POLICY

Engineering Efficient Technology Transfer

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Academic and industry leaders strategize for efficient translation of university-driven biomedical engineering innovations.

In June 2011, the American Institute for Medical and Biological Engineering (AIMBE) hosted a workshop in Palo Alto, California, entitled *A Call to Action: Defining the Industry-Academic Relationships for Effective Technology Transfer in Medical and Biological Engineering* (*1*). The gathering attracted 80 participants, including academic and industry leaders engaged in medical and biological engineering research and development as well as U.S. government officials. Implicit in the charge of those gathered was to diagnose the obstacles of academic-industry technology transfer in the biomedical arena and to identify best practices that would hasten translation of innovations to the marketplace. Here, we briefly describe the history and current status of technology transfer and outline recommendations for creating a more efficient and effective process.

By definition, technology transfer is the process of transferring skills, knowledge, and technologies among governments, universities, and other institutions to private industry for market production and application. More succinctly, technology transfer is the process of converting scientific and technological advances into marketable goods or services.

HISTORY OF TECHNOLOGY TRANSFER

The passage of the Bayh-Dole Act of 1980 (*2*, *3*) was a watershed moment for innovation in the United States. This solitary piece of legislation modernized federal policy toward the transfer of technology, spawning an innovation revolution. In large part, the legislation released the protective grip of the federal government and allowed patents developed by federally funded research to be retained by private entities. This sizable but straightforward change in policy made immense breakthroughs in the fields of medical and biological engineering possible. The results are real and tangible. Thousands of new companies and jobs were created, involving the translation of life-saving therapies and technologies that have improved the quality of life for millions of Americans (*4*).

Yet, as successful as the Bayh-Dole Act has been, it was not a panacea. There still exists a lag in the flow of technology from the university laboratory to the industrial assembly line. This means that new innovations—the kinds that improve quality of life, reduce the cost of health care, and spur job growth—are left to rust on lab benches across the country. This vast loss of potential recently motivated the Obama Administration to author two Presidential Memoranda (*5*) that direct federal research agencies to streamline processes for the development of public-private research partnerships and university–startup company collaborations and the distribution of small-business research and development grants. The administration also gave federal agencies more flexibility to partner with industry and has directed these agencies to develop a 5-year strategic plan to track the number of patents generated by academic laboratories.

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However, as helpful as government action can be to reignite the transfer of technology, additional bottlenecks that lie outside the government's reach continue to stifle innovation. These problems require different solutions, and these solutions must encompass all phases of the technology transfer process.

The flow of technology transfer essentially begins in university laboratories, where research projects are executed and discoveries are made. Medical technology innovations that result from academic research are sent to a university's Office of Technology Transfer (OTT), to patent-protection offices, and ultimately to the corporate sector for development into products that benefit patients. Although most are familiar with this "bench to bedside" paradigm, the capturing of university innovation for technology transfer is not as linear as it seems. Distinct and fundamental differences exist between the missions of the research-oriented university faculty, the often overburdened technology transfer offices, and the profit-driven corporations. As a result, these differing goals create obstacles, conflicting expectations, and misunderstandings that stifle sustainable and enthusiastic partnerships and hinder the commercialization of ideas. Sometimes these obstacles stop ideas from reaching the market entirely.

Improving communication and understanding among the stakeholders in academia and industry was a focal point of the AIMBE workshop. It is not uncommon for academic faculty members who are engaged in research to be unaware of the potential commercial aspects of their work. Yet OTTs rely on these investigators to initiate contact with the corporate sector. Further exacerbating the process is the perception from industry that most OTTs simply "shop" technology to potential industry buyers, hoping to establish a connection. However, industry's reflected interests in interacting with universities go well beyond "buying" or even "shopping" for intellectual property (IP), as corporations often want to partner with individual researchers in the earlier, developmental stages of innovation research.

Effective communication early in the innovation process would benefit partnerships between universities and industry and prevent potential obstacles from arising. Some of the most significant roadblocks in negotiations between academia and industry occur during the process of valuation and discussions of IP ownership, indemnification, royalties, and conflicts of interest (COI). Often, negotiations can stagnate because academic representatives do not have enough information to appreciate the market factors that contribute to base IP valuation. For example, medical devices such as electrocardiograms encompass many individually patented components, including electrode probes, digital amplifiers, leads, and display monitors. Corporations that are responsible for product development must therefore possess the expertise to assess and produce these multiple-IP products. From the corporate perspective, proprietary issues restrict corporations from sharing information regarding risk mitigation and value assessment for given products and markets. Lack of knowledge on the university side coupled with the inability to share knowledge on the corporate side can make IP negotiations difficult.

Workshop participants from industry also expressed a desire for academic representatives to have an understanding of a com-

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pany's strategic financial plan and corporate missions. Companies are more willing to discuss potential projects and innovations that align with their strategic plans and market knowledge. A better understanding between academia and industry about constraints versus incentives would allow researchers to communicate with entrepreneurs and venture capitalists from a more business-oriented standpoint. The ability for an academic to understand the financial implications behind new technologies will lead to better communication between the parties, facilitating the establishment of partnerships that spark innovation.

A first step toward fostering communication and effective partnerships between industry and academic institutions would be to promote systematic interaction among industry personnel, scientists, engineers, clinicians, and a variety of trainees. Potential mechanisms for accomplishing this goal include discussion forums, symposia, or something as simple as informative lunches or receptions that include leaders in industry and academia. These discussions can be broadcast as Webcasts or Webinars and advertised on social media outlets to reach the largest audience possible. However, an essential element of this early communication is the creation of comprehensive research agreements that presume some IP might emerge at a later time. These agreements would reduce unnecessary barriers to relationship-building and are needed to educate all involved parties so that no COI or IP lines are unnecessarily crossed.

One of the most intriguing recommendations was that university-industry interactions would be better served if universities had a more systematic approach to industry relations. Virtually every university has an Office of Sponsored Programs (*6*), which is designed to handle all funded interactions with government agencies and foundations (Fig. 1). However, industry interactions with academia encompass a wide array of programs, which include early- to late-stage research, technology transfer, legal relationships for sponsored research, licensing agreements, startup ventures, workforce development, and advisory boards. Moreover, one or more of these interactions can derive from distinct schools or colleges within a given institution. Workshop participants thus supported the idea of having a single university office or point person responsible for these necessary and symbiotic interactions. One suggestion was to create an "Office of Industry Programs" within a university, also referred to as an "innovation entity," which could serve as a central point of contact for joining the industry and investment communities, technology transfer offices, and academic researchers. These innovation entities would guide projects through the complex relationships inside and outside the university. Adopting this systematic approach to technology is a best practice that can make building relationships with academia more inviting to industry.

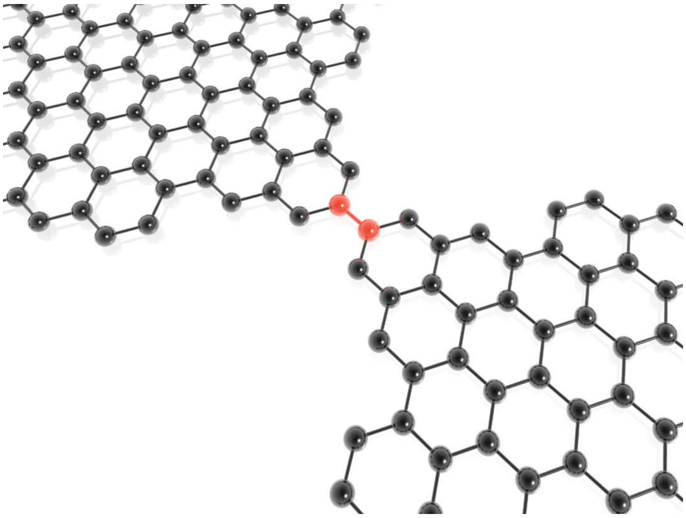

Fig. 1. Intricacies of innovation. Navigating the complex geometry of the technology transfer process can be tough. An "Office of Industry Programs" may help to mesh academic discoveries with industry's innovation strategies.

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An additional challenge central to improving relationships is the need to identify metrics of success for technology transfer at universities. A measurement system is needed that engages the entire academic institution holistically and not just the OTTs. Examples of hard metrics that could be used include clinical adoption or impact of IP on human health, eventual commercialization, return on investment, publications, licenses, formation of startup companies, impact on students, and creation of jobs.

In the same vein, additional and more qualitative measures may involve investigating the number of faculty educated about and in the innovation process. Universities need to be more cognizant of the breadth and depth of expertise of the personnel within their technology-transfer offices, especially with each individual's capacity to converse at an appropriate technical level with a corporate partner. This means that companies must have confidence that they can rapidly identify the appropriate technology-transfer personnel or university staff members with whom to substantively discuss the scientific, technical, and business issues for a potential innovation and how they relate to that company's strategic goals.

It was well recognized among workshop attendees that one size does not fit all for technology transfer, because various factors, including geography, state politics, and access to capital, affect OTTs. Nonetheless, extraordinary opportunities exist to improve the partnership of industry and academia. The best OTTs are those that see their role as removing obstacles to translation and innovation. In turn, industry needs to be aware of and willing to engage with universities that focus on technologies that are closely aligned with a company's strategic interests. If placed into practice, the aforementioned recommendations could go a long way in facilitating effective transfer of technology so that innovators can reach their ultimate goal—helping patients.

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10.1126/scitranslmed.3003004

Citation: K. Lutchen, J. Ayers, S. Gallagher, L. Abu-Taleb, Engineering efficient technology transfer. *Sci. Transl. Med.* **3**, 110cm32 (2011).

Science Translational Medicine

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Sci Transl Med **3**, 110cm32110cm32.
DOI: 10.1126/scitranslmed.3003004

Science Translational Medicine (ISSN 1946-6242) is published by the American Association for the Advancement of Science, 1200 New York Avenue NW, Washington, DC 20005. The title *Science Translational Medicine* is a registered trademark of AAAS.