are rare. Instead, each of the three steps is usually highly uncertain.

The commercial potential of a newly disclosed product is usually unclear. Because prosecuting a patent is relatively expensive, a licensing office cannot file for patent protection on every item that is disclosed to it, nor can the office afford to file every patent in every country. Thus, it must make commercial judgments.

The office must also find licensees. Sometimes, an appropriate licensee is obvious, perhaps because the researcher responsible for the patented product has already identified a manufacturer for it. More often, though, candidates for licensing are much harder to find. Licensing offices must publicize their holdings and licensing personnel must establish networks of trade contacts. Even after a licensee has been identified and agreement has been reached, some monitoring is often necessary to be sure that the terms of the agreement are met. Therefore, carrying out the basic tasks of prosecuting patents and negotiating licenses requires experience and judgment.

By creating patent portfolios, academic licensing offices have begun to accomplish each of their two main jobs, obtaining revenue if a product is successful and increasing the chance of technology transfer by ensuring that patent protection is secure. However, building a patent portfolio does not alone generate effective technology transfer. Relatively little transfer takes place through arm's-length agreements. Because research designs are usually far from commercially ready, much additional work and money must be expended to bring them to market. Because the additional work often must draw on tacit knowledge held by the developer, ongoing contact between the research site and manufacturing personnel is usually necessary. The patent and license office must be able to negotiate the terms of such research development contact.

The task of the licensing office becomes even more difficult if the licensee is a startup venture or a small firm. Rather than simply receive a share of the firm's revenue, in the form of royalty checks, the licensing office must often help the venture become organized enough to generate income in the first place. Hence, licensing personnel, like commercial loans officers in a financial institution, sometimes must also be part-time managers of their clients.

◄ Equity Positions ►

The task of dealing with a small firm becomes particularly acute when the university has an equity position in it. Many universities are now experimenting with taking equity positions in startup ventures, hoping both to garner revenue from products that traditionally have left the university without a license and to increase the incidence of technology transfer. Although only one equity venture is included in this study (several other cases were still at the research prototype stage), there are several hundred equity projects covering a diffuse set of products and processes now under way.

The terms under which equity participation ventures are established vary widely. In some cases, the equity is held directly by the university. In others, the university has established a for-profit subsidiary to invest in the ventures. Usually, the university's equity position is received in lieu of royalties and/or license fees, but in some cases the university or a subsidiary established by it also has invested cash in the new venture.

Sometimes, academic licensing personnel take an active role in advising management, but often they step back, at least once the venture is underway. Often the university or its subsidiary take an active part in finding venture capital for the new firm. Because almost all such equity ventures have emerged within the past five years, it is too early to identify the most successful models.

In general, however, taking an equity position in a new venture will entail all the difficulties of dealing with a small firm, plus potential financial, organizational, legal, and political issues related to the university's dual status as research institution and commercial shareholder.

To summarize this section, effective technology transfer can be broken into two parts. One part includes the basic tasks of an academic patent and license office. By obtaining appropriate patents on products with commercial potential, the office lays the groundwork for garnering revenue from licenses and other revenue sources. This step may also increase the incidence of technology transfer by ensuring that patent protection exists and thereby providing incentives for firms to invest in additional development. However, technology transfer does not consist solely of patenting and licensing.

A far bigger part of technology transfer consists of research development work. Such research development has at least three components. One is information dissemination, linking commercializable products with capable manufacturers. A second is managing flows of tacit information, assisting research and manufacturing personnel to maintain the long-term contact that is usually needed to bring a research prototype to commercial production. The third component of research development that is sometimes necessary is providing organizational support for the commercializing firm.

The research development part of the work of the patent and license office is likely to intersect with other operations throughout the university, such as sponsored project offices, research and industrial parks, university attorneys, and industry liaison offices. The institutional form of the intersections varies by university. In some, whether for size or historical reasons, several of the operations are housed in one office. In many, though, operations that may influence the effectiveness of technology transfer are spread throughout the campus or across a multi-campus system. Thus, an academic patent and license office

must not only coordinate its contact with external licensees, but it must coordinate its work with internal development agencies. Compounding the coordination chore, the work may also intersect with national research development organizations, such as the National Technical Information Service or the British Technology Group. Overall, effective technology transfer requires both technical and organizational skills.

CONCLUSION

Universities are important sources of industrial advances. Some results are spectacular, such as gene-slicing and magnetic resonance imaging. Others are incremental improvements, such as coils for a magnetic resonsance system. Whether spectacular or seemingly mundane, the advances affect the way we live and work.

Commercial products developed from academic research prototypes have sometimes produced income for the institutions within which the research was carried out. Stanford University and the University of California, for example, have received millions of dollars of royalty income from recombinant DNA patents. More frequently, though, the potential revenue has not been realized. Instead, most technology transfer has occurred informally, via consulting, students, publications, conferences, and other venues.

Although contact between individual researchers and commercializers continues to be critically important, organization level contact between American academic institutions and corporate manufacturers is becoming more common. Most revenue-generating agreements have occurred on campuses that operate on-campus patent and license offices. In the last decade, many research institutions have set up such offices, hoping to tap into the revenue stream that flows from their research. At the same time, the institutions hope to increase the incidence of technology transfer, by providing conduits between their researchers and commercial manufacturers. The explosion of new in-house operations is still too recent to be judged but most appear to be at least paying their way.

Many of the on-campus patent and license operations are experimenting with new research development models, especially forms of equity participation. At the same time, the licensing offices are learning how to coordinate their research development work with other on-campus and external agencies. Watching and analyzing the development of these models of licensing and research development will be fascinating and important activities for many years to come.

Endnote

A fear frequently expressed in Washington and in the popular press is that foreign firms may obtain knowledge from American universities and transfer it abroad. This certainly occurs. On the other hand, American firms also benefit from research undertaken in foreign universities and it is not clear that the American technological trade balance is strongly negative. Therefore, it is not clear that license agreements between United States academic institutions and foreign firms represent an attack on American industrial competitiveness. Moreover, many foreign firms that obtain technology from U.S. academic institutions establish research and manufacturing operations in the United States, close to the institutions, in order to realize the tacit benefits of ongoing research contact. Thus, technology transfer from American universities to foreign manufacturers often results in American economic development and technological advance.

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