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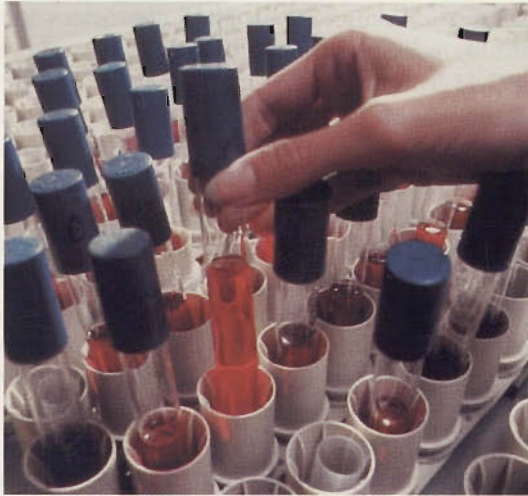
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Offices of Technology Transfer

Privatizing University Innovations for Agriculture



Today most universities with active research programs have an office of technology transfer (OTT) that establishes patents and sells patent use licenses to commercial enterprises. OTTs are relatively new phenomena. A recent survey by the authors found that, from a sample of thirty-four U.S. universities, twenty-eight established OTTs during the 1980s and 1990s. Prior to the advent of OTTs, sponsored projects offices transferred a few university patents to the private sector.

Universities spend considerable public and private funds on research. In 1993-94, for example, research-oriented universities spent \$12.3 billion on research, or nearly 16 percent of their total operating budgets (National Center for Education Statistics). Much of this research results in basic innovations and concepts that later allow the private sector to create commercial products (Parker and Zilberman, Mansfield). Other university research may lead directly to commercial-ready or near-ready products. In either situation, universities must facilitate transfer and provide property rights protection if their research findings are to usefully and profitably find their way into the marketplace.

The wide array of innovations transferred from

universities to society impacts agriculture, natural resource use, and the environment. For example, one recent technology agreement transfers university research findings and property rights for a field kit to test sites for organic contaminants; another uses recombinant DNA techniques to measure mercury in water and lead in soils; and a third transfers the rights to produce high-yield, sterilized, hybrid cotton plants (AUTM 1994).

Some observers believe that OTTs will become a focal point of university fund-raising, and that one day some universities will be able to operate mostly on the royalties produced by their research projects. Others believe that the quest for royalties will subvert universities and compromise their unique commitment to the pursuit of knowledge and innovation for the public good. Because the process of technology transfer has changed so much and so rapidly, its basic character and potential effects puzzle many of those affected. Here, based on ongoing research for the University of California's Systemwide Biotechnology Research and Education Program, we discuss the mechanisms of technology transfer from research institutions to the private sector, the driving forces behind the technological transfer

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process, and the potential impact of OTTs on colleges of agriculture.

OTT operations

OTTs transfer innovations to the private sector primarily through patents and licenses. These licenses generate royalties and fees for the university. University OTTs aim to increase the flow of innovations from university scientists to the private sector and, as a result, generate income.

In the first step of this process, the office seeks information from university scientists concerning potentially marketable innovations. Most offices spend considerable effort networking with university faculty to gain recognition, build confidence in their abilities to handle the transfer of an innovation, and then market the technology. For example, the University of California system's OTT has six-

ways to protect the intellectual property that it represents. The office may file a patent application. Some OTTs maintain a legal staff and handle all patenting, licensing, and marketing in-house. Others focus on marketing and contract legal services to outside agencies. While most offices recover legal fees directly through licensing agreements, some do not file for patent protection until licensees are found.

As OTTs age, their personnel needs change. They require more personnel to negotiate, monitor, and enforce contracts. A mature OTT employs individuals with backgrounds in physical sciences and finance as well as economics, statistics, law, and other fields.

The office may seek potential licensees for an innovation at the same time it applies for a patent. Established OTTs have extensive lists of existing clients and will try to match the innovation with an appropriate company. New OTTs are limited in their ability to match private sector clients with individual professors and researchers.

Most offices will handle both exclusive and multiple licensing arrangements. The choice of arrangement depends upon the range of innovation uses, whether the innovation is a product or a process, its level of applicability or refinement, the scope of legal protection available, and the degree of overlap among uses. The type of arrangement will also depend on the institution's policy on income sharing and venture capital investments. In some cases OTTs will grant multiple licenses, but each license will be for an exclusive commercial use or for a particular class of consumer.

OTTs not only connect scientists with investors, they may also help establish new companies to commercialize the innovation. They do this for two reasons: (1) the scientists involved may want to start their own firm to take the innovation to market, and (2) existing companies may not be geared to develop and market the new advance. In many of these cases, a scientist will eventually sell his or her interest in the start-up to a larger company. In its first five years, the University of California's OTT licensed nearly 80 percent of its medical biotechnology to new companies, including Genentech and Chiron.

In some cases, a university may take equity in lieu of part of the up-front fees. While most universities prefer to receive royalties in cash, a limited number, most notably MIT, prefer equity. However, even when universities invest or take equity in new ventures, they may prefer not to do so. For example, the University of California did not develop guidelines until early 1996 that would allow it to engage in equity sharing or venture capital investment.



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teen technology transfer officers who identify faculty members with new patentable ideas, work on registering patents, look for potential clients, negotiate contracts, and follow up on the contracts.

Both the sophistication of the innovation and the willingness of the inventor to play a role in the technology transfer process help to determine the eventual success of the product. Many OTTs work closely with their university's sponsored projects office to help companies and researchers form collaborative research arrangements that smooth the transfer process.

When a scientist files an invention disclosure, the office evaluates it for marketing potential and legal protections. If the OTT feels that an innovation has commercial prospects, it will next consider

Income generation and distribution

The OTT's performance will rise and fall with the university's research activity. Computer science, biotechnology, and engineering usually create more marketable innovations than economics, history, or French. The teaching load of the faculty, the public versus private status of the university, its location, and the "quality" of its faculty also affect OTT income generation.

Many university technology transfer officers attribute net profits equally to the four stages of bringing a new technology to market: discovery, development, manufacturing, and marketing. Universities usually receive the quarter allotted to discovery, unless they are also responsible for some of the development (C. Voelker, personal interview, UC Office of Technology Transfer, 1996). Thus, if the profit margin for a pharmaceutical is 12 percent of sales, the university will ask for a 3 percent royalty from sales, or 25 percent of net profits. Since sales are easier to monitor than net profit, most agreements use sales for their basis. Chemical commodities often show profit margins of 5 percent, and royalties may be 1 percent of sales.

Many licensing agreements include an up-front percentage of the expected annual royalty once the market for the product becomes established. Generally, OTTs assume it will take five years to successfully introduce a new product and that market share may erode after fifteen years. For example, the initial market share may be 10 percent, increase to 30 percent, and then fall. However, projections vary with the product, and the long-run share usually ranges from 10 to 50 percent.

The OTT may spread the up-front fees over several milestone events such as completion of a working prototype, or passing certain tests required by regulatory agencies such as USDA, EPA, or by the university itself. The university may also reserve the right to cancel the license if a timetable of milestone events fails to materialize. Milestone events and partial payments establish a pattern of diligence and guard against unused (and nonpaying!) property rights. The university calculates the projected profits (revenues minus the sum of operation and annualized investment costs) and establishes a minimum payment over the life of the contract.

The buyer of a technology may need to submit periodic progress reports on the product development or market share achieved. The two parties adjust contracts over time as they receive new information about the technology and the product itself. Escape clauses protect the two parties against many types of unforeseen negative developments.

Ability to negotiate the level of royalty received from any given license requires skilled business consultants who have a good idea of the relative value

Table 1. Licenses and royalties received by OTTs at seventy-one U.S. universities, 1992

	Total	Top 10 ^a	Share of Top 10 (%)
Licenses	2,405	1,193	50
Royalties (M\$)	155	86	55
Research funding (M\$)	10,682	4,376	41

Source: AUTM 1995.

^aIn terms of royalties received.

of an innovation. The level of development, and hence the amount of additional research necessary, will play a crucial role in determining the terms of the agreement and the distribution of royalties. Other influential factors include uncertainty, necessary financing, expected time to development, and the degree of intellectual property protection. Innovations with strong, broad patent protections are more likely to receive higher royalties. Weak or narrow intellectual property protections leave the university and the company vulnerable to competition from similar innovations.

Universities divide royalties in a number of ways. Many OTTs follow a policy of distributing equal shares among the university, department, and scientist (H. Weisendanger, personal interview, Stanford U. Office of Technology Transfer, 1991). Other universities split the royalty equally with the scientist (W. Hoskins, personal interview, UC Office of Technology Transfer, 1991). New technologies created through team efforts require OTTs to split royalties across several departments or among different universities. In some cases the actual patent may belong to the university, while in others the patent belongs to the scientist.

Universities that established their OTTs early (such as Stanford, the University of California system, MIT, Harvard, and Wisconsin) now generate the bulk of royalties derived from new inventions. For example, from a sample of seventy-one universities in the United States, the ten leading research universities (as ranked by the amount of dollars received for research purposes during 1992) received 41 percent of the research funding while earning 55 percent of the total royalties and accounting for half the licenses and patents (table 1). The majority of these ten leading universities established their OTTs more than twenty years ago. Lags between the signing of a contract and the realization of revenues reflect the time needed to develop and commercialize a new technology, to pass the battery of regulatory hurdles (such as tests required by FDA for new medical procedures), and to penetrate markets. We could expect that universities and research institutions that established OTTs at later stages will wait for their portfolio of inventions to reach maturity before fully capturing their benefits.

(continued on p. 24)

Table 2. Comparison of average research support, licenses, and royalties

	Licenses Research Support (\$)	Generating Royalties	Royalties (\$)	Royalties as a Percentage of Research Support
Top 10 ^a	437,591,635	119	8,619,931	2.14
Middle of sample	120,336,493	23	1,315,419	1.03
Bottom 10 ^a	16,878,201	6	121,938	0.71

Source: AUTM 1995.

^aIn terms of research funding.*(continued from p. 21)*

In a subsample of the top thirty-one royalty-earning universities, six earned between \$12 and \$26 million in average annual royalties, while twenty-five earned between \$500,000 and \$6 million (figure 1). This large royalty gap traces to a few significant innovations. The two royalty leaders, the University of California and Stanford University, share the important Cohen-Boyer biotechnology patents. These patents represent the cornerstone of the biotechnology industry; they detail a process for gene manipulation that is essential to nearly all biotechnology-related products.

Case studies suggest that the total amount of royalties received is a function of research effort rather than the particular skills of the OTT. In our sample, the top ten universities are heavily "research oriented" (National Research Council) with well-

established departments in molecular cell biology, engineering, medicine, chemistry, and other disciplines that generate inventions. In general, the higher the research support received by an institution, the higher the number of active licenses and the higher the royalties (table 2). Even so, half of the top ten universities earn royalties equal to less than 1 percent of their research budgets, while a few earn significantly more (table 3). After accounting for the royalties funneled into administrative and other support positions, the amount available for actual research becomes significantly smaller. Thus, even universities with well-established OTTs cannot expect royalties to cover their budgetary needs.

While OTTs may not provide universities with significant research financing, they do supply other benefits. For example, contacts made with industry may lead to research grants, graduate student fellowships, internships, and equipment donations.

What OTTs mean to agriculture

OTTs are likely to increase the rate of technological change in agriculture by reducing costs and making private sector utilization of university research discoveries more profitable. University research projects, even those classified as basic research, result in discoveries with commercial potential, and OTTs increase the likelihood that these discoveries

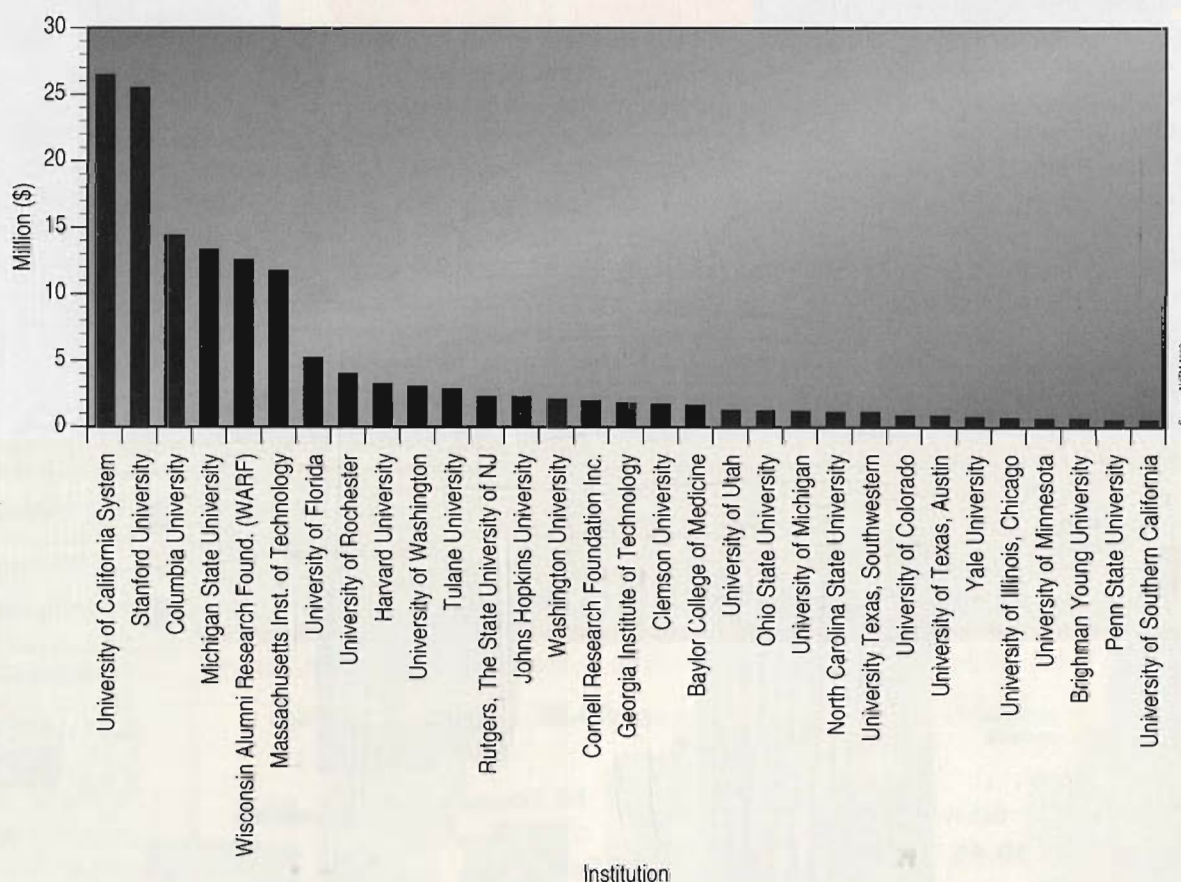


Figure 1. Distribution of royalties for a sample of thirty-one U.S. institutions, 1992

Table 3. General characteristics of top ten OTTs (ranked by total research support), 1992

University/ Research Institution	Total Research Support (\$)	Licenses Generating Royalties	Royalties ^a (\$)	Royalties As a % of Research Support
University of California System	1,550,000,000	254	26,416,218	1.70%
University of Washington	413,000,000	89	3,000,000	0.73%
University of Michigan	346,500,000	53	1,167,600	0.34%
Stanford University	303,300,000	254	25,450,000	8.39%
Wisconsin Alumni Research Found (WARF)	300,000,000	77	12,489,683	4.16%
SUNY Research Foundation	296,281,348	23	365,535	0.12%
Harvard University	296,000,000	90	3,200,000	1.08%
Massachusetts Inst. of Technology	292,000,000	174	11,680,000	4.00%
Cornell Research Foundation Inc.	291,300,000	144	1,922,818	0.66%
Penn State University	287,535,000	35	507,456	0.18%

Source: AUTM 1995.

^aRoyalty figures do not include the value of equity that OTTs may hold.

will realize their potential. The need for more effective utilization of university technology is especially pertinent with the advent of biotechnology and precision farming.

Technology transfers may also increase the competitive structure of some segments of agribusiness. For example, a few large firms are the major suppliers of inputs such as pesticides and seeds. Without public research and OTTs, there may be underinvestment in both research and introduction of new technologies. In such cases, OTTs not only enable the university to transfer innovations to existing firms, but they can help create new firms in the form of start-up companies.

The effectiveness of the technology transfer process is enhanced when the number of potential buyers of the right to develop new innovations increases beyond a few agribusiness firms. In some cases agents for specific agricultural industries, such as commodity groups, may want to purchase licensing rights to innovations. These groups could form alliances with developers and act as venture capitalists to support the commercialization of innovations for their own benefit.

Traditionally, universities have played a unique role in developing technologies that are nonpatentable and have public-good properties such as agronomic practices. The increased social benefit from patentable university research associated with the establishment of OTTs does not mean that the university should concentrate on such research. Rather, economics suggests that overall public benefits can be best enhanced if universities pursue a diversified research portfolio. They should continue to support research that improves net social benefit and results in public goods or innovations that may not be attractive to the private sector.

OTTs complement other mechanisms through which universities transfer technology to the pri-

vate sector. In land grant universities, the Cooperative Extension Service has traditionally helped transfer new technologies to farms. Through extension, the university provides unbiased advice and expertise on new innovations. Traditionally, extension helped transfer technology mainly to crop and livestock farms, with little transfer of technology from the university to agribusiness. This is the role of the OTT. Extension and OTTs complement each other by providing alternative methods to interact with different segments of the agricultural industry. ■

■ For more information

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