



Technology Transfer and Commercialization Partnerships

EXECUTIVE SUMMARY

TECHNOLOGY TRANSFER AND COMMERCIALIZATION PARTNERSHIPS

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**This material is based upon work supported by
the National Science Foundation
under Grant No. EEC-0413603**



original work entitled:
**Exploration of Broader Academic Institution
Participation in PFI**
www.nsf.gov

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**October 2007
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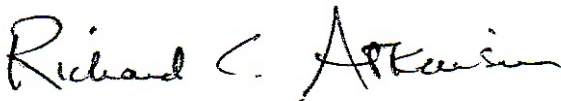
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FOREWORD

Although the idea that knowledge plays a dynamic role in the wealth of nations goes back at least several centuries, recent decades have brought an unprecedented array of opportunities for industry-university collaboration. The best-known exemplars of this collaboration—MIT and Route 28, and Stanford University and Silicon Valley—make clear the enormous potential for stimulating economic growth through the dissemination of scientific knowledge. It is not only the nation's top research universities, however, that have a responsibility to advance economic growth. Other kinds of institutions, from rural universities to community colleges, have their own special and productive contributions to make. This report is a call to recognize the tremendous value of these institutions and to help them become full partners in the application of knowledge for the public good.

Like Innovation Associates' previous reports, *Accelerating Economic Development through University Technology Transfer* and *Developing High-Tech Communities: San Diego*, this study emphasizes the importance of academic partnerships with corporations, federal and state governments, foundations, venture capitalists, and entrepreneurs as contributors, collaborators, and recipients of scientific discoveries. But while partnerships are indispensable, they cannot, by themselves, guarantee success. As these studies also point out, institutions and geographic regions vary greatly in their capacity to carry out technology transfer and commercialization. Wide disparities exist in the availability of resources for translating research results into new products and processes, sufficient seed money and early-stage capital, and the entrepreneurial and management skill to transform a promising startup into a successful business. Repairing the gaps in the commercialization process is a task that urgently needs more state and federal attention. The findings and recommendations of this report are an excellent place to begin.

During my tenure as director in the late 1970s, the National Science Foundation initiated the Industry/University Cooperative Research Program, a venture that was controversial at the time but now is standard practice. We sponsored a number of early analyses of the ways in which research and development spur the economy. And NSF conducted a series of policy studies that laid the groundwork for the 1980 Bayh-Dole Act, which encouraged technology transfer by assigning patent rights to universities. We know much more today than we did then about the problems and the opportunities of innovation. I am confident that NSF will lead the way in encouraging new initiatives to build on what we have learned and to involve academic institutions of all kinds in the enterprise of economic growth.



Richard C. Atkinson
President Emeritus, University of California

EXECUTIVE SUMMARY

Technology transfer and commercialization activities in universities are skyrocketing. In 10 years, academic institutions have nearly doubled the number of licenses executed and more than doubled the number of startups launched.¹ Academic-based innovations have spurred new business development, diversified and advanced existing businesses, and contributed to job growth and economic vitality. Commercialized innovations have contributed to the eradication of diseases, advanced information technology, and brought new products and processes to market in other areas that have contributed to the health and well being of citizens everywhere. Technology transfer and commercialization by their nature are partnership driven – they involve the university linking its research upstream in the innovation chain with corporations that license the university’s innovations and/or by launching startups based on those innovations. Today, there are about 200 U.S. universities and colleges that conduct some level of technology transfer.²

The Massachusetts Institute of Technology, Stanford University and other well-known institutions are technology transfer powerhouses, each producing about 200 licenses and about 20 new businesses every year based on university innovations. But other academic institutions are engaged in the development and transfer of innovations as well as contribute to the economic development of their regions and beyond. Despite geographic challenges and relatively modest research expenditures, universities such as Iowa State University, Brigham Young University, University of North Carolina at Charlotte and University of Akron have succeeded in licensing innovations and forming startups. In 2005, Iowa State University executed more licenses than any U.S. university except one, ranking well above universities that had research expenditures many times higher. In addition, the University of North Carolina at Charlotte and Brigham Young University, with annual research expenditures of only about \$25 million have launched between two and five startups annually.

Supported by a grant from the National Science Foundation’s Partnerships for Innovation (PFI) program, Innovation Associates (IA), with assistance from a National Advisory Committee, identified and examined academic exemplars. The Committee was composed of 16 national leaders in innovation, technology transfer, academia, and economic development. The exemplars selected successfully advanced innovation partnerships through technology transfer despite their modest research expenditures, rural locations and other challenges. The university exemplars were selected from institutions that ranked below the top 50 in research and development (R&D) expenditures by NSF,³ were recommended by Advisory Committee members, and met other criteria that included (but were not limited to) a top 10 ranking nationally, relative to research expenditures, in at least one technology transfer category such as patents filed, licenses executed, active licenses, and startups launched.⁴ We selected a variety of

¹ Calculated by Innovation Associates; data derived from FY 1996 AUTM Licensing Survey™ and FY 2005 AUTM Licensing Survey.™ The FY 1996 data represents 131 universities; FY 2005 data represents 158 universities.

² Estimated by the Association of University Technology Managers.®

³Source: Table 26. R&D expenditures at universities and colleges, by FY 2003 R&D expenditures: FY 1996–2003. NSF. (Latest available at the time of exemplar selection.)

⁴ Based on FY 2003 AUTM Licensing Survey.™ (Latest available at the time of exemplar selection.) Rank was derived by IA based on AUTM data (such as number of patent applications) per \$ thousand R&D expenditures.

examples that ranged from a major research university located in a rural area to a very small institution that specialized in a niche innovation field. IA/National Advisory Committee also selected one minority institution and one community college that exhibited exemplary innovation partnership qualities. The exemplars were

- Alfred University
- Brigham Young University
- Florida Agricultural and Mechanical University
- Iowa State University
- Montana State University
- Rensselaer Polytechnic Institute
- Springfield Technical Community College
- University of Akron
- University of Central Florida
- University of North Carolina at Charlotte

This report is the first to provide a detailed description of academic institutions that are emerging; these institutions have been successful in technology transfer and commercialization even though they lack the substantial R&D funding and other factors normally associated with high-performing institutions. The research builds on previous findings on technology transfer in major research universities described in *Accelerating Economic Development through University Technology Transfer*.⁵

LESSONS AND RECOMMENDATIONS

IA found that successful technology transfer was not dependent on any one factor but instead on the confluence of multiple factors inside and outside the academic institution. Technology transfer and commercialization are as much an art as a science, and personal relations between technology transfer agents and faculty, corporate licensees, and business and investment communities were key to successful efforts. In most exemplars, the university president showed leadership and commitment to technology transfer, and it was actively embraced by deans and department chairs. These academic leaders set the tone and instituted incentives to create an academic culture that rewarded technology transfer and entrepreneurship. Their commitment often stemmed from the institution's broader mission to disseminate knowledge and innovation, and sometimes was part of the institution's engagement in economic development.

Exemplars demonstrated an understanding that excellent technology transfer is built on excellent research. Several exemplars identified their institution's core research strengths and developed strategies to build on those research strengths. Some academic institutions such as Alfred University and the University of Akron focused on specific research niches, hired known faculty in these areas, and worked in partnership with local industries to attract research funding. Several of the exemplars aggressively sought and received federal funding, which was critical to building their core research areas. Institutions such as Alfred University and Rensselaer

⁵ Diane Palminteri, *Accelerating Economic Development through University Technology Transfer*, Innovation Associates, 2005. (To download go to www.InnovationAssociates.us)

Polytechnic Institute also benefited from state funds that supported collaborative research centers, and used these state monies to leverage federal funds.⁶

Many of the successful academic institutions had a history of working with corporations in their community and state. For example, Iowa State University had long-established relationships with the agricultural sector, and the University of Akron had a history of success in working with chemical and polymer industries. The Universities' service to those industries through various outreach, extension services and research partnerships developed personal, trusted relationships that paid off later in successful technology transfer outcomes. Moreover, these institutions emulated other successful research universities by focusing more on building strong corporate and entrepreneurial relationships and less on immediate technology transfer outcomes. The institutions' leaders recognized that the benefits of entrepreneur, corporate and foundation contributions and sponsored research were often far greater than the potential royalty income earned from technology licenses. As a result, several of these institutions such as Rensselaer Polytechnic Institute have received substantial financial donations from successful entrepreneurs and others associated with the institution.

An important element in launching startups based on academic research was the presence of entrepreneurial resources, including seed capital and incubation, and the linkages between technology transfer activities and these resources. This was especially true for institutions located in rural and other areas with few entrepreneurs and little investment capital. Rensselaer Polytechnic Institute, for example, developed one of the nation's earliest incubators and research parks in order to fill a gap that existed in the traditional industrial community in which the Institute was located; Iowa State University also created incubation space and a research park to help retain spin-offs in the University's rural community. In most cases, state and community support were essential in establishing and maintaining entrepreneurial infrastructure and services at or around academic institutions.

The findings from case studies on exemplars form the basis for recommendations provided here. In addition, many members of the National Advisory Committee provided input to the recommendations, particularly the recommendations directed to national policy makers. We provide recommendations for three groups: (a) national policy makers, (b) academic leaders, and (c) state and local government, organizations and policy makers. These recommendations are more fully described under "Lessons and Recommendations" in Part I of the report.

Recommendations for National Policy Makers

- Provide additional funding for partnership-related programs, particularly PFI and I/UCRCs.
- Create and fund new initiatives to bridge the "valley of death."
- Provide technology transfer and commercialization education and mentoring for emerging academic institutions.

⁶ Reference is to state Centers for Advanced Technology funded by the New York Office of Science, Technology and Academic Research.

- Assess and address technology transfer from a corporate perspective.
- Promote regional R&D partnerships.
- Develop metrics that effectively capture the value of innovation-related activities.
- Create a clearinghouse for technology transfer data and best practices and actively disseminate information.
- Review programs government-wide that support small technology enterprises.
- Recognize that innovation involves advancing science and technology at various levels, by multiple means and through a wide range of academic institutions.

Recommendations for Academic Leaders

Building the Innovation Pipeline

- Focus on building excellent research and leveraging research strengths.
- Target and build niche research areas, particularly in institutions with limited research funding.
- Aggressively pursue federal funds to support research strengths, and leverage state and corporate funding to attract federal funds.
- Build research strengths in space dominated by local industries.
- Create research centers that involve industry members and form flexible and strong informal as well as formal relationships.
- Tap corporations, foundations and successful entrepreneurs to build research capacity and entrepreneurial programs.

Promoting Technology Transfer

- Set a tone that supports a technology transfer culture.
- Raise technology transfer to a higher level and promote excellence.
- Focus on building industry partnerships to achieve long-term benefits rather than short-term “pay-offs.”
- Build flexibility and responsiveness into technology transfer programs.

- Make a commitment to economic development.
- Focus on launching startups as part of the institution's technology transfer and economic development commitments.

Fostering Entrepreneurship to Support Commercialization

- Build entrepreneurial resources in academic institutions, and link technology transfer activities to those resources.
- Increase linkages with sources of investment capital for startups.
- Build networking opportunities.

Building Credibility and Awareness

- Capture the results from technology transfer and other industry partnerships.
- Publicize technology transfer successes.
- Educate state policy makers on the value of technology transfer and industry research partnerships.
- Educate federal policy makers.

Recommendations for State and Local Governments, Organizations and Policy Makers

Promoting R&D Funding, Collaboration and Technology Transfer

- Promote research, collaboration, technology transfer and enterprise development at the highest level.
- Work with academic institutions to identify core research competencies.
- Provide state funding for targeted R&D in academic institutions.
- Encourage industry-university R&D collaboration by funding cooperative grants and research centers, and implementing tax incentives.

Building an Entrepreneurial Environment

- Develop/enhance regional infrastructure and services to capture and retain startups from academic institutions.
- Build investment and networking opportunities.

- Educate academic institutions about local/state entrepreneurial resources and coordinate the resources with those at academic institutions.
- Develop programs and work with academic institutions to improve Small Business Innovation Research and Small Technology Transfer Research awards.

Promoting Academic Institutions as Economic Assets

- Work with corporations and foundations to encourage sponsorship and participation in academic-based R&D, technology transfer and entrepreneurial development.
- Market academic institutions as community/state economic assets.
- Encourage university leaders to become fully engaged in economic development.
- Help academic institutions evaluate their impact on local and state economies and present the outcomes to policy makers.

Although these recommendations cut across different types of academic institutions, some recommendations are more important for those institutions challenged because of location, modest research funding and other factors that make it more difficult for them to transfer technologies. For example, it is especially important for modestly funded institutions to focus on building niche research areas. In addition, academic institutions located in rural or traditional industry areas often have fewer entrepreneurial and investment resources available to them, and therefore have a greater need to develop internal resources and pro-actively seek linkages with external resources. These resources usually involve state and federal government support for entrepreneurial infrastructure and services, and incentives to stimulate and attract early-stage capital. Moreover, emerging institutions often must provide more aggressive technology transfer and entrepreneurial incentives to build an innovation and entrepreneurial environment.

OUTSTANDING ISSUES

Technology transfer and commercialization are part of an innovation continuum that starts with basic research and ends with the introduction of a product, process or service in the marketplace. It exists as part of a larger, dynamic “ecosystem” that involves many factors including culture, environment, and processes that affect its optimization. In that context, we briefly discuss three outstanding issues that affect the ability of academic institutions to achieve successful technology transfer and commercialization.

Commercialization and the “Valley-of-Death”

The most pervasive issue that impedes commercialization of academic-based innovations is commonly referred to as the “valley-of-death.”⁷ There are many factors that contribute to the valley and these factors differ somewhat depending upon whether an academic institution

⁷ For our purposes here, we describe the valley of death as the gap between later stage, academic-based innovations and the commercial application of those innovations in the market place.

transfers an innovation by licensing it to an established corporation or by launching a startup. If an innovation is launched through a startup, investment capital particularly seed and early-stage capital is often a key factor in the ability of the startup to commercialize the university-based innovation. Other factors involve building sufficient business and management capacity. If institutions that launch startups are located in areas with few entrepreneurs and venture capitalists, these obstacles to commercialization become even greater. Whether a university-based innovation is licensed to an existing corporation or transferred by launching a startup, major commercialization impediments also often revolve around the innovation's early developmental stage and lack of direct and immediate applicability for commercial use.

The federal government spends about \$141 billion per year in R&D and invests almost \$30 billion of that amount in academic R&D.⁸ But it devotes an insignificant amount to the technology transfer and commercialization of the research, and the partnerships that facilitate it. The "commercialization side" of research has been the missing link in the pipeline that moves innovation from research to the marketplace. NSF and national policy makers should not only be concerned about expanding the research pipeline but also accelerating the research through it. In response, we have recommended that national policy makers address the "commercialization side" of technology transfer by exploring options to bridge the valley-of-death and implement pilot projects to test promising options.

Involvement of Minority Institutions and Colleges

Discussions on innovation, technology transfer and commercialization rarely involve minority institutions, non-research intensive institutions, and community colleges. These institutions have a role in innovation, and greater partnerships between research universities and colleges are called for to address the full spectrum of innovation and innovation dissemination. In addition, minority institutions often are challenged in technology transfer and entrepreneurial development because of limited funding, a lack of attention by top administrators, and limited experience. In order to address some of these weaknesses, we have recommended that academic institutions successful in technology transfer educate and mentor minority and other emerging institutions.

Technology Transfer Effects on Industry-University Relations

An increasingly common concern being voiced by university research directors is that corporations are more hesitant to engage in research partnerships because of more stringent university protection of their intellectual property. Although we do not have empirical evidence to support their contentions, some research directors believe that increasing pressure to formalize technology transfer agreements early in the research process has led to decreasing sponsored research. In response to these concerns, we have recommended that NSF or other appropriate entity more thoroughly assess the effect of technology transfer practices from a corporate as well

⁸ \$141 billion is a FY 2007 estimate by the American Association for the Advancement of Science (AAAS) based on final FY 2007 appropriations (P.L. 110-5); Table I-4. Major Functional Categories of R&D, AAAS R&D FY 2008. AAAS. Source for federal government funding of academic R&D: Table 31. R&D expenditures at universities and colleges, ranked by all R&D expenditures for the first 200 institutions, by source of funds: FY 2005. NSF.

as academic perspective, with the intent of developing practices that optimize industry-university R&D relations as well as protecting the university's intellectual property rights.

CONCLUSIONS

In conclusion, the nation is experiencing rapidly expanding academic-based, technology transfer and commercialization. This growth has been fueled by expanding federal research funding, facilitated by relationships between academic institutions and corporations, and promoted by academic leadership. The benefits derived from technology transfer include greater academic attraction of top, entrepreneurial-minded faculty and students, return on investments from successful entrepreneurs and corporations that “give back” to the institution, long-term improvement of the institution's entrepreneurial and economic environment, and fulfillment of the institution's mission to disseminate knowledge and innovation.

Academic institutions that have modest research funding face different challenges than those with greater funding. We have addressed some of the ways in which universities with modest research expenditures can achieve technology transfer results; that is, by (a) promoting a technology transfer and entrepreneurial culture, (b) identifying and focusing on research niches, (c) working with states and local industries to leverage industry-university strengths, (d) pursuing federal research funding, (e) implementing hiring and promotion policies that reward technology transfer and entrepreneurship, and (f) creating and linking entrepreneurial resources to technology transfer activities in order to effectively launch startups.

An implicit, overriding theme in this report involves more broadly defining innovation and expanding the view of innovation players. Innovation is not only high-tech – it encompasses many types of R&D and related activities, at many levels and in different types of academic institutions. In addition, technology transfer has increasingly become defined as the protection of intellectual property. But more broadly defined, technology transfer involves informal as well as formal relationships, services, and exchanges that mutually benefit each party.

Academic institutions challenged because of limited research expenditures and location can be successful in technology transfer, and investors and corporate customers would do well to include a broader spectrum of institutions when seeking new innovations for licensing and development. We encourage academic leaders to engage in all aspects of technology transfer and commercialization, and policy makers to provide the support and incentives needed to bridge current gaps, thus encouraging a greater number and variety of institutions to participate and benefit.

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