U.S. Academic Technology Transfer Models: Traditional, Experimental And Hypothetical

By Linara Axanova

Abstract

The primary mission of U.S. academic technology transfer offices (TTOs) has historically been to protect intellectual property (IP), find licensees and negotiate licenses. Over the 30 years since passage of the Bayh-Dole Act, many successful technology transfer (TT) operating models have been developed, but the debate continues over how efficiency can be improved, how interaction with the private sector can be enhanced, how economic development can be increased, and how more income can be generated. Traditional academic TT models, those that have stood the test of time, can vary depending on the core mission, focus, size, and organization of the TTO itself, as well as of the special character of the institution it serves. An increased focus on generating revenue, among other factors, has led many TTOs to experiment with new approaches. These include a corporate approach to starting and funding companies, alliances with large pharmaceutical companies, use of outside business experts to help select technologies to pursue, and others. More radical and broader models have been proposed at a hypothetical level, such as allowing faculty to send their inventions to TTOs at any institutions they wish. It seems unlikely that any one "best" TT model will emerge, as each institution has different goals, resources, size, stakeholders, and willingness to invest. But considering the full spectrum of traditional, experimental and hypothetical approaches allows us to understand the landscape, and peek beyond the horizon.

I. Introduction

In age-old tradition, the goals for most universities are teaching, research and service. These were more recently joined by the new missions of knowledge transfer and economic development. The genesis of this change in the United States can be traced to the Bayh-Dole Act of 1980, which allowed U.S. universities to own inventions made during publicly-funded research, and gave U.S. universities great latitude in exercising and commercializing resulting (IP) rights. Although the Bayh-Dole Act is 30 years old, efforts to develop optimum models for operating academic TTOs are best understood as part of an ongoing evolution.

Today, this evolutionary process is intensifying. Recent successes in financial return, job creation and product marketing have shown that TT works. In the current economy, universities need to generate new revenues and government needs to create new jobs, and TT seems to provide a tantalizing answer to these needs. At a macro level, the effectiveness of university technology transfer and the Bayh-Dole Act are subjects of significant debate and discussion among members of Congress, the Obama administration, experts on entrepreneurship and others (Lederman, 2010), and the potential for seismic shift by law or regulation is ever present. At a local level, university presidents and boards are equally keen on seeing TT deliver its promise, sometimes leading to dramatic changes in institutional policy and priorities.

These same pressures are intensifying the evolution of TTOs at street level. But the evolution at this level is harder to see, as it is occurring heterogeneously. Because this evolution has been going on for some time, U.S. TTOs are anything but uniform; it is safe to say that no two TT programs are alike, even though many of the underlying policies, standard agreements and operating philosophies are shared (Batalia, 2006). A recently released report by the National Research Council, "Managing University Intellectual Property in the Public Interest" says, "because of the wide variety among institutions in their resources, the scale and focus of their research efforts, their experience in technology licensing, and not least their missions, there cannot be a single template for technology transfer that all institutions should attempt to model" (NRC Report). Even within a single state system such as the University of California, each campus' technology transfer program is structured, funded, sized, and motivated differently (Neighbour, 2006). In addition, many of the factors influencing a TTO's organization and operation are dynamic and can grow, shrink, and change shape or direction, shifting the overall balance of each program (Weeks, 2006). And even a well-established and successful TTO seeks to improve, leading to small refinements as well as big changes, depending on shifting objectives, current problems, anticipated problems, and incremental improvement ideas. This variability is compounded by big differences in the maturity of TTOs. There are some very experienced offices such as at the Massachusetts Institute of Technology (MIT) and Stanford University that were established in the 1940s and 1970s, respectively; yet other universities only established their TTO in the 1990s.

Considering the variability of TTO operations and the intensified interest in TT in both the university boardroom and the halls of Congress, everyone is asking: where are we, and where are we going? By sorting through the various "models" for TT that have been written about over the years, including traditional models that have been used for several decades, experimental models now being tried, and hypothetical models proposed and yet to be tried, this review hopes to answer these questions–at least for now.

II. Traditional Models

2.1. Philosophical/Mission Models

Traditional TTOs in the U.S. aim to serve core missions of (i) service to faculty, (ii) service to the public (i.e., by bringing new products to market), (iii) economic development (e.g., by supporting start-up companies licensing locally), (iv) revenue generation, and (v) compliance with the Bayh-Dole Act and institutional policies (Batalia, 2006; Crowell, 2006). Each TTO may focus more resources and attention on some of these goals than others, but traditional TTOs generally share them all. Most programs dynamically blend these models to address the current needs of their campuses and regions, and the overall goals can be viewed as lying within a pentagram bounded by the core missions described above. Typically, the goal of any particular TTO lies somewhere in the middle of the pentagon with a skew towards one or several of these core missions (Figure 1).

The relative priority of each mission for a given TTO is largely determined by factors such as (a) primary missions and goals of the university; (b) the university's size, administrative structure and budget, (c) the internal and external environment, (d) interests of stakeholders, and (e) availability of venture investment funds (Figure 2).

■ Linara Axanova, Ph.D.,
The Salk Institute for Biological Studies,
Licensing Associate,
La Jolla, CA
E-mail: laxanova@salk.edu

While a traditional TTO attempts to serve all of the above-mentioned missions, it has been suggested that it is important for a TTO to identify a single primary goal, and to then implement strategies, objectives and tactics consistent with that chosen goal (Sharer & Faley, 2005). Faley & Sharer state that "for any organization, having unfocused goals can lead to conflicting operational objectives and ultimately to operational ineffectiveness" (Faley & Sharer, 2005). In other words, an organization that attempts to be "all things for all people" is a "recipe for strategic meritocracy and below-average performance" (Porter, 1985). Sharer & Faley described operational and strategic considerations that vary depending on the primary strategic goal chosen, and they detail distinctly different measures of success for programs having different primary goals (Sharer & Faley, 2005). Of course, the primary goal chosen has to be aligned with the goals and missions of the academic institution (Weeks, 2006).

In view of the forgoing, there are some programs that are so significantly skewed towards a particular mission that they can

Figure 1. Schematic presentation of potential distribution of TTO Missions. TTO 1 focuses more on economic development and revenue generation, and TTO 2 focuses more on serving faculty and the public.

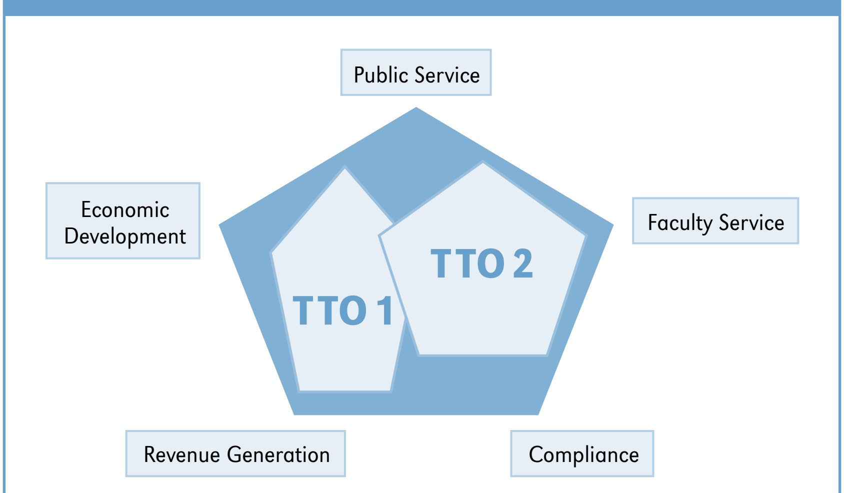
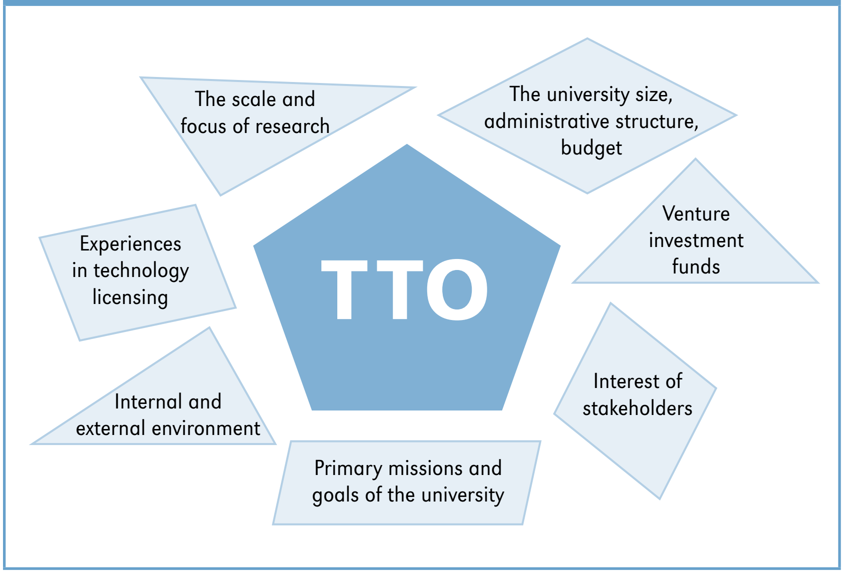


Figure 2. Schematic presentation of internal and external factors that could shape the missions and structure of a TTO in a unique manner.



be considered as operating under different models.

2.1.1. The Service Model

At some U.S. universities, the distribution of knowledge and satisfaction of faculty is the primary mission. Measures of success under the service model include the number of published patents, exposure to new research funding opportunities, and recruitment and retention of faculty; with less emphasis placed on license revenue, equity, startup formation, or local job creation (Rasor & Heller, 2006; Batalia, 2006).

2.1.2. The Economic Development Model

In the economic development model, the emphasis is on improving the local economy. The TTO seeks platform technologies that can become the basis of startup companies, or technologies that dovetail with interests or abilities of existing local companies. Such TTOs may work closely with regional, state, and/or local economic development officials to achieve common goals. This model is commonly associated with related university support, such as development of a mixed-use government-academia-industry "research park" with high-tech lab space, shared instrumentation, access to students and administrative support. Measures of success include the creation of local jobs and the retention of graduate students in those jobs, as well as tax revenue generation, office/lab space occupation and community growth (Batalia, 2006).

2.1.3. The Revenue Model

In the Revenue Model, emphasis is placed on profitability, and office personnel work with selected faculty members to develop strategies for generating licenses and startup opportunities that will maximize the financial return to the institution. The university will often assist by making investments, which take the form of not only funds for filing patent applications, but also funds for prototype development, proof-of-concept studies, business plan development, outside consultants, and other needs. These TTOs strive to become profit centers within the university; however, the unpredictable nature of licensing revenue makes it difficult to project profits or losses. Measures of reward for a revenue model TTO include gross revenue, net revenue, equity cash flow and new industry-sponsored research partnership funds (Batalia, 2006). This revenue model is somewhat unique in that there is proof it works: regression analysis of the data from AUTM annual reports has confirmed that programs that make generating royalty income their top priority produce better financial results than TTOs that do not (Friedman and Siberman, 2003).

2.2. Organizational Models

Irrespective of how traditional TTOs balance priorities in its philosophical/mission model, TTOs also follow one or more of several traditional *organizational* models that relate to TTO's physical location, relationship with its institution, and work integration. (Figure 3).

2.2.1. Physical Plant Models

Many traditional TTOs have their own separate offices, but some also have satellite offices dedicated to specific schools or colleges (e.g. Harvard Medical School office or Michigan's Engineering Satellite office). Some TTO are co-located with the office of sponsored programs or the vice president for research (Rasor & Heller, 2006).

2.2.2. Operational Models

Furthermore, traditional TTOs in the U.S. vary in their operating structure. Many TTOs are part of the university, typically reporting to the research administration, e.g., Rutgers University, but some

Figure 3. TTOs differ in their operating structure, work integration model and segregation of duties structure.

TTO Organization Structure
Operational Models • reporting to the research administration • reporting to the financial administration • separate non-profit or for-profit units
Work Integration • vertical ("cradle to grave") • horizontal (licensing, business development, patent management, marketing units)
Segregation of Duties by Technology Field • life sciences, devices, digital technologies ect.

TTOs report to the financial administration, *e.g.*, Wake Forest University (Batalia, 2006). However, others operate as a separate non-profit or for-profit business unit or foundation, the oldest and most famous being the University of Wisconsin Research Foundation (WARF). A TTO that is separate from the university can offer operational and managerial advantages which include segregation of legal risk, more freedom from state bureaucracy, independent and timely decision making, flexibility in hiring and personnel management, collaborative decision making by board members having both academic and business backgrounds, clear financial profit-and-loss responsibilities, and independent accountability (MacWright, 2006).

2.2.3. Work Integration Models

Work tasks in a traditional TTO in the U.S. can be handled by staff that are either vertically or horizontally integrated. The choice between the two is largely dependent on the size of the office. Larger offices may further segregate tasks by technical field.

2.2.3.1. Vertical Integration

In this approach, individual licensing staff members handle an invention from the time it is disclosed until the patent expires (so-called "cradle to grave" case management). Many TTOs, especially smaller ones, divide the workload by giving each professional a portfolio with the responsibility to manage each technology from disclosure through triage, patenting, marketing, licensing, and even collecting royalties (Wheaton, 2006). This approach offers the advantage of centralized awareness and coordination with all major aspects related to a particular technology. Some professionals in the field believe that there is a value in maintaining continuity throughout the lifecycle of a project–e.g., knowledge gained after receiving and evaluating a disclosure may prove useful in licensing. In addition, such vertical work structure makes it easier for researchers to develop a collegial relationship with their TT officer. Moreover, it allows staff to have more opportunities for professional development, more opportunities to practice their profession through a broader range of activities, and can also provide more professional satisfaction by allowing staff to complete licenses for inventions they helped to evaluate and file patent applications. (Wheaton, 2006).

However, there are limitations to this approach. It requires the talents of very skilled individuals, with experience in processes ranging from invention disclosure though commercialization. The breadth and depth of these varied processes can leave little time for proactively promoting the technology (Allan, 2001). For this reason some universities using vertical integration also have task-specific personnel dedicated to marketing technologies to industry.

2.2.3.2. Horizontal Integration

For large universities and university systems, it is possible to use a horizontal work structure that encourages specialization. In this model, distinct but integrated groups of specialists are on staff, each focusing on a separate function such as licensing, business development, patent management, marketing, material transfer, or administration. The TTO at the University of California, Los Angeles (UCLA) is an example of such an organization (Neighbour, 2006). An interesting element of the UCLA program is the use of business development professionals to stimulate relationships with faculty in areas that are likely to produce potential solutions to market needs. Another example of horizontal organization has been used at the University of Washington, with distinct operational units handling invention licensing, digital ventures, policy and strategic initiatives, and finance and business operations (Severson, 2006).

2.2.3.3. Segregation of Duties by Technology Field

Some TTOs, typically at bigger universities or university systems, separate staff into operational units based on the type of research or disclosures they work with: life sciences, devices, physical sciences, or digital technologies (Rasor & Heller, 2006). Staff within each technology-based unit may then be organized vertically (cradle-to-grave), or horizontally (by sub-specialty).

2.3. Financial Models

Irrespective of the philosophical/mission model they have or the operational models they use, TTOs can be further distinguished by how they spend their funds on patent protection.

2.3.1. The "Business-Like" Model

For large TTOs and others with substantial budgets, investing in patents is often done on an ad hoc basis, where decisions on how much to invest in patenting given technologies are made on a case-by-case basis, much like a large company might make such decisions, depending upon the nature of the technology, its market potential and relative risk, with the costs of patenting being a secondary consideration (Chesbrough, 2007). The only point of departure from the way a company would make such decisions is that goodwill with the faculty inventors is also considered.

2.3.2. The "Protect it all" Model

Some U.S. universities with a primary mission of service to the faculty may lean towards this model, where they file patent applications on every invention, either provisional, regular or both. This is especially likely for smaller universities with fewer disclosures made by the faculty (Powers, 2010). While providing inventor satisfaction, the obvious disadvantage is wasting money on patents that do not have high chances of generating revenue. But if the number of inventions is small, this may not be an obstacle.

2.3.3. The "Pay As You Go" Model

Another approach some small offices use is a 'pay-as-you-go' approach, usually adopted when the funds for patenting are limited. They protect as many inventions as they can within their allotted funds, abandon those that don't generate commercial interest before downstream costs are incurred, and defer action on others for which funds aren't available (Rasor & Heller, 2006).

2.3.4. The "Just-In-Time" Model

Under this model, the goal is to find a licensee before the big money is spent on converting a provisional patent application to a Patent Cooperation Treaty (PCT) or regular U.S. application. This model is based on the fact that patents are expensive 'products', and making more 'products' than you can sell (license) is a waste of money (MacWright, 2007). This approach can be equated with the "just-in-time" manufacturing model used in business today: because of the cost of manufacturing, keeping a warehouse of products ties up money, and making products 'just-in-time" to be shipped to customer is far more economically efficient. The key to this model is to, whenever possible, negotiate a license or at least identify a willing licensee before spending money to convert a provisional application to a PCT or regular U.S. application, and plan for the licensee pick to up the cost of patenting (MacWright, 2007).

The University of Virginia Patent Foundation used this approach. If no potential licensee is found before the provisional conversion date, patenting is only considered if (a) industry has said they would be interested if there was more data to prove it works, (b) the inventors are still working on it, and (c) the inventors have funds to carry out the experiments industry wants done. Those inventions that pass this test are then ranked on the basis of potential market value, and those with the highest value are converted to PCT or US applications, depending on funds available at the time (MacWright, 2007).

III. Experimental Models

There are some recent TT models that diverge from the traditional approach. They appear to be works-in-progress, but show some interesting features.

3.1. The Research-Oriented Model

Michael Cohen advocates a research-oriented approach, in which the TT manager partners with the faculty inventor by making finding research sponsorship a priority, and not over-focusing on potential licensing revenue. The TT manager demonstrates respect for the insights and preferences of the faculty inventor, and collaborates with them in formulating the IP strategy (Cohen, 2010). Although many if not most TTOs treat the faculty inventor's wishes with respect, this model is characterized by a heavy primary emphasis on the faculty inventor's research interests, and a soft, secondary interest in licensing and revenues.

3.2. The Revenue Generation Model

3.2.1. Licensing-Focused

A brief review of any recent Association of University Technology Managers (AUTM) annual report reveals that some of the oldest and largest U.S. TTOs generate tens, even hundreds of millions in licensing income annually, e.g., MIT, Stanford University and Columbia University. These examples seem to make some academic leaders believe that if their TTO is less successful, they must be "using the wrong model." Combined with the effects of the current slow economy, more and more universities appear to be adopting more revenue-oriented approaches. Those institutions are hiring TT leadership that comes with extensive corporate experience, in attempt to promote higher revenue generation from increased licensing and start-up formation.

For instance, the University of Pittsburgh's TTO emphasized its function as a "business unit" in 2001. By 2006, they had increased licensing revenue by 300 percent, increased the number of license/option deals by more than 250 percent, increased the number of start-up companies, and increased the number of faculty disclosing inventions (Capelli, 2006).

A more recent example is Ohio State University (OSU), where deans traditionally encouraged publication or research rather than commercialization (Cohen, 2010). In 2006, OSU sought to change this by hiring TT and commercialization leaders who came with experience in start-ups and in the pharmaceutical industry. Upon joining the universities, these new leaders met with deans and serial inventors, evaluated financially successful TTOs and toured research parks, in order to identify the most efficient strategy to improve the revenue return at OSU. They concluded that OSU was not selective enough in evaluating technologies, and they adopted a new evaluation process that included review by of panel of internal subject-matter experts and external business advisors, to discuss and evaluate each new invention disclosure. OSU is also establishing an Office of Commercialization, which will be an umbrella organization that will house the TTO, a virtual Proof of Concept center, the Industry Liaison Office and the Center of Entrepreneurship. Top-ranked innovations will move directly to the POC center, where they will secure university support—whether through creation of a business plan, prototype development, or additional experimentations—to take them closer to commercialization. It is recognized that these changes will not bear fruit immediately. OSU is committing 10 years to the effort, with the goal of growing annual licensing revenue to $132 million in 2020 (for comparison, licensing revenue was $2 million in 2008) (Cohen, 2010b).

3.2.2. Entrepreneurism-Focused

Another example of a U.S. university focused on revenues is University of Utah, but rather than focusing on licensing income, they focus on revenues from start-up companies. They have reported creating over 60 university spinout companies in three years, a 94 percent spinout survival rate, and the lowest cost per spinout in the U.S. (Krueger, 2009). Krueger and colleagues say that several thing need to happen for success with this approach: (a) an increased focus on applied research, (b) an entrepreneurial organization that is proactive, accepts risk, is innovative, and acts on opportunities instead of avoiding threats, (c) a broad understanding that a new venture needs different kinds of advice, support and funding at different stages of development, and (d) entrepreneurial training across the entire ecosystem (Krueger, 2009).

University of Washington (UW) has also moved aggressively towards start-ups. Like OSU, UW brought in TT leaders that are "not academics but come with the for-profit, commercial background" (Huang, 2009). Today, UW makes an extensive effort to connect researchers with venture firms and technology companies at an early stage in commercialization. Meetings are held with researchers, technology specialists from industry, and venture capitalists, with a focus not on a "license coming out of it, but a relationship with a more pro-active and long-term approach." Interestingly, VCs are allowed to hold "office hours" on campus, during which researchers can come in and talk with the VCs about technology commercialization and start-up companies (Huang, 2009).

3.2.3. Which is Best, Licensing or Start-ups?

A study by Swamidass evaluated which is most effective for maximizing TTO income: licensing to established businesses or licensing to start-ups? For his evaluation, Swamidass chose to analyze data from Stanford University, a recognized TT leader. The analysis of Stanford's data showed that at least for Stanford, licenses to startups were 6.4 times more likely to bring in large incomes (over $500,000 per license) than licenses to non-startups (Swamidass, 2009). Thus, the authors suggest that fostering the creation of start-ups and nurturing them can enhance the overall financial effectiveness of TTOs.

Of course, fostering and nurturing start-ups is not so easy for some institutions as it seems to be for the big TTOs. O'Shea & Allen, using MIT as an example, identified key factors that could determine success or failure in the start-up arena: (a) the magnitude of the science and engineering resource base, (b) availability of industry funding for research, (c) quality of the faculty, (d) organizational quality (the TTO, entrepreneurship programs and inter-disciplinary research programs), (e) ability to effectively prioritize inventions and capacity to quantify market potential, (e) emphasis of TT in the university's mission, (f) an entrepreneurial culture and its history and traditions, and (g) a beneficial regional location (O'Shea & Allen, 2005). Arvids Zeidonis's work (e.g. Mowery et al., 2001) similarly shows clear patterns of where university spinouts proliferate. There are more spinouts where there are more experienced founders available, and where science and technology classes taught by faculty included a commercialization focus. There were also more spinouts where there was an obvious local/regional industry cluster for that technology. However, there were fewer spinouts where there was less access to complimentary corporate assets and complementary technologies and less access to critical resources such as financing (Mowery *et al.*, 2001).

3.3. The Mann Foundation Model

Some universities have recently weighed the 'pros' and 'cons' of a new approach to TT proposed by the Alfred E. Mann Foundation, in which the Foundation would create a new foundation called the Alfred Mann Institute, and provide it with a $100 million endowment; the annual proceeds from the endowment would then be invested in a select few technologies, using a heavily corporate approach to starting companies and developing their technologies (Blumenstyk, 2007). Stephen Dahms, Mann Foundation president and CEO, says, "Universities that license biomedical technology at the basic research/discovery stage are likely to receive 1 percent of the royalties the product is capable generating, if and when that product is ultimately commercialized." The Mann Foundation predicts that the likelihood of commercialization and rate of return can increase five-fold or more when manufacturing prototypes are completed by the university-based institute (Sequin, 2007).

The first Alfred Mann Institute at an American university began operation about five years ago at the University of Southern California (a private institution) (Blumenstyk, 2007). In October 2006, the Mann Foundation also signed a deal with the Techniom-Israel Institute of Technology in Haifa, in which the Foundation agreed to provide an outright gift that would eventually be worth $100 million, or to provide an alternative that would produce an equivalent amount of income (Blumenstyk, 2006).

But not all universities approached by the Mann Foundation have embraced this model. Several public and private universities have rejected the Mann Foundation's proposals, due to concerns that the Foundation was seeking too much control over universities' IP rights (Blumenstyk, 2007). Mann offered the University of North Carolina (UNC) $200 million, to establish a double-sized institute serving both UNC–Chapel Hill and North Carolina State University (NC State) in Raleigh. The gift would have been one of the 15 biggest ever made to a university (Whelan, 2006). However, UNC–Chapel Hill and NC State declined the Foundation's offer, as the universities didn't think giving the Institute the right to "cherry-pick" the most promising inventions made good business sense. The universities wanted the right to select which inventions would be sent to the Institute for possible development, but the Mann Foundation found that unacceptable. "If the university can pick and choose what they make available to us, it defeats the purpose," Mann said (Whelan, 2006). Robert Lowe, professor of entrepreneurship at Carnegie Mellon University, says universities don't want a single entity to have first rights to inventions because it can interfere with academic freedom and in some cases amount to a giveaway (Whelan, 2006).

Nevertheless, not all universities have agreed with this analysis, and Purdue University has received $100 million to endow an Alfred Mann Institute to enable the commercialization of innovative biomedical technologies that will improve human health. "Through Purdue's Alfred Mann Institute for Biomedical Development, we are participating in a new model of university technology transfer for a new century," said Purdue President Martin C. Jischke, "Our agreement states that preferential consideration will be given to Indiana companies wanting to license the university technologies that are further developed by the Alfred Mann Institute at Purdue" (Sequin, 2007). The Institute has a board of 10 directors, composed equally of Purdue and Mann Foundation representatives. Mann or his designee serves as chairman. The Institute will help identify approximately two new biomedical projects per year out of hundreds at Purdue with commercialization potential, with hope of growing to as many as six ongoing projects when in full operation. The institute is designed to add value through four key phases: intellectual property analysis and project selection, market analysis, product development, and developing an exit strategy. Royalties and financial returns for technologies returns were negotiated but not announced" (Sequin, 2007).

While this is an ongoing experiment, the results are yet to be seen. Given the long time frame for developing medical technologies, it may be a decade before we know how successful this model may be.

3.4. Alliances with Large Pharmaceutical Companies

In the current challenging economic environment an increasing number of pharmaceutical companies are approaching academic research institutions with offers of broad academic-biopharma collaborations aimed at improving the commercialization of early-stage research discoveries in a cost-effective manner (Morrison & Licking, 2010). Such companies include Pfizer, AstraZeneca, Johnson & Johnson, Merck and others. Few details are publically available about most of these relationships.

One example is Pfizer's Centers for Therapeutic Innovation (CTI) program, which is perhaps the largest such program, and its structure and operation is fairly well publicized (Cain, 2010). To date, Pfizer has established CTI programs in San Francisco, San Diego, New York City and Boston, each in partnership with leading institutions from one of those cities.

Pfizer is seeking projects that satisfy strict criteria: there must be a novel compound with the potential to be pushed into the clinic fast, and backed by highly motivated investigators (Cain, 2010). Pfizer will build and staff company "CTI laboratories" to be co-located with their partner academic medical centers (AMCs) in biotech hubs or science parks. The CTI laboratory staff will include Pfizer employees plus leading basic and translational science instigators and doctoral candidates from the AMCs. Postdoctoral fellows will be funded by Pfizer and will provide the core technical expertise for the projects. In addition to funding and space, faculty and post-docs will be given access to select Pfizer compound libraries, proprietary screening methods, and antibody development technologies (Pfizer Press Release, 2011). Pfizer will have the first option to license clinical leads produced through CTI-sponsored projects, while clinical leads that are not licenses by Pfizer may be licensed to third parties by the AMC or furthered through alternative means (Pfizer Press Release, 2011). Researchers retain publication rights, and a joint university/Pfizer steering committee will guide each project, to assure that the interests of both parties are advanced.

The University of California, San Francisco (UCSF) signed on as the first partner in Pfizer's CTI program in November 2010. UCSF can receive up to $85 million in research support and milestone payments over the course of the five-year partnership. A year later, in January 2011, Pfizer announced that seven major research-based medical centers in New York City, namely Rockefeller University, New York University Langone Medical Center, Memorial Sloan-Kettering Cancer Center, the Mount Sinai Medical Center, Columbia University Medical Center, Albert Einstein College of Medicine of Yeshiva University and Weill Cornell Medical College, had joined Pfizer's CTI program. Pfizer is committing up to $100 million in baseline funding to the New York CTI (Cain, 2010). Several months later Pfizer opened a CTI in Boston, Massachusetts and signed an agreement with Beth Israel Deaconess Medical Center, Boston University, Children's Hospital Boston, Harvard University, Partners HealthCare (the parent company of Massachusetts General, Brigham and Women's hospitals and several hospitals that are teaching affiliates of Harvard Medical School), Tufts Medical Center, Tufts University, and the University of Massachusetts Medical School (Johnson, 2011).

Similar to Pfizer's CTI initiative, but less of an institution-driven approach, is being used by London based GSK, which is launching an outreach program aiming to create up to ten relationships with individual researchers throughout the world. Somewhat similar to the Pfizer's approach, GSK will form a virtual project team with each of them, and like Pfizer, will provide the academic scientists with access to GSK resources. But GSK's approach is more modest and targeted, focused on individual scientists having specialized expertise (Ratner, 2011).

These academia-biopharma partnerships promise to benefit both academia and industry, as both groups recognize the need to accelerate translation of scientific discoveries into medical therapies. It remains to be seen if such partnerships will deliver on their promise.

3.5. TTO Collaboration Model

Another interesting experiment started in 2009, when the university of Pennsylvania and Arizona State University teamed up in a three-year experiment that will allow each to take advantage of the other's expertise in commercializing the inventions of their researchers. The two institutions have established a formal schedule that sets out how they will split income, depending on how much each university does for the other. While universities often work together on TT projects when faculty members' research collaborations produce jointly owned inventions, this kind of collaboration between two unrelated American universities is uncommon (Blumenstyk, 2009). If successful, it may offer an attractive alternative to the Kauffman proposal described below.

3.6. The Holistic Model

In September of 2009, University of North Carolina President Irskine Bowles reported on an extensive review of TT at the 17 institutions making up the UNC system, which relied heavily on outside business experts to evaluate and broaden UNC's approach to TT, in order to provide an institution-wide vision: "to move from a predominant mode of patenting, protecting, and complex negotiating for one-off revenues towards a more strategic, higher payoff technology development model focused on mentoring, partnership, and marketing" (Innovate, Collaborate, Accelerate, 2009). To develop and plan implementation of this new vision, three teams, comprised of university, private and public sector partners, closely examined UNC innovation and technology development efforts through the lenses of university culture, industry partnerships, and economic development (Innovate, Collaborate, Accelerate, 2009).

To implement this new vision, the teams recommended the following steps:

1. Identify unique strengths in research and IP at each UNC institution.
2. Seek to combine each institution's strengths in order to yield greater results.
3. Enhance support of entrepreneurial faculty, staff, and students.
4. Recognize entrepreneurship and technology development in promotion and tenure policies and through other reward and incentive programs for faculty, staff and students.
5. Pilot new marketing-focused and relationship-based staffing models for TT.
6. Create and disseminate UNC technology commercialization legal guidance documents and other aids to form a toolbox of resources to aid faculty, staff and partners in making negotiations simpler and faster.
7. Create an ecosystem, by linking the offices of technology transfer, sponsored research, development and other stakeholders, to trans form technology development from a peripheral activity to a central one.

The sweeping nature of this new model is enticing; however, a concern may be raised about lack of significant funds that were allocated for the implementation of the proposal. The report states that "campuses are encouraged to reprioritize and relocate resources," e.g. to implement the plan through re-deploying the existing funds and "arranging certain percentages of funds from sponsored research awards or industry-sponsored gifts and endowments" towards this end. Nonetheless, the report sets ambitious goals: "Within the year of 2010/2011 campuses should follow a goal of reaching a 10 percent increase in total sponsored research award dollars, a 20 percent increase in number of inventions disclosed, a 50 percent increase in number of relationships with industry partners, [and a] 50 percent decrease in time to agreement on licenses," among others (Innovate, Collaborate, Accelerate, 2009).

IV. Hypothetical Models

As universities have embraced TT as a core mission, there have been an increasing number of new and sweeping ideas, some of which have been radical and controversial.

4.1. The Kauffman Model

Analysts at the Ewing Marion Kauffman Foundation in 2010 made the radical proposal that faculty should be permitted to protect and license their inventions through independent agents or other university TTOs, rather than through their own institution's TTO. Kauffman's proposal argues that this would increase competition among TTOs, with the same benefits that competition provides in the commercial marketplace, while allowing universities to retain their royalty revenues. In a memorandum to the U.S. Department of Commerce, Kauffman stated that TTOs vary widely in their effectiveness and in the experience of their staff, and it is a disadvantage that faculty must disclose their inventions to their own TTO. Virtually all universities only use their own TTO to pursue licensing opportunities, and most TTOs do not have "the economies of scale to optimally commercialize faculty innovation" (Litan & Mitchell, 2009). They proposed a "straightforward solution to inefficiency of the technology licensing market," by giving faculty inventors much greater say in who will be the licensing agent for their innovation. "It bears emphasis that the right to choose an agent is and would remain independent of the ownership of the IP, which would remain with the university" while "the royalty sharing arrangements faculty-inventors may have with their universities [would be unchanged,] but [the proposal is to] simply and solely grant faculty-inventors greater freedom to choose the licensing agent" (Litan and Mitchell, 2009).

Kauffman's proposal has been widely criticized by TT professionals, who largely agree that feasibility of the practical implementation of the Kauffman's proposal is quite questionable. 2010 AUTM president Arundeep Pradhan noted that TTOs exist to ensure that results of research are translated into useful products that benefit society, and different organizations and research institutions differ, reflecting their local and regional needs, diverse cultures and priorities. He further argued that consolidation of TTOs or creation of a 'centralized office" would create an entity that is unlikely to reflect the wants and needs of individual institutional or regional needs (Pradhan, 2010). This argument is bolstered by the lack of success of centralized offices in the past, e.g., in the University of California system and at Ohio State University (Neighbour, 2006; Cohen, 2010b). Moreover, evidence shows that technology transfer works best when faculty has a strong, ongoing relationship with their university TTO, which becomes difficult when the office is located at a distance and serves broad inventor populations (Pradhan, 2010).

Powers and Campbell (Powers and Campbell, 2010) explain that "turning faculty into wild west entrepreneurs," as the Kauffman proposal would do, would be problematic for several reasons: (i) faculty that believe they have the next cure for cancer or tomorrow's Gatorade will confront greater conflict of interest forces from real or perceived "get rich" expectations, (ii) this will undermine campus collegiality, which is a building block of innovation, and would significantly undermine campus-based scientific collaborations, and (iii) makes the incorrect assumption that faculty know how or have the time to market inventions themselves, and that faculty are equipped to be effective independent agents for commercialization.

Others TT professionals argued that the Kauffman proposal would add another layer of bureaucracy to the TT process, including the need for agreements between the patent assignee and the licensing agent, which would add time to the technology transfer process; and that it would potentially reduce the inventor's share of royalties through management fees assessed by the licensing agent. Moreover, as many university inventions involve several faculty members and, increasingly, several institutions, this could pit co-inventors against each other as they strive to select a licensing agent (Pradhan, 2010). Additional arguments against Kauffman's proposal may include (i) interference with the TTO mission of providing education and counseling to faculty; (ii) challenges maintaining compliance with university policies and requirements of federal and state funding agencies, (iii) concern that the university's tax-exempt status and bond-financed facilities not be improperly leveraged or jeopardized by for-profit entities, (iv) concern that technologies leaving the state could erode state support for universities aimed at economic development; and (v) concerns that outside agents would not protect the interests of the university and its faculty inventors.

More recently, a panel organized by the National Research Council reviewed the Kauffman proposal and soundly rejected it. The panel said that Kauffman has not provided evidence that it would be more effective than the current system, and were such evidence to emerge, "other significant practical consequences and policy considerations would have to be considered, such as the potential for conflicts of interest and adverse effects on public accountability" (NCR Report). The panel further continues, "Arguments brought up by Kauffmann presume superior faculty knowledge of critical elements of the technology transfer process and stronger faculty incentives relative to those of technology transfer personnel."….[but] "[i]n general, faculty are neither trained nor expected to be knowledgeable about the complex array of economic and legal issues and technical matters that are involved in determining how an invention can best be licensed. In principle, the expertise of faculty and technology transfer personnel are somewhat complementary." "[W]hat is crucially missing from arguments for changing the current system, however, is any evidence of the degree how much faculty inventors would be motivated to commercialize their inventions if their institutions did not provide internal support in the form of hiring professional personnel and paying or securing payment of the cost of patenting and negotiating license. In the absence of such evidence, it is reasonable to presume that the incentive structure of the academic system, with its emphasis on building a scholarly reputation, weighs heavily on most research faculty as do the opportunity costs of time spent in other, often unfamiliar pursuits," concludes the NRC Report (NRC Report).

4.2. Inventor Ownership Model

The "teacher's privilege," under which faculty inventors own their own inventions and do with them as they please, was the dominant model in Europe for many years. In an effort led by former University of Georgia faculty inventor Renee Kaswan (*www.IPAdvcate.org*), it has been proposed that U.S. universities should relinquish invention ownership to their faculty inventors. The NCR review panel expressed "strong public policy reservations about any proposal to assign IP to inventors," due in part to (i) complications in maintaining compliance with the Bayh-Dole Act's requirement that a share of revenue be directed back to support research, which may be harder to monitor and achieve from individual inventors than from research institutions; (ii) potential difficulties with observance of good licensing practices; (iii) a concern that exercise of IP rights has the potential to create institutional or faculty member conflicts of interest and commitment; and (iv) a concern that since many inventions are the product of research collaboration, disagreements between faculty members or between faculty members and students about how to commercialize joint inventions could hobble their efforts

(NRC Report). The NRC report concluded, "[e]vidence for the assertion that an inventor ownership system would generate much more commercialization activity then the current structure is lacking" (NRC Report).

V. In Conclusion

Despite the passage of 30 years since the Bayh-Dole Act, most U.S. TTOs are still evolving, seeking to develop the most effective practices while adjusting to the dynamic environment and trying to meet increasing external expectations. Just like biological systems in nature, TTOs transition through phases of development, acquiring increasingly complex organization, policies and procedures. The business and academic environments are evolving, too, to which TTOs must also adapt.

The recent economic downturn has affected and shaped the natural evolution of academic TT in the U.S. TTOs are increasingly expected to become both drivers of economic development and sources of university funding, and this has attracted great attention to their performance, and has spawned great criticism of their shortcomings. This attention, wanted or not, is growing on a federal level as well as in local academic communities.

This increased attention is leading to more and more calls for a "better model' for TT. It is unlikely that there will be a model that will allow all TTOs to be all things to all people, and meet these intense new demands with ease. Nevertheless, the foregoing review of traditional, experimental and hypothetical TT models should help, in that it, at least for now, answers the question, "Where are we now, and where are we going?" Admittedly, this question is a moving target, and the evolution of the relatively new and exciting field of academic technology transfer will likely continue for a long time to come. ■

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